Original Research

SAGE Open
January-March 2022: 1–16

DOI: 10.1177/21582440221079903
journals.sagepub.com/home/sgo
SAGE

Joint Distribution Promotion by Interactive Factor Analysis using an Interpretive Structural Modeling Approach

Fuli Zhou[1], Yandong He[2], Felix T. S. Chan[3], Panpan Ma[4], and Francesco Schiavone[5,6]

Abstract

With the increasing demand of individual customption and awareness of cost reduction in express delivery organizations, the Chinese express industry faced with serious challenges especially under the background of government's strict restrictions on environment and transportation. Therefore, a new service mode called joint distruction (JD) is being tried by the logistics industry, which is expected to address the challenges on online shopping. However, the insufficient understanding of JD adoption factors and their complicated interactions blocks the effectively implementation of the joint distribution. This study aims at identifying potential factors for JD adoption and promoting an effective joint distribution by discovering the interactive relationships among addressed factors. Firstly, potential ingredients for the adoption and implementation of JD are summarized from the literature and industrial interviews. Then, 23 variables are selected and classified into as objectives, drivers, barriers and affected operations. The Interpretive Structural Modeling (ISM) approach is then employed to analyze the crucial factors and the mutual influences amongst 23 variables. Finally, a case study is performed to construct the hierarchical structure of factors toward joint distribution adoption using the proposed ISM-modeling steps. The perplex hierarchical co-relationships are also identified by categorizing the driving variables and dependent variables. Results can assist express enterprises to promote the novel joint distribution mode and acheive higher efficiency of logistics operation by better understanding on crucial factors of JD adoption and implementation.

Keywords

joint distribution, express logistics, interactive factor analysis, interpretive structural modeling

Introduction

With the evolution of rapid globlization and increasing internet popularization in China, online shopping shows an increasingly prevailing tendency, where oline retail sales had grew with 433.4% and reached 50 billion in 2020 (He, Zhou, et al., 2020). The rapid development and booming of e-commerce industry has brought great opportunities to the Chinese express service and transportation industry (Wang et al., 2020). The increasing online shopping product covers from consumption goods to creative service. The logistics link is a critical segment of online shopping, and it has become the main issue of online shopping industry since the long waiting time comparing with business flow and information exchange (Bask et al., 2012; Zhou, He, et al., 2020). With the soaring scale of e-commerce industry and increasing internet users, the rapid growth of online shopping industry is bringing serious challenges to Chinese express enterprises. For instance, express organizations are facing increasing cost pressures, as well as the diversified customer

[1]Industry & Innovation Research Center, and Business Logistics Research Center of Yellow River Basin, College of Economics and Management, Zhengzhou University of Light Industry, Zhengzhou, China
[2]Shenzhen Zhongsheng Intelligent Technology Co., Ltd, Shenzhen, China
[3]Department of Industrial and Systems Engineering, The Hong Kong Polytechnic University, Hung Hom, Hong Kong
[4]College of Computer and Communication Engineering, Zhengzhou University of Light Industry, Zhengzhou, China
[5]Department of Management Studies & Quantitative Methods, Parthenope University of Naples, Naples, Italy
[6]Department of Strategy and Management, Paris School of Business, Paris, Île-de-France, France

Corresponding Authors:
Fuli Zhou, Industry & Innovation Research Center, and Business Logistics Research Center of Yellow River Basin, College of Economics and Management, Zhengzhou University of Light Industry, No. 136, Kexue Avenue, Zhengzhou 450002, China.
Email: deepbreath329@outlook.com

Yandong He, Shenzhen Zhongsheng Intelligent Technology Co., Ltd, No. 6, Lanqing 1st Road, Luhu community, Guanhu street, Longhua District, Shenzhen, China.
Email: ydhe602@163.com

demands. In addition, the express industry is regulated by governmental departments regarding logistics-related regulations and environmental principles (He et al., 2016; Yu et al., 2014). However, the optimizaiton philosophy under traditional distribution mode limits the innovation practices of modern logistics, especially for the massive express delivery volume under e-commerce logistics scenario. To promote the development of online shopping logistics, the synergetic distribution mode is proposed to deal with the online shoping logistics by NUDDG (National Urban Distribution Development Guidelines) in 2013 (He, Zhou, et al., 2020). In the next year, the couple of objectives in terms of cooperative opration preformance for logistics organizations are launched to improve performance of online shopping logistics by National State Council of China (Zhou, He, et al., 2019). A novel logistics service modes is proposed by academic experts for online shopping, namely joint distribution (JD), and practical solutions are explored to put it into industrial practice by industrial practitioners (Ge et al., 2013; He et al., 2016). Joint distribution (JD) is defined as a novel logistics distribution by many enterprise participants in certain area, aiming at improving efficiency of logistics and resources integration. Driven by the win-win principle, the JD can be acheived by sharing logistics resources and designed profit allocation mechanism (He, Zhou, et al., 2020; Liu et al., 2020). JD is a concept at the organizational level, playing a significant role on reducing the logistics costs, improving the utilization of logistics resources, facilitating environmental performance, easing congestion, improving the logistics efficiency, and satisfying the personalized requirements of terminal customers in Chinese express enterprises for online shopping sector (He et al., 2016; Su et al., 2018; Sun et al., 2015; Wei & Sun, 2015). Theoretically speaking, the joint distribution will be regarded as an innovative distribution mode to assist achieve the distribution cost reduction and better service providing, comparing with other industrial applications in last mile delivery (He, Zhou, et al., 2020; Wang et al., 2019; Yuen et al., 2019). Based on the definition and theoretical philosophy of this innovative distribution mode, the JD can be performed by all involved participants, including logistics service providers, e-commerce organizations, and express logistics enterprises, which aims at achieving service efficiency improvement and environmentally friendly promotion by resource integration, business collaboration and information sharing (He, Zhou, et al., 2020; Zhou, Lim, et al., 2019). In addition, the development of logistics infrastructure and operational experience motivate to the novel distribution mode adoption (He, Zhou, et al., 2020; Wang et al., 2020).

The joint distribution concept has been put forward, and the theoretical models have been studied by many academic researchers (Wang et al., 2019; Yao, 2016a; Yuen et al., 2018; Zhou et al., 2018). The efficient implementation of JD mode assists to achieve the sustainable development by effective resource integration (He et al., 2017; He, Zhou, et al., 2020; Zhou, He, et al., 2019; Zhou, Wang, et al., 2019). In addition, the National Urban Distribution Development Guidelines (NUDDG) also encourages industrial organizations to perform this novel distribution mode with a better efficient logistics service. However, JD is still an emerging concept in the Chinese express industry for online shopping, and it is difficult to adopt JD especially in the Chinese express industry in practical industries (He, Zhou, et al., 2020). Due to the regulative and organizational boundaries among different organizations, the JD mode fails to apply into the industrial sector, especially for small-and-medium enterprises (SMEs).

For every express enterprise, such as objectives, drivers and barriers to adopting JD and affecting operations are extremely important (He, Zhou, et al., 2020; Liu et al., 2020). The reason why the industrial sector fails to perform JD mode is that it is not familiar to recogize these complex factors. Besides, it is also difficult for industrial managers to figure out the complicated interactions among these influentail variables. The interpretive structual modeling (ISM) approach, firstly propsoed by Warfield in 1974, enables industrial managers to understand the perplex interrelated factors of the complex system (Hsu et al., 2015; Zhou, Lim, et al., 2019). The ISM method provides a better understaning on the interpretive definition or term through constructing a structural hierarchy with multiple levels. It not only assists industrial managers to probe into the factor analysis, but also could improve the management performance. The ISM approach has been widely used to improve management performance in manufacutring and logistics sectors (Agrawal et al., 2020; Awan et al., 2018; Lim et al., 2017; Raj et al., 2008; Sarhan et al., 2019; Wan & Jones, 2013; Wu et al., 2012; Xu & Zou, 2020; Zhou, Lim, et al., 2019). The recent industrial practice contributions on the ISM approach and its applications are summed up in Table 1.

From the Table 1, the ISM approach has been proved to study the complicated interrelated factors of the industrial system. The better understanding on complex interactions of JD adoption factors will assist to identify the cruical barriers of JD adoption, contributing to JD implementation for industrial plants. Therefore, it is necessary to probe into mutual correlations among these factors and develop a framework for JD adoption in the Chinese express industry.

This research attempts to answer the following questions: (1) What are the potential factors influencing joint distribution adoption in Chinese market; (2) What are the main drivers and barriers of JD adoption, as well as complicated interactions among these potential factors? To the best of our knowledge, this study first tries to develop a hierarchy model by identifying the complex factors of JD adoption. Specifically, this research aims at identifying influenctial factors on joint distribution adoption, and tries to explore the interactative relationship among these ingredients. To promote JD adoption and improve mangement performance of logistics distribution business, this study employes an ISM approach to identify the interractive factors of JD

Table 1. ISM Applications of Industrial Scenarios in China.

