Research on Interactive Development of Manufacturing Industry and Logistics Industry Based on Depth Grey Correlation Analysis

Taking Xinjiang as an example

Liu Xiaqing [1, 2]
1. College of Foreign Languages
Shandong Institute of Business and Technology
Yantai, P.R. China
2. College of Economics and Management
Nanjing University of Aeronautics and Astronautics
Nanjing, P.R. China
e-mail: liuxiaqing111@163.com

Li Songqing
College of Foreign Languages
Shandong Institute of Business and Technology
Yantai, P.R. China
e-mail: liuxiaqing718@163.com

Zhang Na*
Commercial College
Shihezi University
Wujiaqu, China
e-mail: 332853225@qq.com
* Corresponding Author

Dou Yuting
College of Foreign Languages
Shandong Institute of Business and Technology
Yantai, P.R. China
e-mail: zhangzhiheng2001@163.com

Abstract—With the development of economic globalization and socialized division of labor, logistics industry has been playing significant role in improving industrial modernization, competitive advantage of manufacture, and national economic quality. Taking Xinjiang as an example, total output value of logistics increases by years, while its cost decreases dramatically. Manufacturing industry plays a vital role in national economic development of China, a manufacturing power. It is necessary and essential to strengthen the supporting role of logistics towards manufacturing and leading role of manufacturing towards logistics, so as to improve interactive development of two industries. This paper builds a depth grey correlation analysis model, analyzes the correlation development of manufacturing industry and logistics industry in Xinjiang, establishes an evaluation indicator system including volume of freight traffic, rotation volume of freight transport, total industrial output value, storage, total output value of mail business and total output value of eleven main manufacturing industries in Xinjiang. The eleven industries are categorized into three groups in accordance with correlation degree. For instance, textile industry, non-ferrous metals mining and dressing industry are closely correlated with logistics industry. Finally, in terms of practical situation of Xinjiang and analysis results, some recommendations for policy making are proposed.

Keywords-depth grey correlation analysis; interactive development; main manufacturing industry; logistics; Xinjiang

I. INTRODUCTION

Since the implementation of the 12th Five Year Plan, the collaboration and interactive development of manufacturing industry and logistics industry has drawn the attention of governments and society. Documents such as Logistics Medium and Long-term Plan issued by the State Council indicate the importance and urgency of the interactive development of manufacturing and logistics industry. Strategies of "One Belt and One Road", and "Walking out" provide solid policy guarantee for the interactive development. Logistics, known as accelerator of economy development, has become a new economic growth point in national economy, and its development level is one of important indicators for modernization and comprehensive national power.

Grey system theory, proposed by Professor Deng Julong in 1982, is widely used in solving uncertain problems with little data and poor information. Grey correlation analysis judges the correlation in accordance with the similarity of the geometry of the order curve. The more similar, the closer the correlation is. In the process of development, the more similar the changing trend, the closer the correlation is, and vice versa. [1-2] The grey correlation provides quantization measurement for analyzing the changing trend, which is appropriate for dynamic trend analysis. [3] In view of such factors as ever-changing and uncertain property of the correlation between

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logistics and manufacturing, logistics statistics delay, the data collected about domestic logistics has the characteristics of small sample and uncertain information.

The intrinsic correlations between factors are often neglected in grey correlation analysis. The intrinsic correlations reflect the importance of indicators in weight determination. Therefore, this paper adopts the concept of depth grey correlation coefficient, which to a certain extent reveals the relative importance of each indicator. [4] The depth grey correlation coefficient is denoted as

$$q_i(k)=\frac{\gamma\left(X_i(k),X_0(k)\right)}{\sum_{i=1}^{n}\gamma\left(X_i(k),X_0(k)\right)} \quad (1)$$

where $q_i(k)$ is the depth grey correlation coefficient, and $\gamma\left(X_i(k),X_0(k)\right)$ is the grey correlation coefficient of the action sequence $X_i=\left\{x_i(k)\,|\,k=1,2,\cdots,m\right\}\left(i=1,2,\cdots,n\right)$ and the reference sequence $X_0=\left(x_0(1),x_0(2),\cdots,x_0(m)\right)$.

