

Analysis on the Synergy Degree of Zhengzhou-Europe International Block Train and Zhengzhou Cross-border E-commerce Composite System

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Abstract: Zhengzhou is an important node city along “the Belt and Road”. Zhengzhou-Europe international block train and cross-border e-commerce are two important export-oriented development platforms in Zhengzhou and both of them are of great importance to promote the construction of Zhengzhou international logistics center. On the basis of composite system synergy degree model, the author constructed a synergy evaluation model of Zhengzhou-Europe international block train and cross-border e-commerce, and analyzed the synergy degree of the composite system in recent years. The author found that the order degree of the subsystems of Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce has revealed a zooming trend, but the coordinating measurement with respect to the composite system has showed a trend of “low at the beginning but increase rapidly year by year”. This is mainly because Zhengzhou-Europe international block train and cross-border e-commerce are two emerging business models in recent years. And they are run by two respective companies so that the collaboration between the two systems is not tacit enough. And then, the author specifically put forward some strategies and suggestions to promote the win-win development of Zhengzhou-Europe international block train and cross-border e-commerce composite system.

1. INTRODUCTION

Zhengzhou is an important “the Belt and Road” node city. Zhengzhou-Europe international block train and cross-border e-commerce are two important and fast-growing export-oriented development platforms and carrier in Zhengzhou. Zhengzhou-Europe international block train is committed to build a land “Silk Road” for Zhengzhou to communicate the Europe and even the world, while the cross-border e-commerce an online “Silk Road”. Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce not only support the construction of Zhengzhou international logistics center but also have great significance to promote the development of “the Belt and Road” countries.

As an important part of China-Europe Railway Express, Zhengzhou-Europe international block train refers to the cross-border container block train that start in Zhengzhou(China), with stops in Kazakhstan, Russia, Belarus and Poland, finally arrive at Hamburg(Germany). The whole distance of Zhengzhou-Europe international block train is 10214 kilometers and the number of it is “80001”. It is the “No.1” of all the block trains from China to Europe. The first Zhengzhou-Europe international block train start to run on July 18,2013. And by the end of June 2017, the total running trains are 675, the cumulative value of goods are 3.532 billion US dollars and the gross loadage are 345.5 thousand tons. Zhengzhou-Europe international block train has developed to a main artery of railway logistics that run through the Eurasia and “Connect home and abroad, link the east, the central and the west of China”.

Zhengzhou is one of the first 5 node cities of “cross-border e-commerce service” in China and has

been approved by the General Administration of Customs of P.R.C to be the first node city to develop cross-border trade and e-commerce in June 2013. Zhengzhou has been approved again to be a comprehensive pilot zone of China (Zhengzhou) cross-border e-commerce in Jan 2016, and the e-commerce begin to show an explosion trend. The volume of trade of Zhengzhou cross-border e-commerce reaches to 4billion US dollars in the first half of 2017 and the import-export business cover more than 40 countries. The Zhengzhou cross-border e-commerce business is at the forefront among all the node cities in China and is moving forward to the grand goal of “Buy and sell globally”.

Business flow and logistics are inseparable; business flow is the premise of logistics while the latter is the guarantee of the former. The relationship between Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce are similar, they have a close relation and develop together. In the future development, they should pay more attention to mutual promotion and synergy development. But for the moment, Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce are operated by two independent companies. The former is run by Zhengzhou International Hub Development and Construction Co., Ltd and the latter is run by Henan Bonded Logistics Center, they belong to two relatively independent subsystems. It is necessary to deeply analyze the synergy development of Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce and then put forward some proposals to promote the win-win development of them in order to enhance the development of them, achieve the organic combination of international logistics and cross-border business flow as well as promote the construction of