No.	Author	Industrial application of ISM method
1	Shen et al. (2016)	Factor analysis of implementing Emission Trading System
2	Gao et al. (2015)	Root-cause analysis for alarm flood
3	Hsu et al. (2015)	Identify critical drivers affecting university technology transfer
4	Xu and Zou (2020)	Factors affecting building energy performance identification
5	Ai et al. (2014)	Identify the hierarchical structure of accident factors
6	Wan and Jones (2013)	Risk factors affecting the information technology service management project
7	Singh et al. (2020)	Influential factors of supply chain flexibility in the personal hygiene industry
8	Singh and Bhanot (2020)	Barrier analysis of IoT implementation in manufacturing industry
9	Wu et al. (2012)	Identify the major factors affecting wind power construction project
10	Sarhan et al. (2019)	Strategic lean construction implementation in Saudi construction industry
11	Rana et al. (2019)	Barrier exploring of e-commerce adoption in UK
12	Raj et al. (2008)	Drivers identification of flexible manufacturing system in India
13	Patri and Suresh (2017)	Factor analysis affecting lean implementation of healthcare industry
14	Babu et al. (2020)	Risk factor analysis in Indian manufacturing supply chain
15	Ali et al. (2020)	Barrier analysis of lean six sigma implementation
16	Awan et al. (2018)	Influential factors on social sustainability achievement in manufacturing firms
17	Zhou, Lim, et al. (2019)	Barrier analysis for ELV recycling promotion

implementation under the online shopping scenario in China. This is the first systematic study to identify the dominant variables and investigate the mutual relationship among the recommended variablers for adopting JD in China using the ISM approach. The better understanding on the factors' interaction will assist industrial managers to perform JD implementation and innovative management practices.

The reminder of this research is organized as follows. Section 2 presents a literature review on the concept and applications of JD, as well as the factors are identified for JD adoption in terms of express industry. The solution methodology is proposed and illustrated in Section 3. Subsequently, the questionnaire development for the study is designed and described. Section 5 presents the industrial application using the developed interpretive structural modeling (ISM) approach. Findings and results are given in Section 6 from the investigated case, and finally conclusions are drawn.

Literature Review

Background of Joint Distribution in Express Industry

With the development of e-commerce industry, there are many innovative concepts, models and industrial practices being proposed and applied by academics and practitioners. Lan and Zhang (2003) argued that the economies of scale could be achieved by the dispersed logistics resource integration relying on the rapid-processing information technology and the integration of gathering customers. Much evidence shows that the effective collaboration among different logistics agents has proven to be efficient to improve logistics operations in many industries (Guajardo & Rönnqvist, 2015; Su et al., 2021). With the increasing of operational cost in the Chinese express industry for online shopping during the past ten years, JD (or called collaborative distribution) is proposed and introduced as an effective and efficient express logistics service mode in China (He et al., 2016; Yao, 2015).

In China, express logistics is an emerging trend and it is also one of the most rapid developing industries motivated by the booming of e-commerce industry. JD mode brings much benefits to express enterprises, for instance, the distribution cost reduction by the logistics resources integration and express delivery business innovation, alleviating environmental emission and traffic pressure (Ge et al., 2013; He et al., 2016; Hu & Qiang, 2013; Yao, 2015, 2016b). However, the implementation situation is not as good as expected in the Chinese express industry, and this novel distribution mode has not been taken into practice, especially for those small-and-medium enterprises (SMEs). To promote the JD adoption and achieve better performance, it is necessary to identify the mutual correlation among influential factors for JD adoption in the Chinese express industry. According to Borade and Bansod (2012), these factors are calssified into objective items, barriers, drivers and affected operations.

Objectives and Drivers of JD Adoption

Researchers also had various opinions about the objectives and strategic drivers for JD adoption. Zhang (2013) suggested that the primary objective of JD was to configure the resources in advance by forecasting express demand accurately, thereby improving logistics efficiency through resources integration and deployment. Wei and Sun (2015) believed that JD could serve more customers for small-and-medium enterprises (SMEs). However, with the increasing globalization of online shopping, large

Table 2. Objectives, Strategic Drivers, Barriers and Affected Operations for JD Adoption.

Type	Items	Reference sources
Objectives	Improving profit (OB1)	Wright et al. (2010); Schmoltzi and Wallenburg (2011); Schmoltzi and Wallenburg (2012);
	Improving service quality (OB2)	Ge et al. (2013); Zhou, Wang, et al. (2019); Zhou et al. (2021)
	Scheduling resources in advance (OB3)	Ge et al. (2013); Zhang (2013); Zhou, He, et al. (2019); Zhou, Ma, et al. (2020);
	Improving logistics efficiency (OB4)	Ge et al. (2013); Guajardo and Rönnqvist (2015) ; Yao (2015)
	Improving coverage rate of the network (OB5)	He et al. (2016); He et al. (2020); Zhou et al. (2018)
Strategic drivers	Competition (SD1)	Bask et al. (2012); Montoya-Torres et al. (2016); Sun et al. (2015)
	Globalization of online shopping (SD2)	He et al. (2016); Yu et al. (2014)
	Higher operation cost (SD3)	Guajardo and Rönnqvist (2015); Louwerse et al. (2014); Montoya-Torres et al. (2016); Sun et al. (2015)
	Personalized customer demands (SD4)	Yao (2015); Zhou et al. (2016); Zhou et al. (2018); Zhou, Lim, et al. (2019)
Barriers	Problem in sharing infromation (B1)	Closs and Savitskie (2003); Evangelista et al. (2013); Hartmann and Grahl (2011); Lan and Zhang (2003); Niesten and Jolink (2015); Nyaga et al. (2010); Zacharia et al. (2011)
	Lack of trust between partners (B2)	Hofenk et al. (2011); Niesten and Jolink (2015); Nyaga et al. (2010)
	Irrational distribution of benefits (B3)	Krajewska et al. (2008); Schmoltzi and Wallenburg (2011); Wang et al. (2015); Wright et al. (2010)
	Leakage of business secret (B4)	He et al. (2016); Hou et al. (2015)
	Internal/external integration (B5)	Gimenez and Ventura (2005); Sharma and Choudhury (2014); Yao (2017)
	Lack of logistics industry standards (B6)	Our contributed barrier
	Low level of management (B7)	Albers and Brekalo (2016); Brekalo et al. (2013); Wan and Jones (2013); Zhou, He, et al. (2020)
	Problem in cost-sharing (B8)	Albers and Brekalo (2016); Sun et al. (2015)
	Lack of top management involvement (B9)	Albers and Brekalo (2016); Brekalo et al. (2013); Zhou, He, et al. (2020)
	Lack of understanding of the JD value (B10)	Our contributed factors
Affected operations	Business process (AO1)	Our contributed factors
	Forecasting (AO2)	Schmoltzi and Wallenburg (2011); Schmoltzi and Wallenburg (2012); Zhang (2013)
	Transportation plan (AO3)	Krajewska et al. (2008); Zhang (2013); Zhou et al. (2016); Zhou, Wang, et al. (2017)
	Sorting plan (AO4)	Zhang (2013); Zhou et al. (2016); Zhou et al. (2017); Zhou, Ma, et al. (2020)

enterprises have to unite with one another to improve their coverage rate of the delivery network through JD mode adoption. Wang et al. (2015) argued that the purpose of JD was to improve profits for express enterprises no matter which service mode they adopt.

Research on JD shows that cost reduction is one of the most important drivers. According to the statistical report of the China National Post Office, the growth rate of business income is less than that of business volume, from 2008 to 2015, and the average price per unit continues to decline in 2015 (He, Zhou, et al., 2020).

Similar to the shipping transportation, the shipment resourses are usually integrated to undertake joint transportation task due to its sufficient to finish in a single way or waste reduction (Louwerse et al., 2014). The joint distribution is a similar service mode to achieve cost reduction in distribution link. With globalization of online shopping and increasingly personalized demands of customers, more and more express service prividers shifted their eyes on meeting customer's demands and consumers stasfication. In this case, some express service providers were motivated to adopt JD to overcome the growing competition and to reduce distribution cost (Sun et al., 2015). Thus, the potential objectives and drivers in adoping JD are collected in Table 2.

Barriers of JD Adoption

There exists some discrepancy regarding barriers of JD adoption for different organizations. It is difficult to share various information of different organizations due to a lack of trust among partners in logistics alliances, and it will be a big barrier to adopt JD (Nyaga et al., 2010). There was research found that the reluctance of enterprises in sharing

customer's information are major problems to promote JD adoption.

Since the JD is always achieved by the logistics alliance, the effective alliance management had significant effects on the operational performance in industrial practice (Albers et al., 2013; Borade & Bansod, 2012; Brekalo et al., 2013; Wan & Jones, 2013). According to our interview with managers and the literature review, there existed some discrepant recognition on barriers of JD adoption. There are two groups based on whether they have adopted JD mode, and some differences were found between these two groups. Enterprises which had already adopted JD thought that internal/external integration was the main barrier, while the others viewed the leakage of business secrets and lack of top management involvement as the main issues. However, problems in cost-sharing and matters in benefit distribution were common problems for both groups. They argued that the effective mechanism design on cost-sharing and benefit sharing was crucial for JD adption. Moreover, many authors encouraged that we should also pay much attention to better understanding the value of joint distribution, and the lack of relative logistics standards and norms. Thus, the following barriers collected are taken into account in adoping JD (Table 2).