Since logistics is categorized into productive service industry, the theoretical basis and research methods for "manufacturing and logistics" is similar to those for "manufacturing and productive service industry". As early as 1999, Se Hark Park measured the relationship between manufacturing and other productive service activities by calculating independence degree. [5] Wang Junhu revealed the objective requirements for simultaneous development of service industry and manufacturing based on grey correlation analysis on manufacturing and service industry of various areas in China with different development levels.[6] Yuan Kezhu studied the correlation between logistics and manufacturing in Changjiang triangle area.[3] Han Xiaoli, *etl.* concluded that the collaborative development of manufacturing and logistics in Jiangsu Province is at the level of critical state of collaborative and non-collaborative.[7] Wang Zhenzhen calculated the correlation between different manufacturing industries and logistics.[8] Most researches on manufacturing and logistics in China pay more attention to the relationship of two industries and empirical studies, and focus on the analysis of interactive development situation, and little research is conducted for interactive mechanism of the two industries.

This paper builds a manufacturing-logistics correlation model based on the study of current situation of manufacturing and logistics which is revealed from the statistic data. The correlation of manufacturing and logistics is studied by means of the depth grey correlation model, in order to find out the collaboration mode of typical manufacturing and logistics. This paper takes Xinjiang as a research object, and its research results have great practical significance for improve industrial competitiveness of Xinjiang.

II. CURRENT SITUATION OF LOGISTICS AND MANUFACTURING INDUSTRY IN XINJIANG

A. Current Situation of Logistics

With the development of market economy, the logistics has nine development tendencies, that is, full of information, networked, automated, sharing, globalized, standardized, specialized, integrated and socialized. [8] President Xi Jinping proposed a significant strategy "one belt one road", which provides opportunity for logistics development. Logistics in Xinjiang is at the transition from physical allocation to comprehensive logistics, supply chain logistics, and global logistics, the demand in logistics market is expanding and socialized service system is being established gradually. The development tendencies of logistics in Xinjiang are illustrated as following.

- The logistics on a whole grows fast. In 2013, the whole society freight reached 837.17 million ton, which was increased by 7 percent, railway, highway, civil voyage, and pipeline take the proportion of 8.84%, 81.86%, 0.008%, and 9.3 respectively. The freight transfer is as high as 249.029 billion ton kilometer, which drops by 2.67%. At present, Xinjiang has formed a logistics transportation pattern that highway transportation.
- Logistics infrastructure has been improved. An integrated transportation network system is formed, which connects inland, Central Asia, South Asia, and Europe. In September, 2013, "co-consulting, co-building, and sharing" principle suggested by "New Silk Road Economic Belt" actively propelled the connection and cooperation of areas along the Line. Total distance of highway is as long as more than 170 million meters, length of railroad lines in service rises up to 5 million meters, cruising range of civil aviation reaches 2.3 billion meters, and a comprehensive collecting and distributing system has been formed. Such supporting facilities as warehouse logistics facilities for bulk farm products, logistic distribution center for agriculture material, and cold-chain logistics infrastructure for fresh agriculture products are built, network technology is applied to logistics, and the role of modern logistics platforms are highlighted.
- The number and scale of logistics enterprises increase rapidly. Traditional transportation, storage, freight forwarding companies are transforming to modern logistics enterprises. A batch of new type logistics companies are emerging, and large-scale logistics enterprises such as ZTO express, Yuantong Logistics, Shunfeng Logistics, Yunda Express have entered and been stationed in Xinjiang. There are more than 1300 registered Post Office business-net spots.
- Logistics agents have a tendency of diversified development, and a multi-layered logistics enterprise group with varied ownership and multiple service modes has been formed, which drives the emergence and development of professionalized, large-scale third-party logistics companies.

However, there exist a lot of problems in the development of modern logistics as well.

- The overall scale of logistics in Xinjiang is relatively small, and the logistics cost is still higher than other developed areas. Added value of logistics in Xinjiang takes proportion of less than 10% in GDP, which is much lower than national

average. Total social logistics cost takes the proportion as large as 18% in 2014, which is a bit higher than national average level.