2. LITERATURE REVIEW

Recent years, there are quite a few results about the research on cross-border block trains and e-commerce. Among them, the research on cross-border block trains mainly focus on the problems of development and the solutions (Jiafeng Li, 2016; Rong Chen, 2015), operations management (Qianli Dong, 2016; Huanhuan Qin, 2016), cost economy (Xinping Fu et al. 2016) and so on. And the research on cross-border e-commerce mainly focus on the problems of development and the solutions (Peiqiong Wei, 2017; Lei Sun, Fang Wang, 2015), operations management (Lu Yang, Chengke Zhang, 2017; Xuanxuan Zhang, Cuohua Cao, 2017) and supply chain management (Huijun Zhou, Wei Yan, Lang Xu, 2017; Yuqiong Tao, 2017) and so on. The research on the relationship of the cross-border e-commerce and cross-border block trains and the composite system thereof have two kinds of results. The first kind of result are from the perspective of cross-border logistics supporting the development of cross-border e-commerce, which analyze the problems of logistics and the constraints thereof, logistics operation and model innovation (Dandan Zhang et al. 2017; Helga Pavlić Skender, Alen Host, Melisa Nuhanović, 2016; Ewa Płaczek, 2010); while the second kind mainly analyze the synergy development of the cross-border e-commerce and cross-border logistics composite system, this kind of literatures are less, for example, Li Xue and et al. (2016) explained the synergy operation mechanism of the cross-border e-commerce through synthetically applying the supply chain process structural thought of SCOR Model and the synergy supply chain management thought of CPFR Model (Xue Li, Xiaofang Xun, Xiaozhi Li, 2016). Wang Chunzhi and et al. (2015) conducted research on the service spare parts cross-border logistic collaborating system based on the grounded theory to promote the optimization and competitiveness of logistic chain overall benefits. Zhang Xiaoheng and et al. (2016) studied the cross-border e-commerce and cross-border logistics synergy: mechanism and path. He confirmed the synergy rubric by constructing the structural equation model of cross-border e-commerce logistics.

In summary, the previous research has rarely involved the synergy degree measurement of cross-border international logistics and cross-border e-commerce. What's more, Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce are new things that begin to develop rapidly in recent years, so the research on the synergy development of them are still less. Therefore, this paper will analyze the cross-border e-commerce and modern logistics on the basis of composite system synergy degree model and measure the synergy degree of Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce in recent years, and provide some proposals to promote the coordinated and win-win development of them in the future.

3. THE SYNERGY DEGREE MODEL OF COMPOSITE SYSTEM

According to the thesis of synergetics (Haken, 1990), systematic coordination means that the system elements are harmonious with each other in the process of development and evolution, and the degree of harmony is called synergy degree. While the coordination of composite system means the harmony between each subsystem, and it is called composite system synergy degree. The harmony between each subsystem is beneficial to help realize the overall effect of composite system and obtain a better overall efficacy of "1+1>2" (Ansoff H I, 1965). Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce are now operated by two independent companies so the subsystems of them are also belong to two relatively independent subsystems. The two subsystems have all developed much in their own field but how is the condition of their mutual promotion and synergetic development?

This paper borrowed the research of Meng Qingsong and et al. (2000), and constructed the synergy degree model of Zhengzhou-Europe block train and Zhengzhou cross-border e-commerce composite system and measured it.

Suppose $S = \{S_1, S_2\}$ is the composite system of Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce, wherein S_1 is the subsystem of Zhengzhou-Europe international block train, and S_2 is the subsystem of Zhengzhou cross-border e-commerce, both are always interacting with each other to promote the composite system change from a random state into an ordered state.

Let $e_1 = \{e_{11}, e_{12}, \dots, e_{1j}\}$ be the order parameter of the subsystem of Zhengzhou-Europe international block train; and let $e_2 = \{e_{21}, e_{22}, \dots, e_{2j}\}$ be the order parameter of the subsystem of Zhengzhou cross-border e-commerce. Wherein, $j = 1, 2, \dots, n$, means the number of the order parameter index included in the two subsystems, $\alpha_{1j} \leq e_{1j} \leq \beta_{1j}$, $\alpha_{2j} \leq e_{2j} \leq \beta_{2j}$ (α_{ij} is the lower bound of e_{ij} , and β_{ij} is the upper bound of e_{ij}). When e_{ij} is benefit index, bigger numeric value is better, When e_{ij} is cost index, smaller numeric value is better.

The calculation formula for the order degree of order parameter:

$$u_i(e_{ij}) = \frac{e_{ij} - \alpha_{ij}}{\beta_{ij} - \alpha_{ij}} \quad (1)$$

$$u_i(e_{ij}) = \frac{\beta_{ij} - e_{ij}}{\beta_{ij} - \alpha_{ij}} \quad (2)$$

If e_{ij} is benefit index, use formula(1), and if e_{ij} is cost

index, use formula(2).

We can know from the formulas above, when $u_i(e_{ij}) \in [0,1]$, the bigger the $u_i(e_{ij})$ is, the greater the contribution it will make to the subsystems.

In general, the “total contribution” that made by the variable of order parameter e_j to the system S_j can realize by the integration of $u_i(e_{ij})$, and the order degree of subsystem $u_i(e_i)$ can also obtained by integration. Below is the calculation formula:

Linear weighted sum method:

$$u_i(e_i) = \sum_{j=1}^n \lambda_j u_i(e_{ij}) \quad (3)$$

Or, geometric method:

$$u_i(e_i) = \sqrt[n]{\prod_{j=1}^n u_i(e_{ij})} \quad (4)$$

Wherein λ_j is the weight of the j_{th} order parameter index. The geometric method can well reflect the coupling degree within each subsystem and help avoid the effects bring by subjective weighting method as well as meet the requirements of analyzing, so this paper calculate the order degree of subsystem $u_i(e_i)$ with geometric method.