Operations Affected by JD

Under JD mdoe, the express enterprises try to forecast parcel deliveries requirement relying on shared information between themselves and e-commerce enterprises or express enterprises. And then the configured resources are deployed and planned to provide distribution service. In order to reduce the operation cost, express enterprises need to perform demand forecasting, transportation and sorting plans, which result in showing a great influence on the business process. To solve this kind of resources deployment problem, many programming models are formulated and developed to help achieve cost reduction and satisfaction improvement facing with dynamic customer demand in JD (Ge et al., 2013; Zhou et al., 2016; Zhou, Lin, et al., 2017). Besides, transportation and sorting plans were found to be significantly affected. Zhou et al. (2016) studied multiclass terminal location-heterogeneous VRP issue under JD environment in urban distribution. The study observed that JD reduced the distribution cost while meeting uncertainties in customer demands. Thus, the following affected operations are collected in JD adaption (Table 2).

In order to depict the variables in terms of the adoption and implementation of JD in the Chinese express industry, the twenty-three variables have been taken into account. From the Table 2, the twenty variables listed were taken from the previous literature and three were considered after discussion with managers from express enterprises. The list variables from literature review are also be approved by the industrial managers.

Solution Methodology

This study aims at developing a hierarchical model for the identification on the complex relationships among the abovementioned potential factors of JD adoption. The ISM is an effective modeling method which is usually used to identify various ingredients (Raj et al., 2008), and it has been widely applied in the industrial sectors by developing different kinds of models.

ISM approach was developed to understand qualitatively the complex interactions among the various ingredients (Warfield, 1974; Zhou, Lim, et al., 2019). The adoption and implementation of JD in an express enterprise relys on the objectives, drivers, barriers and effects (Borade & Bansod, 2012). These four kinds of variables in adopting JD are strongly correlated, and the complicated relationshop hinders better understanding and JD practical implmentation. Based on the ISM approach, a variety of relationships among these variables are discovered, and these variables are structured into a multi-level hierarchy. The obvious characteristics of ISM are summarized by (Raj et al., 2008):

(1) This method is interpretive, so it can be used to decide whether and how these different variables are correlated and interacted.
(2) It is a structural hierarchy analytical method. Therefore, the factors are extracted and the structural hierarchy diagram is constructed from the complex factor set.
(3) The ISM approach has been widely applied to describe the order and direction of influential factors.

The ISM steps and implementation details involved are shown in the following Figure1 (Dixit & Raj, 2018; Kannan & Haq, 2007; Kannan et al., 2010; Sajid et al., 2017; Zhou, Lim, et al., 2019).

From the above Figure 1, the ISM-based modeling steps are as follows (Ming et al., 2017; Sharma et al., 2020; Zhou, Lim, et al., 2019).

Step 1. Determination of the potential factors of JD adoption. The listed factors from objective items, barriers, drivers and affected operations perspective have been collected based on literature review and industrial interveiw.

Step 2. Investigation of contextual relationship among considered factors based on the judgment of the expert panel. The contextaul relationship between each two pairwise variable within each dimension are investigated and collected by using the "lead to" term.

Step 3. Generation of structural self-interaction matrix (SSIM). The quantified matrix is formulated based on judgments of the expert panel and quantification rules. To manifest the directed influential relationships between any two variables, four symbols and definitions are adopted:

V: Variable *i* will contribute to achieving variable *j*;

A: Variable *j* will contribute to achieving variable *i*;

X: Variable *i* will contribute to achieving variable *j*, and vice versa;
O: Variable *i* and variable *j* are unrelated, and has no relationship.

Step 4. Calculation of reachability matrix. The initial reachability matrix is established by shifting to binary codes, and the transformation is done by following the presented rules below:
If the element (*i, j*) is *V*, the assigned value $R(i, j)=1$, and $R(j, i)=0$.
If the element (*i, j*) is *A*, the assigned value $R(i, j)=0$, and $R(j, i)=1$.
If the element (*i, j*) is *X*, the assigned value $R(i, j)=R(j, i)=1$.
If the element (*i, j*) is *O*, the assigned value $R(i, j)=R(j, i)=0$.
The final rechability matrix is obtained by incorporating the transitivity rule.

Step 5. Level partition of potential factors. The establishment of level partition is generated by clustering the variables of the same level based on the derived reachability and antecedent sets.

Step 6. Generation of the directed diagraph. The directed diagraph is drawn after removing the transitive links based on the final reachability matrix.

Step 7. Relationship statement using an ISM hierarchy model. The hierarchy ISM model is generated by the obtained diagraph.

Step 8. Logical inconsistency check and MICMAC analysis. In this final step, the ISM model is checked for logical inconsistencies, and if any, the corrections are made. Also, the MICMAC analysis is conducted by examing the driving power and dependence power of potential factors.

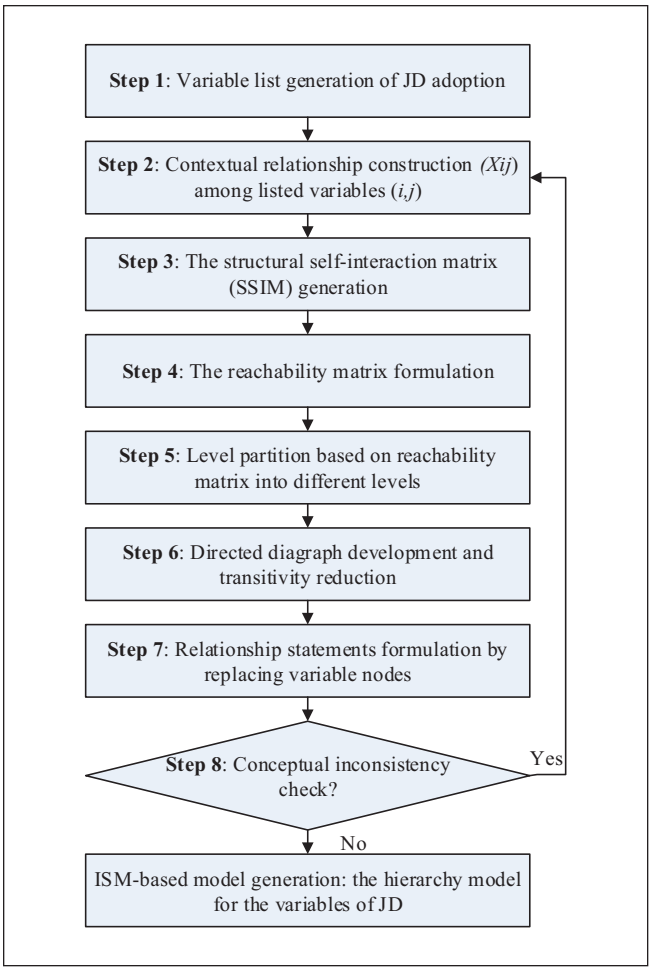

Figure 1. Implementation details of ISM-based approach.

ISM Application

Data Collection of Factor Interactors

The expert-based decision making information has proven to be efficient for factors identification and better understaning on the industrial application (Zhou, Lim, et al., 2019; Zhou, Soh, et al., 2020). For identifying the complicated relationships among different variables, the expert opinions are investigated based on expert-related techniques (e.g., brain storming, Delphi method, nominal group technique, etc.). In this study, an expert panel was generated, and five experts were consulted and asked to collect the contextual co-relations amongst the various varibles from the acedamia and industry. The investigation of the expert panel is performed at Industry & Innovation Research Center, and Business Logistics Research Center of Yellow River Basin. The reserach center has built a solid coopertation with logistics firms, e-commerce merchant, manufacturing enterprises and governmental departments, as well as collaborated with famous research teams worldwide. The expert panel comes from the research center, collaborative research institutes and industrial organizations. One author of this paper, two experts from academia and two experts from industrial organizations (two of the eight express organizations) were included in the pilot study to obtain expert judgment. Then, a contextual description on factor interation was discussed and collcected, meaning that one variable can influence or lead to the occurrence of another variable. On basis of the two pair-wise analysis and data collection, the perplex contextual relationships among the listed variables are constructed and formulated based on above ISM modeling step analysis.

Structural Self-interaction Matrix (SSIM) Generation

We develop a structural self-interaction matrix (SSIM) to manifest the interacted relations between any two variables within the same group. The investigated SSIM matrixes are found in Tables 3 to 6, respectively.

Table 3. SSIM for Objectives.

Variable *i* \ *j*	OB5	OB4	OB3	OB2
OB1	O	A	A	A
OB2	A	A	A	
OB3	O	V		
OB4	O			

Note. OB is short for objective variable.

Table 4. SSIM for Strategic Drivers.