- Demand and supply for socialized and specialized logistics is insufficient. Existing logistics companies are transformed from small-scaled traditional transport companies, storage and transport companies that has the characteristics of single function and service, and scattered source. It is hard for those companies to form strong competitive. Nowadays, more than 75% manufacturing companies and 70% of commerce and trade companies depend mainly on their self-support logistics, and the third party logistics only occupy about 4% in the logistics market.
- Logistics infrastructure is deficient and technological equipment and management tool fall behind. Railway transport capacity is inadequate and the ratio of supply and demand is only 1 to 3. In accordance with the current rate, the transportation cost for 100 million RMB Yuan is twice the national average. Most of high freight terminal is less mechanized and automated, and dead lifts loading and unloading operation falls far behind the large-scale mechanized container transportation. In addition, multimodal transportation has not been formed for lacking integration among logistics.
- Informationalization level of logistics in Xinjiang lags behind. There lacks sound service network ad information system, information sharing and real-time tracking system has not been built and labor cost is high. The lack of information sharing platform limits the communication between upper stream and lower stream and hinders the development of supply chain.

B. Current Situation of Manufacturing Industry

The development level of manufacturing is an important indicator for evaluating the economic strength in the area. Xinjiang mainly relies on its source-based industries, for instance, rich minerals and natural gas, and it gives insufficient support for the development of manufacturing. Therefore, it is critical for Xinjiang to speed up economic transformation, and analyze and evaluate the development level and competitive power of manufacturing, so as to put forward reasonable countermeasures and realize the great-leap-forward development.

In recent year, China pays more attention to the Western areas, which are revealed clearly from national development strategies. For example, Kashgar is identified as the sixth special economic zones and the first inland special economic zone in 2010. Xinjiang with its unique resource superiority and geographic advantage has become a key area for the implementation of systematic openness strategy. Rapid progress and development have been seen in Xinjiang since 2008, which attributes to the development of agriculture. The total value of output increases at the same speed of the GDP which is much lower than the average growth of national total industrial output value 14%. In the respect of inner structure of industry, resource-based industry accounts for a large proportion. On account of backward management concept and technology bottleneck, the development of the resource-based industry is limited which in turn negatively influences the integral development of industry in Xinjiang. The good news is that the manufacturing grows steadily and its output value kept rising during 2008 and 2009 when the total output value had negative growth, and the proportion of manufacturing has been increasing gradually.

The top ten of manufacturing in Xinjiang concentrates on featured resource processing industries, among which oil processing, coking, and nuclear fuel processing ranks at the top places. As a whole, the output value of manufacturing in Xinjiang is driven by resource-related industries and heavy chemical industry.

III. INTERACTIVE DEVELOPMENT OF LOGISTICS AND MANUFACTURING INDUSTRY

A. Indicator Selection

Logistics in Xinjiang began to develop recently, so there are few related statistical data. In this case, statistics of freight transportation are used for referee, considering the fact that freight transportation is the dominate form of logistic process and runs through the whole process of logistics activities. Therefore, volume of freight traffic, rotation volume of freight transport, total industrial output value, communication and transportation, storage, total output value of mail business are selected as principal factors. As for manufacturing industry, oil and natural gas exploration industry, ferrous metals mining and dressing, non-ferrous metals mining and dressing, petroleum refining, coking and nuclear fuel processing industry has great competitive advantages. In this paper, 11 industrial enterprises above designated size are chosen as comparative sequence indicators with consideration of current situation of Xinjiang industries and advice and recommendations from experts.

The dimension of raw data is different, so the indicators should be made dimensionless for comparison. Initial value method is used in this paper, in which each numerical value is divided by the initial value in this sequence and a new sequence is gotten. In other words, the new sequence is a percent of indicator value to its initial value.

B. Data Resource

In accordance with relevant statistical material such as “Statistical Yearbook 2014 for Xinjiang Uyger Autonomous Region”, the data for logistic and manufacturing industry from 2008 to 2013 is cleared up. As is shown in Table 1, volume of freight traffic, rotation volume of freight transport and communication and transportation, storage, total output value of mail business, total industrial output value, total volume of foreign trade are used to approximately represent the indicators influencing the development of logistics. 11 industries are selected as the indicators of main manufacturing industry, namely, coal mining and dressing, petroleum and natural gas exploration industry, ferrous metals mining and dressing industry, non-ferrous metals mining and dressing industry, non-metal mineral mining and dressing industry, farm and sideline food processing industry, food manufacturing industry, textile industry, petroleum

processing, coking, and nuclear fuel processing industry, ferrous metals smelting and rolling industry, non-ferrous metals smelting and rolling industry.