The composite system of Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce remains in the process of dynamic evolution, suppose $u_i^{t_0}(e_i)$, $u_i^{t_1}(e_i)$ respectively denote the order degree of the subsystems of Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce in the period t_0 and t_1 . If $u_i^{t_1}(e_i) \geq u_i^{t_0}(e_i)$, it means that in the period $[t_0, t_1]$, the subsystems of Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce have positive synergy, and the composite system of them is positively synergistic.

Suppose U is the synergy degree of the composite system, and the calculation formula is:

$$U = \theta_2 \sqrt{\prod_{i=1}^2 |u_i^{t_1}(e_i) - u_i^{t_0}(e_i)|} \quad (5)$$

The synergy degree of the composite system U provides us the measure criterion or evaluation criterion to examine the coordinated development effect of Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce composite system.

From formula(5) we can know that $U \in [-1,1]$. When $U \in [0,1]$, bigger numeric value means a higher coordinated development degree of the composite system; when $U \in [-1,0]$, smaller numeric value means

that there is at least one subsystem in the composite system is not transform to the orderly direction, and we can consider that the composite system is under uncoordinated development state from t_0 to t_1 .

Particularly, $U = 1$ means the composite system is extremely coordinated and $U = -1$ means extremely uncoordinated.

4. THE SYNERGY DEGREE MEASUREMENT OF COMPOSITE SYSTEM

4.1 The choice of order parameter index

Choosing the appropriate subsystem order parameter is the key to the construction of synergy degree composite system model. According to the synergetic theory, we can learn that the synergetic development of Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce means that the subsystems of them transforming from a random state into an ordered state under the domination of order parameter. Here we need to choose the order parameter respectively and construct an order parameter index system of composite system in accordance with selecting principle of scientificity, relativity, availability, and rationalization etc. And also, we should take the operating characteristics of the two subsystems into consideration.

As for the subsystem of Zhengzhou-Europe international block train, this paper selects the overall carrying loadage, the value of goods, the running trains, the leaving trains to be the order parameter evaluation index. While as for Zhengzhou cross-border e-commerce, the volume of business, the value of goods, the export volume. Zhengzhou-Europe international block trains comes formally into operation on July 18, 2013 and the pilot project of Zhengzhou cross-border e-commerce also start its business test in July 2013. For the sake of precisely examining the synergy of the composite system, this paper constructs the model based on the data in 2014, 2015, 2016. All the data of this paper are mainly from the official websites of Zhengzhou International Hub Development and Construction Co., Ltd and Henan Bonded Logistics Center, the core area of Zhengzhou cross-border e-commerce comprehensive pilot zone. The detailed data are shown in Table 1 and Table 2.

Table 1: The numeric value of order parameter index of Zhengzhou-Europe international block train subsystem.

	2014	2015	2016
loadage (10 thousand tons)	3.61	6.35	12.86
value of goods(a hundred million US dollars)	4.30	7.14	12.67
the running trains	87	156	251
the leaving trains	78	97	137

Table 2: The numeric value of order parameter index of Zhengzhou cross-border e-commerce subsystem.

	2014	2015	2016
volume of business (10thousand orders)	49.4	5001. 6	8290. 3
value of goods(a hundred million Yuan)	1.05	39.26	64.00
export volume (10thousand orders)	4.4	475.5	2938. 1

4.2 The measurement of the order degree of order parameter for subsystem

The data in Table 1 and Table 2 are benefit index, so we calculate with formula (1) and obtain the order degree of order parameter of the two subsystems shown in Table 3 and Table 4. And in the process of calculating, the upper bound and the lower bound of the order parameter index are respectively derived from the corresponding data of the actual volume in 2013 and the predicted volume in 2017 of the two subsystems.

Table 3: The order degree of order parameter of Zhengzhou-Europe international block train subsystem.

	2014	2015	2016
$u_1(e_{11})$	0.090958	0.238428	0.588805
$u_1(e_{12})$	0.168410	0.316946	0.606172
$u_1(e_{13})$	0.158602	0.34408	0.599462
$u_1(e_{14})$	0.290698	0.401163	0.633721

Table 4: The order degree of order parameter of Zhengzhou cross-border e-commerce subsystem.