Variable *i* \ *j*	SD4	SD3	SD2
SD1	V	A	A
SD2	V	O	
SD3	V		

Note. SD is short for strategic driver.

Formulation of the Reachability Matrix

According to the generated SSIM above, the reachability matrix is calculated and developed based on the ISM-based modeling steps. The initial reachability matrix is constructed by converting the lingustic variable into a binary value based on investigated SSIM. The final reachability matrixes in terms of four kinds of listed factors are obtained by consolidating the transitivity analysis, found in the following Tables 7 to 10.

Level Partitions of the ISM Model

In this part, the reachability and antecedent sets are derived from the final reachability matrix (Warfield, 1974). The reachability set of each variable comprises the variable itself and those can assist to achieve. Whereas the antecedent set of each variable also comprises the variable itself and the those may contribute to alleviating it. The intersection set of each variable can be obtained by deriving from its corresponding reachability and variables in antecedent sets. The factors of both the reachability set and the intersection set included are made in the top-level of the ISM hierarchy (Ali et al., 2020; Babu et al., 2020; Lim et al., 2017; Singh et al., 2020). After that, it is discarded from the other remaining variables. The above procedures are repeated, and the specific level of listed factors is then obtained as shown in Tables 11 to 14, respectively.

Formation of ISM-Based Hierarchy Model

According to the parted levels, the hierarchy model is structured and established, which is illustrated in the following Figure 2. The directed relationship among listed factors is represented by an arrow. After checking the logical inconsistency, the final ISM model for the factors in adopting and implementing JD illustrating the hierarchy levels is given in Figure 2.

From the formulated ISM-based modeling steps, the hierarchical ISM model of JD adoption is established from objectives, barriers, drivers and affected operations dimension. As we can see from the Figure 2, improving profit objective (OB1) is located as the first level, which means the siginificant factor of OB1. This investigation result is similar to the previous reseach conclusion by Hu and Qiang (2013). In terms of strategic driver factors, the higher operation cost (SD3) is the most obvious driver to motivate the JD adoption. For barrier dimension, the internal/external integration (B5) factors is the most siginifcant barrier on joint distribution adoption, which is influenced by other barrier factors in a complicated interaction. The affected operations analysis after JD adoption assists to understand the interactive influence of these business links, and results show business process (AO1) factor will be influnced by other operation factors after implementing joint distribution. This reminds industrial managers should pay much attention to business synchronous innovaiton with adoption and implementation of the novel joint distribution.

MICMAC Analysis

On basis of multiplication properties of matrices, Matriced' Impacts croises-multipication applique' and classment, abbreviated as MICMAC, has been widely employed to assist to better understand the novel mangement concept in industrial sectors (Chandra & Kumar, 2018; Kadam & Bandyopadhyay, 2019; Singh & Bhanot, 2020; Zhou, Lim, et al., 2019). During the implementation of MICMAC analysis, the driving power and dependence power can be extracted and identified, which help industrial managers to better understand management practices. Generally speaking, MICMAC analysis is employed to classify the listed factors into four regions.

Autonomous enablers: these variables tend to show weak perfomance in terms of driving power and dependence power, which are placed in Quadrant-I region.
Dependence enablers: In the second quadrant (Quadrant-II), these variables have weak driving power while having strong dependence power.
Linkage enablers: these variables have strong driving power and also strong dependence, which are located in Quadrant-III region.
Independent enablers: In the Quadrant-IV region, these ones have strong driving power while having weak dependence power.

Following the above analysis, these factors distributed in different regions are shown and presented based on the driving power and dependence power value in Figures 3 and 4.

Table 5. SSIM for Barriers.

Variable *i* \ *j*	B10	B9	B8	B7	B6	B5	B4	B3	B2
B1	A	A	O	V	A	V	A	O	A
B2	A	O	A	O	O	V	A	A	
B3	O	V	X	O	O	O	O		
B4	O	V	O	A	O	V			
B5	A	A	O	A	A				
B6	O	O	O	V					
B7	O	V	O						
B8	O	V							
B9	A								

Note. B is short for barrier factor.

Table 6. SSIM for Affected Operations.

Variable *i* \ *j*	AO4	AO3	AO2
AO 1	A	A	O
AO 2	V	V	
AO 3	X		

Note. AO is short for affected operation.

Table 7. Final Reachability Matrix for Objectives.

Variable	OB1	OB2	OB3	OB4	OB5	Driving power
OB1	1	0	0	0	0	1
OB2	1	1	0	0	0	2
OB3	1	1	1	1	0	4
OB4	1	1	0	1	0	3
OB5	1	1	0	0	1	3
Dependence power	5	4	1	2	1	13

Table 8. Final Reachability Matrix for Strategic Drivers.

Variable	SD1	SD2	SD3	SD4	Driving power
SD1	1	0	0	1	2
SD2	1	1	0	1	3
SD3	1	0	1	1	3
SD4	0	0	0	1	1
Dependence power	3	1	1	4	9

Table 9. Final Reachability Matrix for Barrier Analysis.

Variable	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	Driving power
B1	1	1	0	1	1	0	1	0	1	0	6
B2	1	1	0	1	1	0	1	0	1	0	6
B3	1	1	1	1	1	0	1	1	1	0	8
B4	1	1	0	1	1	0	1	0	1	0	6
B5	0	0	0	0	1	0	0	0	0	0	1
B6	1	1	0	1	1	1	1	0	1	0	7
B7	1	1	0	1	1	0	1	0	1	0	6
B8	1	1	1	1	1	0	1	1	1	0	8
B9	1	1	0	1	1	0	1	0	1	0	6
B10	1	1	1	1	1	0	1	1	1	1	9
Dependence power	9	9	3	9	10	1	9	3	9	1	

Table 10. Final Reachability Matrix of Affected Operations.

Variable	AO 1	AO 2	AO 3	AO 4	Driving power
AO1	1	0	0	0	1
AO2	1	1	1	1	4
AO3	1	0	1	1	3
AO4	1	0	1	1	3
Dependence power	4	1	3	3	11

Table 11. Level Partitions for Objectives.

Variable	Reachability set	Antecedent set	Intersection set	Level
OB1	1	1,2,3,4,5	1	I
OB2	1,2	2,3,4,5	2	II
OB3	1,2,3,4	3	3	IV
OB4	1,2,4	3,4	4	III
OB5	1,2,5	5	5	III

Table 12. Level Partitions for Stragetic Drivers.

Variable	Reachability set	Antecedent set	Intersection set	Level
SD1	1,4	1,2,3	1	II
SD2	1,2,4	2	2	III
SD3	1,3,4	3	3	III
SD4	4	1,2,3,4	4	I

Table 13. Level Partitions for Barriers.

Variable	Reachability set	Antecedent set	Intersection set	Level NO.
B1	1,2,4,5,7,9	1,2,3,4,6,7,8,9,10	1,2,4,7,9	II
B2	1,2,4,5,7,9	1,2,3,4,6,7,8,9,10	1,2,4,5,7,9	II
B3	1,2,3,4,5,7,8,9	3,8,10	3,8	III
B4	1,2,4,5,7,9	1,2,3,4,6,7,8,9,10	1,2,4,7,9	II
B5	5	1,2,3,4,5,6,7,8,9,10	5	I
B6	1,2,4,5,6,7,9	6	6	III
B7	1,2,4,5,7,9	1,2,3,4,6,7,8,9,10	1,2,4,7,9	II
B8	1,2,3,4,5,7,8,9	3,8,10	3,8	III
B9	1,2,4,5,7,9	1,2,3,4,6,7,8,9,10	1,2,4,7,9	II
B10	1,2,3,4,5,7,8,9,10	10	10	IV

Table 14. Level Partitions in Terms of Affected Operations.

Variable	Reachability set	Antecedent set	Intersection set	Level
AO1	1	1,2,3,4	1	I
AO2	1,2,3,4	2	2	III
AO3	1,3,4	2,3,4	3,4	II
AO4	1,3,4	2,3,4	3,4	II

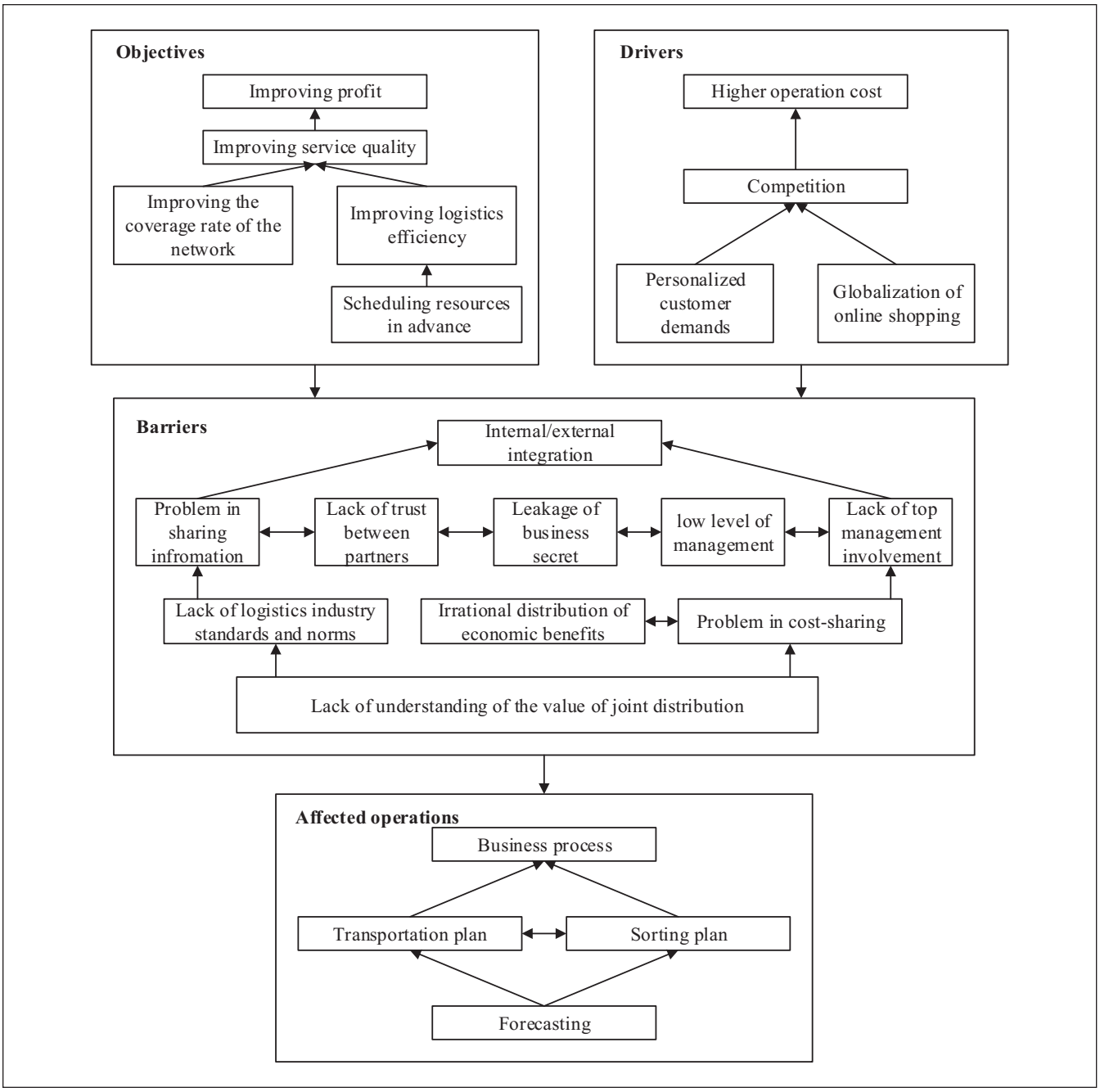

Figure 2. ISM-based model for JD adoption factor analysis.

The MICMAC analysis assists us to better understand the factors' influence on JD adoptions, as is illustrated in Figures 3 and 4. To our surprise, it is noteworthy that there are no autonomous variables which show little influence on JD adoption in our list factors. Hence, all considered variables listed have some effect on JD adoption. The dependent variables are identified, including improving profit (OB1), improving service quality (OB2), competition (SD1), personalized customer demands (SD4), internal/external integration (B5), and business process (AO1); suggesting that industrial managers should pay much attention to the influential mechanism of these variables affected by other listed factors.

In addition, problems in sharing information (B1), lack of trust between partners (B2), leakage of business secrets (B4), low level of management (B7), lack of top management involvement (B9), transportation and sorting planning (AO3, AO4) have high value for both driving power and dependence power, regarding as the linkage variables, demonstrate a strong influence on JD adoption. Half of the barrier factors are located at the linkage region. Therefore, effective management practices should be studied, developed and designed

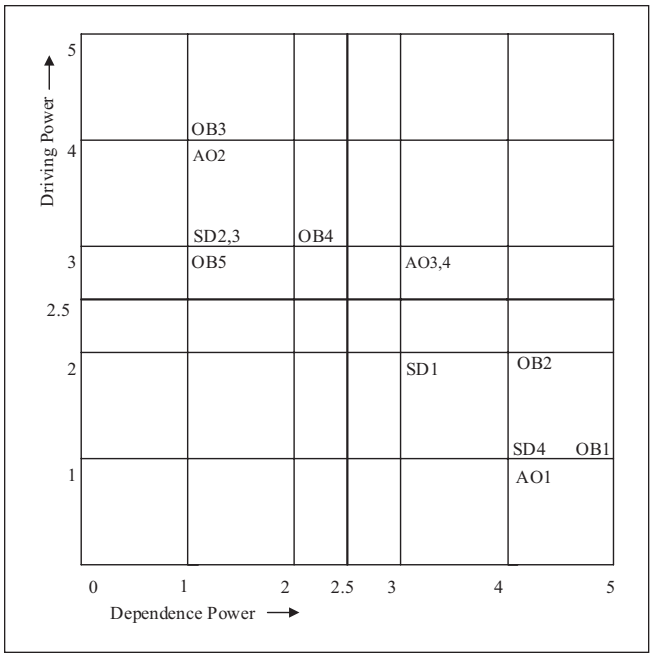

Figure 3. Driving and dependence power illustration of strategic JD factors.

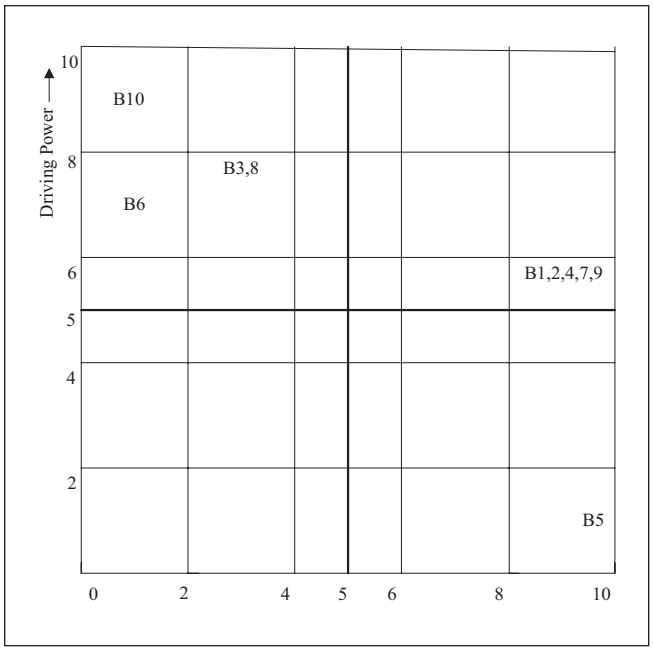

Figure 4. Driving and dependence power diagram of barriers.

to overcome these integration barriers, facilitating to promote JD adoption.

Finally, scheduling resources in advance (OB3), improving logistics efficiency (OB4), improving the coverage rate of the network (OB5), globalization of online shopping (SD2), higher operation cost (SD3), lack of logistics industry standards and norms (B6), irrational distribution of economic benefits (B3), problem in cost-sharing (B1), lack of understanding of the value of joint distribution (B10) have high driving power while with low dependence power. These variables are strong drivers of JD adoption, which will have great effect on other factors of objectives, drivers, barriers, and affected operations. This reminds us that industrial managers should focus on these variables and understand the interactive relationship among them.

Discussions and Research Implications

In this study, an ISM model was built to provide a common framework for factor analysis of JD adoption in Chinese express industry. There are 23 factors being collected and addressed, which are supposed to be crucial for adoption and implementation of joint distribution mode. The generated parted levels and hierarchy model help to better understand JD adoption and promotion.

Research Discussions

The objective factor analysis could help indsutrial managers to better understand the objectives of JD adoption and their interactions. From the objective factor dimension, improving profit factor (OB1) is regarded as the most important objective regarding JD adoption. Hu and Qiang (2013) argues that it is urgent for Chinese express service enterprises to promote the logistics service chain strategy from a single mode to a joint distribution (JD) mode, thus bringing more profit for the whole distribution alliance and the system. This study also has the same conclusion, which shows that improving profit (OB1) is the most important objective of JD adoption, as Figure 3 illustrated. Therefore, improving profit variable has relative low driving power while with high dependence power presented in Figure 4. Scheduling resources in advance (OB3) and improving the coverage rate of the network (OB4) have a higher driving power while with low dependence power. Both industrial interviews and the literature reveal that an important crux of JD adoption is the dynamic information sharing among e-commerce enterprises, express service enterprises and customers. It is no doubt that the effective information sharing mechanism contributes to the resources scheduling, which motivates the JD adoption and implementation (Montoya-Torres et al., 2016). Considering the interactions of objective factors, for instance, the OB3 is at the bottom level, which will lead to other objective factors achievement. Therefore, industrial managers should pay much attention to the objective of scheduling resources in advance (OB3), which would directly bring more profits and better service quality.