	2014	2015	2016
$u_2(e_{21})$	0.003443	0.363883	0.603248
$u_2(e_{22})$	0.009592	0.376115	0.613429
$u_2(e_{23})$	0.000853	0.095828	0.592341

4.3 The measurement of the order degree of subsystems

Using formula (4) to calculate and obtain the order degree of Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce subsystems. The results are shown in Table 5.

Table 5: The order degree of Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce subsystems.

	the order degree of Zhengzhou-Europe international block train subsystem	the order degree of Zhengzhou cross-border e-commerce
2014	0.163020	0.003043
2015	0.319582	0.235826
2016	0.606816	0.602944

4.4 The measurement of the synergy degree of composite system

Using formula (5) to calculate and obtain the synergy

degree of the composite system. The results are shown in Table 6. Then respectively draw the trend graph of the order degree of Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce subsystems and the synergy degree of the composite system. See Figure 1.

Table 6: The synergy degree of composite system.

the synergy degree of composite system	
2014	0.022271
2015	0.190906
2016	0.324729

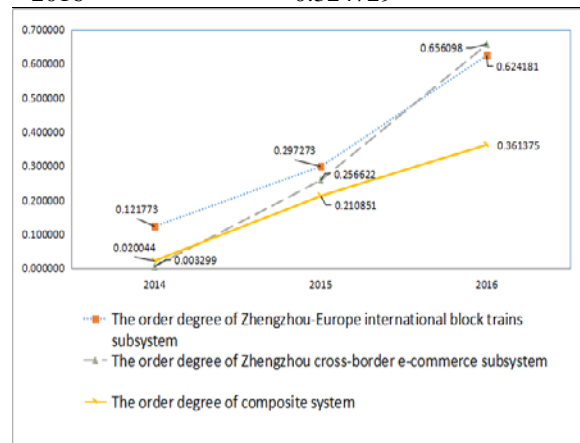


Figure 1: Trend graph of subsystems order degree and composite system synergy degree.

4.5 The analysis of composite system synergy degree

From Table 5, Table 6 and Figure 1, we can learn that:

(1) The order degree of order parameter of Zhengzhou-Europe international block train subsystem has continuously improved. The order degree of its subsystem rising exponentially from 0.163020 in 2014 to 0.606816 in 2016 which means that the operation of Zhengzhou-Europe international block train develops rapidly toward orderly and benignize orientation.

There's an old saying that those who conquer the central plains, win China. Zhengzhou is located in the core of the central plains in China, the congenital geographical advantages make Zhengzhou to be the vital caravan of the transportation and logistics of the East, the Central and the West of China. Zhengzhou is also a place that connects the Bohai, the Yangtze River delta and the Pearl River economic circles, which provides an endless supply of cargo for Zhengzhou-Europe international block train. Zhengzhou-Europe international block train adopted the operating mechanism of "guided by government and commercialized operation" and achieved remarkable social and economic results by creating advantages in operation, organization, assembling & evacuating network and talents. And the running trains, the roundtripping balance, the value of goods, the overall loadage and the load factor are all ranking top of all the China-Europe Railway Express. The project "one main line and three branch lines" of Zhengzhou-Europe international block train was elected to be the first batch multimodal transportation demonstration projects of China in May 2016. The support of government, the

advantage in location as well as the well operation of the enterprise itself, have all contributed much to make the Zhengzhou-Europe international block train subsystem developing for the orderly direction.

(2) The order degree of order parameter of Zhengzhou cross-border e-commerce subsystem showed a rapid rising trend. The subsystem order degree was still very low in 2014, only 0.003043, but it ups to 0.235826 in 2015 which is 70 times more than the former year, and increase to 0.602944 in 2016. That means each part inside the system gradually step into the synergetic development.

Henan Bonded Logistics Center pioneered the cross-border shopping bond entry pattern (1210 pattern), which means that the cross-border e-commerce enterprises centralized purchasing the goods from overseas, and send to domestic bonded warehouse. When customer ordered online, the logistics company will send the commodity from the warehouse to domestic customers. The cross-border shopping in "1210 pattern" can provide more ensure on the quality and the speed of delivery than overseas purchasing agents, express delivery with customs clearance process and direct mail. Henan Province, with a population of more than a hundred million, is the largest province in population of China. And the central Henan urban agglomeration with Zhengzhou as its core has a population of two hundred million or so which has formed a huge a consumer market and has contributed much to the rapid development of cross-border e-commerce. With the integration of Henan free trade pilot region, Zhengzhou cross-border e-commerce comprehensive pilot zone and Zhengzhou comprehensive bonded zone in Jingkai District, the E-commerce in Zhengzhou has gained good performance of "total orders breaking one million, taxes breaking one billion and volumes breaking 10 billion". Zhengzhou cross-border e-commerce subsystem will continuously develop toward the orderly direction thanks to the constant innovation of the operation pattern, the huge external demand and the superimposed policy benefits.