To identify the drivers and motivations of JD adoption, the strategic driver factor analysis is taken into account in this study. Results show that higher operation cost (SD3) factor is the most important driver due to intense competition

among more than ten thousand express service enterprises in China. This is also in line with the current e-commerce development environment and industry status in Chinese market. It is also found that personalized customer demands (SD4) and the globalization of online shopping (SD2) have higher driving power, indicating that express service enterprises should pay much attention to the personalized customer demands. However, it is difficult to meet the increasingly personalized customer demands just relying on express service enterprises under the globalization of online shopping atmosphere, specifically; on their own, thus JD is a novel way to collaborate with other industrial organizations and supply chain members for express service enterprises. Along with competition, personalized customer demand and globalization of online shopping are also strategic drivers motivating JD adoption in Chinese market.

The barrier factor analysis could assist managers to identify the crucial barriers of JD adoption, contributing to the contermeasures making for JD promotion. The resource integration among partners is regarded an essential factor for service quality and customer satisfaction improvement in previous study (Yao, 2016a), and this study also has the similar observations. The internal/external integration factor (B5) is discovered to be the principal barrier for JD adoption. This barrier is considered to be an internal cause in our study, and the barrier factors in the second level (e.g., problems in sharing information (B1), lack of trust between partners (B2), leakage of business secret (B4), low level of management (B7), and lack of top management involvement (B9) have indirect influence on the adoption of JD through the internal/external integration (B5) factor. The ISM model result shows that sharing information factor is as important as we investigated. Hence, managers must pay much attention to the internal integration within enterprises and external integration with supply chain members or other partners. It must be mentioned that lack of understanding of the value of joint distribution (B10) shows the highest driving power amongst all barriers. It indicates that the fundamental problem lies in the better understanding of JD, and therefore, it is important to make some training plan to help better understand the JD value. The traditional service mode (e.g., self-built logistics network or third party logistics service for online shopping enterprises) should be modified and new collaborative strategies could be integrated and developed under online shopping logistics service chain. Followed by the JD understanding, adoption and operational management, the logistics industry standards and norms, proper benefit distribution and cost-sharing mechanism should be developed and designed to promote joint distribution in Chinese industrial sector.

The affected operation factor analysis will contribute to better the influence of JD implementation on other business activities. After JD adoption, there would be some changes and bring some new challenges for other business activities of these enterprises. When the joint distribution is implemented in industrial scenario, the express service enterprises will be good at information sharing and joint management under the designed sharing mechanism (He et al., 2016). This will be conducive to the accurate and timely forecasting for scheduling of resources in advance and more effective transportation and sorting in the online shopping supply chain. From the MICMAC analysis result, the forecasting operation (AO2) has the highest driving power, followed by transportation and sorting planning (AO3, AO4). Therefore, express service enterprises should pay much attention on these affected operation factors. With the development and promotion of JD mode, those adopted JD express service enterprises also should focus on these affected operations by synchronous innovation.

Theoretical and Managerial Implications

This paper serves both scientific contributions and practical implications to modern logistics sector. In this part, we present the theoretical contributions to joint distribution management practice, and also provide some managerial insights for practical industry.

This study contributes to theoretical knowledge by identifying the potential factors influencing joint distribution adoption, thereby probe into better understanding on various factors of JD promotion. Firstly, the potential factors influencing JD adoption are explored and collected based on the literature review and industrial investigation. There are 23 factors that are addressed from objective, strategic driver, barrier, and affected operation dimension. Secondly, the ISM modeling method is designed to study various factors affecting joint distribution adoption. The employed ISM-based modeling enables to portray the complicated interrelationships maong listed factors. The theoretical implication of the established ISM model is that it can identify crucial drivers and barriers based on an explained multi-level heirarchy, also can observe the complicated interrelationships. The paper reveals the potential factors of JD adoption and promotion from the dimension of objectives, drivers, barriers, and affected opeartions. This study enriches the joint distribution management practice by exploring the factor analysis of JD adoption, which provides some theoretical guidance on better understanding joint distribution and further promotion.

This research also includes a few practical implications for modern logistics industry to promote the novel joint distribution service mode. The potential factors affecting JD adoption from multiple dimensions highlighted are based on previous literature and industrial investigation, and ISM-based model is established by inverstigating judgment of expert panel. Implications to practice of this research include to make full use of experts' knowledge to serve for better understanding of complicated factors interaction followed by joint distribution promotion. From the eastablished hierarchy ISM model and MICMAC analysis, the crucial factors in each dimensional group are identified. The higher operation

cost (SD3) is the most crucial factor motivating JD adoption, and the the internal/external integration (B5) is the major barrier factor for JD promotion. Besides, the affected operations are also discussed for those organizations who have adopted and implemented joint distribution. In addition, the established hierarchy model suggests how the variables are interrelated and interacted toward joint distribution adoption from multiple dimensions. Industrial managers should pay much attention to these crucial factors and the interactions influenced by other variables. It is significant to promote the driving factors to improve the joint distribution adoption. This study could assist industrial managers to concentrate their efforts toward promoting joint distribution through factors identification from multiple dimensions (objectives, strategic drviers, barriers, and affected operations). Finally, this research would contribute to promoting joint distributoin adoption and improve management performance of the modern logistics sector using the novel service mode.

Conclusions and Future Research Directions

Joint distribution is a novel operational way in distribution link, which has been regarded as an effective and efficient logistics service mode. It is faced with a huge challenge for the traditional service mode in logistics sector due to increasing cost pressures, dynamic personalized customer demands and stricter environment and traffic regulations. Besides, the booming development of e-commerce industry also motivates the innovation of logsticis service. To improve the operational efficiency and reduce cost faced with massive delivery packages, the novel joint distribution concept is proposed by logistics resources integration. However, the JD implementation is at infancy for Chinese express service industry, especially for small-and-meduim enterprises (SMEs). This study tries to discover influential factors on JD adoption by formulating a hierarchy ISM model, and probes into managerial insights for JD promotion.

This paper addresses 23 factors which are divided into four categories: objectives, drivers, barriers and affected operations. Then, an ISM-based modeling approach is employed to construct a hierarchy model, facilitating to a better understanding of contextual relationship among these variables. From the study, we can find that the listed 23 variables show great significance in the adoption and promotion of joint distribution. Results show that the principle objectives of JD adoption and implementation are improving profit (OB1) and service quality (OB2) by means of scheduling resources in advance (OB3). Further, it is concluded that the higher operation cost (SD3), as a strategic driver, is the most crucial factor motivating JD adoption and implementation due to the increasingly intense competition among tens of thousands of express service enterprises. However, the internal/external integration (B5) is the major barrier for JD adoption and implementation. Finally, it is also concluded that JD helps express service enterprises to achieve a better profit with innovative business process (AO1) and accurate forecasting (AO4). The academia and industry could benefit from these results for adopting and implementing JD in Chinese express industry.

This study also carries some limitations. Firstly, the ISM method is constructed only based on the local Chinese express service industry. In addition, limited 23 variables are taken into account, and more details should be considered and analyzed to assist better understand the factors of Chinese logistics industry. Besides, the external factors, for instance curtural, regional, type of express firm and scale factors will be also taken into account since the organizational discrepancy. With booming development of e-commerce and modern logistics industry, the novel distribution mode and industrial practices will become significant to JD promotion regarding as new factors. The innovative management practices from different perspectives can be studied to promote joint distribution development. The huge data will be generated with the operational management and industrial experience of joint distribution implementation. The big data analytics or artificial intellegence-based analysis fraemwork can be developed and employed to assist industrial managers to discover other crucial factors for JD promotion. Also, the innovative opertional management practices (forecasting, transpotation planning and vehilce routing problems etc.) toward supply chain activities could be studied under the novel joint distribution promotion era.

Acknowledgments

We would like to thank anonymous referees and editors for their valuable comments and advice.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study is supported by the following programmes: the Philosophy and Social Science Planning Project of Henan Province (grant no. 2020CZH012); the Key Technologies R&D Programme of Henan Province from Henan Science & Technology Department (grant no. 222102210005); the Think-tank Program of Henan Science & Technology from Henan Association for Science & Technology (grant no. HNKJZK-2021-07B); Fundamental Research Funds for Provincial Universities (grant no. 20KYYWF0107, 21KYYWF0103); the Basic and Applied Basic Research Fund of Guangdong (grant no. 2020A1515110785); Guangdong Province Enterprise Science and Technology Commissioner Project (grant no. GDKTP2020066700), and the Scientific Research Starting Fund from ZZULI (grant no. 2018BSJJ071). We also appreciate the Engineering Research Center of New Vehicle Networking Communication Technology, funded by Shenzhen Strategic Emerging Industry Development Project from Shenzhen Development and Reform Commission (grant no. XMHT20190101025).

ORCID iD

Fuli Zhou https://orcid.org/0000-0002-4786-8451

References

Agrawal, V., Agarwal, A. M., & Agarwal, S. (2020). Modelling of factors of e-learning: An ISM approach. *International Journal of Continuing Engineering Education and Life-Long Learning*, *30*(1), 1.

Ai, X., Hu, Y., & Chen, G. (2014). A systematic approach to identify the hierarchical structure of accident factors with grey relations. *Safety Science*, *63*, 83–93.

Albers, S., & Brekalo, L. (2016). Effective logistics alliance design and management. *International Journal of Physical Distribution & Logistics Management*, *46*(2), 212–240.

Albers, S., Wohlgezogen, F., & Zajac, E. J. (2013). Strategic alliance structures: An organization design perspective. *Journal of Management*, *42*(3), 582–614.

Ali, S. M., Hossen, M. A., Mahtab, Z., Kabir, G., Paul, S., & Zuh, A. (2020). Barriers to lean six sigma implementation in the supply chain: An ISM model. *Computers & Industrial Engineering*, *149*, 106843.

Awan, U., Kraslawski, A., & Huiskonen, J. (2018). Understanding influential factors on implementing social sustainability practices in Manufacturing Firms: An interpretive structural modelling (ISM) analysis. *Procedia Manufacturing*, *17*, 1039–1048.

Babu, H., Bhardwaj, P., & Agrawal, A. K. (2020). Modelling the supply chain risk variables using ISM: A case study on Indian manufacturing SMEs. *Journal of Modelling in Management*. Advance online publication. https://doi.org/10.1108/BIJ-08-2021-0459

Bask, A., Lipponen, M., & Tinnilä, M. (2012). E-commerce logistics: A literature research review and topics for future research. *International Journal of E-Services and Mobile Applications*, *4*(3), 1–22.

Borade, A. B., & Bansod, S. V. (2012). Interpretive structural modeling-based framework for VMI adoption in Indian industries. *International Journal of Advanced Manufacturing Technology*, *58*(9–12), 1227–1242.

Brekalo, L., Albers, S., & Delfmann, W. (2013). Logistics alliance management capabilities: Where are they? *International Journal of Physical Distribution & Logistics Management*, *43*(7), 529–543.

Chandra, D., & Kumar, D. (2018). Analysis of vaccine supply chain issues using ISM approach. *International Journal of Logistics Systems and Management*, *31*(4), 449–482.

Closs, D. J., & Savitskie, K. (2003). Internal and external logistics information technology integration. *International Journal of Logistics Management*, *14*(1), 63–76.

Dixit, S., & Raj, T. (2018). Feasibility analysis of FMS in small and medium scale Indian industries with a hybrid approach using ISM and TOPSIS. *International Journal of Advanced Operations Management*, *10*(3), 252–280.

Evangelista, P., Mckinnon, A., & Sweeney, E. (2013). Technology adoption in small and medium-sized logistics providers. *Industrial Management & Data Systems*, *113*(7), 967–989.

Gao, H., Xu, Y., Gu, X., Lin, X., & Zhu, Q. (2015). Systematic rationalization approach for multivariate correlated alarms based on interpretive structural modeling and likert scale. *Chinese Journal of Chemical Engineering*, *23*(12), 1987–1996.

Ge, X., Wang, X., & Deng, L. (2013). Research on open and dynamic vehicle routing problems based on joint distribution. *Journal of Engineering Management*, *27*(3), 60–68.

Gimenez, C., & Ventura, E. (2005). Logistics-production, logistics-marketing and external integration: Their impact on performance. *International Journal of Operations & Production Management*, *25*(1), 20–38.

Guajardo, M., & Rönnqvist, M. (2015). Operations research models for coalition structure in collaborative logistics. *European Journal of Operational Research*, *240*(1), 147–159.

Hartmann, E., & Grahl, A. D. (2011). The flexibility of logistics service providers and its impact on customer loyalty: An empirical study. *Journal of Supply Chain Management*, *47*(3), 63–85.

He, Y., Qi, M., Zhou, F., & Su, J. (2020). An effective metaheuristic for the last mile delivery with roaming delivery locations and stochastic travel times. *Computers & Industrial Engineering*, *145*, 106513.

He, Y., Wang, X., Lin, Y., & Zhou, F. (2016). Optimal partner combination for joint distribution alliance using integrated fuzzy EW-AHP and TOPSIS for online shopping. *Sustainability*, *8*(4), 341–356.

He, Y., Wang, X., Lin, Y., Zhou, F., & Zhou, L. (2017). Sustainable decision making for joint distribution center location choice. *Transportation Research Part D-Transport and Environment*, *55*, 202–216.

He, Y., Zhou, F., Qi, M., & Wang, X. (2020). Joint distribution: Service paradigm, key technologies and its application in the context of Chinese express industry. *International Journal of Logistics Research and Applications*, *23*(3), 211–227.

Hofenk, D., Schipper, R., Semeijn, J., & Gelderman, C. (2011). The influence of contractual and relational factors on the effectiveness of third party logistics relationships. *Journal of Purchasing and Supply Management*, *17*(3), 167–175.

Hou, B., Wang, Y., & Shan, Y. (2015). Research on the urban joint distribution risk evaluation based on fuzzy comprehensive judgement. *Science & Technology Management Research*, *35*(8), 52–61.

Hsu, D. W. L., Shen, Y. C., Yuan, B. J. C., & Chou, C. J. (2015). Toward successful commercialization of university technology: Performance drivers of university technology transfer in Taiwan. *Technological Forecasting and Social Change*, *92*(92), 25–39.

Hu, Y., & Qiang, Q. (2013). An Equilibrium model of online shopping supply chain networks with service capacity investment. *Service Science*, *5*(3), 238–248.

Kadam, S., & Bandyopadhyay, P. K. (2019). Modelling passenger interaction process (PIP) framework using ISM and MICMAC approach. *Journal of Rail Transport Planning & Management*, *14*, 100171.

Kannan, G., & Haq, A. N. (2007). Analysis of interactions of criteria and sub-criteria for the selection of supplier in the built-in-order supply chain environment. *International Journal of Production Research*, *45*(17), 3831–3852.

Kannan, G., Pokharel, S., & Kumar, P. S. (2010). A hybrid approach using ISM and fuzzy TOPSIS for the selection of reverse logistics provider. *Resources Conservation & Recycling*, *54*(1), 28–36.

Krajewska, M. A., Kopfer, H., Laporte, G., Ropke, S., & Zaccour, G. (2008). Horizontal cooperation among freight carriers: Request allocation and profit sharing. *Journal of the Operational Research Society*, *59*(11), 1483–1491.

Lan, B., & Zhang, Y. (2003). A novel logistics service mode for terminal distribution. *Management World*, (6), 147–148.

Lim, M. K., Tseng, M. L., Tan, K. H., & Bui, T. D. (2017). Knowledge management in sustainable supply chain management: Improving performance through an interpretive structural modelling approach. *Journal of Cleaner Production*, *162*, 806–816.

Liu, G., Hu, J., Yang, Y., Xia, S., & Lim, M. K. (2020). Vehicle routing problem in cold Chain logistics: A joint distribution model with carbon trading mechanisms. *Resources, Conservation and Recycling*, *156*, 104715.

Louwerse, I., Mijnarends, J., Meuffels, I., Huisman, D., & Fleuren, H. (2014). Scheduling movements in the network of an express service provider. *Flexible Services and Manufacturing Journal*, *26*(4), 565–584.

Ming, K. L., Tseng, M. L., Tan, K. H., & Bui, T. D. (2017). Knowledge management in sustainable supply chain management: Improving performance through an interpretive structural modelling approach. *Journal of Cleaner Production*, *162*, 806–816.

Montoya-Torres, J. R., Munoz-Villamizar, A., & Vega-Mejia, C. A. (2016). On the impact of collaborative strategies for goods delivery in city logistics. *Production Planning & Control*, *27*(6), 443–455.

Niesten, E., & Jolink, A. (2015). The impact of alliance management capabilities on alliance attributes and performance: A literature review. *International Journal of Management Reviews*, *17*(1), 69–100.

Nyaga, G. N., Whipple, J. M., & Lynch, D. F. (2010). Examining supply chain relationships: Do buyer and supplier perspectives on collaborative relationships differ? *Journal of Operations Management*, *28*(2), 101–114.

Patri, R., & Suresh, M. (2017). Factors influencing lean implementation in healthcare organizations: An ISM approach. *International Journal of Healthcare Management*, *11*(1), 25–37.

Raj, T., Shankar, R., & Suhaib, M. (2008). An ISM approach for modelling the enablers of flexible manufacturing system: The case for India. *International Journal of Production Research*, *46*(24), 6883–6912.

Rana, N. P., Barnard, D. J., Baabdullah, A. M. A., Rees, D., & Roderick, S. (2019). Exploring barriers of M-commerce adoption in SMEs in the UK: Developing a framework using ISM. *International Journal of Information Management*, *44*(Feb), 141–153.

Sajid, Z., Khan, F., & Zhang, Y. (2017). Integration of interpretive structural modelling with Bayesian network for biodiesel performance analysis. *Renewable Energy*, *107*, 194–203.