(3) The synergy degree of Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce composite system is still very low at this stage, but it shows a trend of growing annually. From Figure 1, we can know that the order degree of Zhengzhou-Europe international block train subsystem is a bit higher, the cross-border logistics service provided by Zhengzhou-Europe international block train performs as a pulling force to the development of Zhengzhou cross-border e-commerce; but the order degree of Zhengzhou cross-border e-commerce subsystem grows much faster, it appears on track to surpass the subsystem of Zhengzhou-Europe international block train. And the synergetic pattern will also change from "logistics driving" to "logistics following", the continuous expansion of the development scale of Zhengzhou cross-border e-commerce will bring more supplies for Zhengzhou-Europe international block train. Although the two subsystems are developing toward the orderly direction, the synergy degree of composite system is still very low, 0.022271 in 2014 and 0.324729 in 2016. However, the synergy degree of composite system is

growing year by year which means that Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce present a good trend of mutual promotion and synergetic development.

Concretely analyze it, we will find the main reasons: First, Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce are all in their initial stages of development. Second, Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce are operated by two independent companies for the moment, and their collaboration is still not tacit enough. Third, Zhengzhou-Europe international block train and cross-border e-commerce are two important export-oriented development platforms in Zhengzhou, two important carrier of Henan international logistics and business, as well as the core area of Henan free trade pilot region. From the close correlation of business flow and logistics mentioned above, we can know that the two subsystems are born with strong affinity, so the synergy degree of Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce composite system will improve much in the future and also their relationship.

5. THE STRATEGIES OF IMPROVING THE SYNERGY DEGREE OF ZHENGZHOU-EUROPE INTERNATIONAL BLOCK TRAIN AND ZHENGZHOU CROSS-BORDER E-COMMERCE COMPOSITE SYSTEM

To strengthen cooperation is the fundamental way for Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce to achieve synergetic development and form the community of interests. Based on the analysis above, here we will give some suggestion for promoting the synergetic development of them:

(1) Mutual stock holding. The two operation subjects can achieve their common interest and synergetic operation through stock-exchange and cross-shareholding.

(2) Co-build an information platform. The two subjects can start their co-construction of an information platform on the premise of mutual trust and government supervision so as to integrate the data of Zhengzhou-Europe international block train, Zhengzhou cross-border e-commerce, payment, insurance, custom clearness process, and inspection and quarantine etc.

(3) Share the operation network. Both Zhengzhou International Hub Development and Construction Co., Ltd and Henan Bonded Logistics Center have established their logistics networks and have spent large sum of money to build many "overseas warehouse". The network and resources sharing can not only help to reduce unnecessary overlapping investment, but also help to effectively perfecting deficiencies and improve the efficiency and economic benefits of logistics network home and abroad.

(4) Co-invest to strengthen the intelligent construction.

The two companies can jointly invest in advanced

Internet, Internet of things, cloud computing, and big data technology, and jointly build Zhengzhou Intelligent cross-border e-commerce logistics platform to promote the fully synergy and “seamless connection” of cross-border e-commerce and logistics.

(5) Speed up the cultivation of compound talents and the building of operation team.

(6) Strengthen multi-party collaboration to promote synergetic development.

The synergetic development of Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce needs multilateral cooperation of the government, the enterprises and profession associations. The government should make more policies that are beneficial to the synergetic development and provide accurate instruction; the profession associations should strengthen the supervision of enterprises to lead them healthily develops toward synergetic development direction; and the enterprises of both sides should formulate coherent strategic and implement plans so as to achieve resources sharing and win-win development.

6. CONCLUSIONS

This paper has constructed a synergy degree model of Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce composite system. By analyzing the synergy degree of the two subsystems in recent years, the author found that the order degree of the subsystems of Zhengzhou-Europe international block train and Zhengzhou cross-border e-commerce has revealed a zooming trend, but the coordinating measurement with respect to the composite system has showed a trend of “low at the beginning but increase rapidly year by year”. This is mainly because Zhengzhou-Europe international block train and cross-border e-commerce are two emerging business models in recent years. And they are run by two respective companies so that the collaboration between the two systems are not tacit enough.

Business flow and logistics are born with strong affinity, they have a close relation and develop together. In view of this relation, the paper put forward the further cooperative strategies and suggestions for the synergy development of Zhengzhou-Europe international block train and cross-border e-commerce and the formation of a community of interests.

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