Sarhan, J. G., Xia, B., Fawzia, S., Karim, A., & Coffey, V. (2019). Framework for the implementation of lean construction strategies using the interpretive structural modelling (ISM) technique: A case of the Saudi construction industry. *Engineering Construction & Architectural Management*, *27*(1), 1–23.

Schmoltzi, C., & Wallenburg, C. M. (2011). Horizontal cooperations between logistics service providers: Motives, structure, performance. *International Journal of Physical Distribution & Logistics Management*, *41*(5–6), 552–575.

Schmoltzi, C., & Wallenburg, C. M. (2012). Operational governance in horizontal cooperations of logistics service providers: Performance effects and the moderating role of cooperation complexity. *Journal of Supply Chain Management*, *48*(2), 53–74.

Sharma, M., Joshi, S., Kannan, D., Govindan, K., Singh, R., & Purohit, H. C. (2020). Internet of Things (IoT) adoption barriers of smart cities' waste management: An Indian context. *Journal of Cleaner Production*, *270*, 122047.

Sharma, S., & Choudhury, A. G. (2014). A qualitative study on evolution of relationships between third-party logistics providers and customers into strategic alliances. *Strategic Outsourcing an International Journal*, *7*(1), 2–17.

Shen, L., Song, X., Wu, Y., Liao, S., & Zhang, X. (2016). Interpretive structural modeling based factor analysis on the implementation of emission trading system in the Chinese building sector. *Journal of Cleaner Production*, *127*, 214–227.

Singh, R., & Bhanot, N. (2020). An integrated DEMATEL-MMDE-ISM based approach for analysing the barriers of IoT implementation in the manufacturing industry. *International Journal of Production Research*, *58*, 2454–2476.

Singh, R. K., Joshi, S., & Sharma, M. (2020). Modelling supply chain flexibility in the Indian personal hygiene industry: An ISM-Fuzzy MICMAC approach. *Global Business Review*. Advance online publication. https://doi.org/10.1177/0972150920923075

Su, J., Yang, Y., & Yang, T. (2018). Measuring knowledge diffusion efficiency in R&D networks. *Knowledge Management Research & Practice*, *16*(2), 208–219.

Su, J., Zhang, F., Chen, S., Zhang, N., Wang, H., & Jian, J. (2021). Member selection for the collaborative new product innovation teams integrating individual and collaborative attributions. *Complexity*, *2021*, 1–14.

Sun, L., Karwan, M. H., Gemici-Ozkan, B., & Pinto, J. M. (2015). Estimating the long-term cost to serve new customers in joint distribution. *Computers & Industrial Engineering*, *80*, 1–11.

Wan, J., & Jones, J. D. (2013). Managing IT service management implementation complexity: From the perspective of the Warfield Version of systems science. *Enterprise Information Systems*, *7*(4), 490–522.

Wang, X., Wong, Y. D., Li, K. X., & Yuen, K. F. (2020). Transport research under Belt and Road Initiative: Current trends and future research agenda. *Transportmetrica a-Transport Science*, *17*(4), 357–379.

Wang, Y., Ma, X., Xu, M., Wang, L., Wang, Y., & Liu, Y. (2015). A methodology to exploit profit allocation in logistics joint distribution network optimization. *Mathematical Problems in Engineering*, *2015*(4), 15.

Wang, X., Yuen, K. F., Wong, Y. D., & Teo, C. C. (2019). Consumer participation in last-mile logistics service: An investigation on cognitions and affects. *International Journal of Physical Distribution & Logistics Management*, *49*(2), 217–238.

Warfield, J. N. (1974). Developing interconnection matrices in structural modeling. *Systems Man & Cybernetics IEEE Transactions on Systems, Man & Cybernetics vSMC-4 n1*, *4*(1), 74–80.

Wei, Z., & Sun, J. (2015). A city-based joint distribution model for small and medium_sized electronic enterprises. *Journal of Beijing Jiaotong University*, *4*(1), 104–110.

Wright, C. P., Groenevelt, H., & Shumsky, R. A. (2010). Dynamic revenue management in airline alliances. *Transportation Science*, *44*(1), 15–37.

Wu, Y., Bian, Q., & Ping, L. (2012). The ISM analysis on influence factors of cost control in the wind power construction project. *Physics Procedia*, *24*(Part A), 587–590.

Xu, X., & Zou, P. X. W. (2020). Analysis of factors and their hierarchical relationships influencing building energy performance using interpretive structural modelling (ISM) approach. *Journal of Cleaner Production*, *272*, 122650.

Yao, J. (2015). Resources integration decision about online shopping supply chain based on service capacity equilibrium. *Chinese Journal of Management Science*, *22*(10), 88–97.

Yao, J. (2016a). Dynamic fuzzy game decision about supply chain resource integration in online shopping. *Journal of intelligent & fuzzy systems: Applications in Engineering and Technology*, *30*(5), 2749–2759.

Yao, J. (2016b). Resources integration decision for online shopping supply chain with fourth party logistics. *Journal of System & Management*, *25*(2), 308–316.

Yao, J. M. (2017). Supply chain resources integration optimisation in B2C online shopping. *International Journal of Production Research*, *55*(17–18), 1–16.

Yu, B., Wu, S., & Du, G. (2014). Branch model simulation for express logistics service system evaluation under online shopping. *Chinese Journal of Management Science*, *22*(12), 72–78.

Yuen, K. F., Wang, X., Ma, F., & Wong, Y. D. (2019). The determinants of customers' intention to use smart lockers for last-mile deliveries. *Journal of Retailing and Consumer Services*, *49*, 316–326.

Yuen, K. F., Wang, X., Ng, L. T. W., & Wong, Y. D. (2018). An investigation of customers' intention to use self-collection services for last-mile delivery. *Transport Policy*, *66*(AUG.), 1–8.

Zacharia, Z. G., Nix, N. W., & Lusch, R. F. (2011). An analysis of supply chain collaborations and their effect on performance outcomes. *Journal of Business Logistics*, *30*(2), 101–123.

Zhang, X. (2013). Joint distribution patterns and decision-making paths for terminal logistics: Based on Supply and demand analysis of electric business logistics and community service. *Research on Financial and Economic Issues*, (3), 123–129.

Zhou, F., He, Y., Ma, P., Lim, M. K., & Pratap, S. (2021). Capacitated disassembly scheduling with random demand and operation time. *Journal of the Operational Research Society*, *23*, 1–17.

Zhou, F., He, Y., Ma, P., & Mahto, R. V. (2020). Knowledge management practice of medical cloud logistics industry: Transportation resource semantic discovery based on ontology modelling. *Journal of Intellectual Capital*, *22*(2), 360–383.

Zhou, F., He, Y., & Zhou, L. (2019). Last mile delivery with stochastic travel times considering dual services. *IEEE Access*, *7*, 159013–159021.

Zhou, F., Lim, M. K., He, Y., Lin, Y., & Chen, S. (2019). End-of-life vehicle (ELV) recycling management: Improving performance using an ISM approach. *Journal of Cleaner Production*, *228*, 231–243.

Zhou, F., Lim, M. K., He, Y., & Pratap, S. (2019). What attracts vehicle consumers' buying: A Saaty scale-based VIKOR (SSC-VIKOR) approach from after-sales textual perspective? *Industrial Management & Data Systems*, *120*(1), 57–78.

Zhou, F., Ma, P., He, Y., Pratap, S., & Yang, B. (2020). Lean production of ship-pipe parts based on lot-sizing optimization and PFB control strategy. *Kybernetes*, *50*(5), 1483–1505.

Zhou, F., Wang, X., Goh, M., Zhou, L., & He, Y. (2019). Supplier portfolio of key outsourcing parts selection using a two-stage decision making framework for Chinese domestic auto-maker. *Computers & Industrial Engineering*, *128*, 559–575.

Zhou, F., Wang, X., He, Y., & Goh, M. (2017). Production lot-sizing decision making considering bottleneck drift in multi-stage manufacturing system. *Advances in Production Engineering & Management*, *12*(3), 213–220.

Zhou, L., Baldacci, R., Vigo, D., & Wang, X. (2018). A Multi-depot two-echelon vehicle routing problem with delivery options arising in the last mile distribution. *European Journal of Operational Research*, *265*(2), 765–778.

Zhou, L., Lin, Y., Wang, X., & Zhao, Q. (2016). Integrated optimization for multiclass terminal location-heterogeneous vehicle routing of urban distribution under online shopping. *Computer Integrated Manufacturing Systems*, *22*(4), 1139–1147.

Zhou, L., Lin, Y., Wang, X., & Zhou, F. (2017). Model and algorithm for bilevel multisized terminal location-routing problem for the last mile delivery. *International Transactions in Operational Research*, *26*(1), 131–156.

Zhou, Y., Soh, Y. S., Loh, H. S., & Yuen, K. F. (2020). The key challenges and critical success factors of blockchain implementation: Policy implications for Singapore's maritime industry. *Marine Policy*, *122*, 104265.