TABLE I. RELEVANT DATA OF INTEGRATED LOGSTICS AND MANUFACTURING INDUSTRY IN XINJANG FROM 2008 TO 2013

Indicator	2008	2009	2010	2011	2012	2013
Volume of freight traffic (10,000 ton)	57187.8	60162.8	64596.7	70361.9	78248.8	83716.66
Rotation volume of freight transport (100 million ton)	1656.88	1815.81	2053.82	2199.52	2558.68	2490.29
Total output value, communication and transportation, storage, and mailing business	191.84	209.1	222.47	256.72	357.9	391.97
Total industrial value (0.1 billion Yuan)	4639.02	4184.5	5766.51	7105.31	7886.25	9121.22
Total volume of foreign trade (10,000 USD)	2221680	1382771	1712834	2282225	2517075	2756191
Coal mining and dressing industry	935456.5	1333269.7	1504627.9	1891207.7	2347353.4	2362426.8
Petroleum and natural gas exploration	13501303	8554229.4	11442905.6	14130667.7	13736414.3	13847366.9
Ferrous metals mining and dressing	719870.2	549739.2	877567.9	1043029.9	1216929.3	1495546.1
Non-ferrous metals mining and dressing	369971.4	298993.4	460091.1	567792.1	626231.1	634448.8
Non-metal mining and dressing	63838	64067.1	143433.3	180196.2	157574.7	215645.2
Farm and sideline food processing	1611197.6	1767111.2	2371733.4	2689141.9	3208192.5	3949988.6
Food manufacturing industry	728975.4	904873.2	1103349.2	1145998.6	1266942.4	1834795.9
Textile	866001.4	775562.4	1204723.9	1217671.9	1306516.2	1258401.8
Petroleum processing, coking, nuclear fuel processing	9043414.3	8597993.8	12450842	15720006.4	16731304.5	17295757.9
Ferrous metals melting and rolling	4067096.1	3811228.7	5531476.4	6795822.6	7407811.5	7281798.4
Non-ferrous metals melting and rolling	450403.9	336675	694500.8	1299808.2	2402504.4	5155995.8

C. Depth grey correlatio model construction and results analysis

The first step for measuring correlation between manufacturing industry and logistics is to select development indicators of logistics and manufacturing industry. The indicators are established in accordance with principles of science, practicability, and completeness.

The logistics development indicators include volume of freight traffic x1, rotation volume of freight transport x2, total output value of communication and transformation, storage, and mail business industry x3, total industrial output x4, and total volume foreign trade x5.

The indicators for manufacturing industry encompass total industrial output value of industrial enterprises above designated size which refer to coal mining and dressing industry y1, petroleum and natural gas exploration industry y2, ferrous metals mining and dressing industry y3, non-ferrous metals mining and dressing industry y4, non-metal mining and dressing industry y5, farm and sideline food processing industry y6, food manufacturing industry y7, textile y8, petroleum processing, coking, nuclear fuel processing industry y9, ferrous metal smelting and rolling industry y10, and non-ferrous metal smelting and rolling industry y11. The calculation steps are as following.

Step 1. Establish an evaluation indicator system.

Step 2. Build an indicator sequence reflecting system features and a reference sequence influencing system operation based on the qualitative analysis. This paper takes logistics X as the indicator sequence and manufacturing industry Y as the reference sequence.

Step 3. Make the data dimensionless. The common methods for dimension standardization are initial value method, mean value treatment, interval value method, and normalization. As the indicators in this paper belong to benefit indicators, and the higher correlation level, the better, this paper adopts the initial value method for dimensionless treatment.

Step 4. Calculate absolute different sequences for factors in the indicator sequence and reference sequence, which can be denoted as

$$\Delta_i(k) = | x_0^{'}(k) - x_i^{'}(k) | \quad (2)$$

where $\Delta_i = (\Delta_i(1), \Delta_i(2), \cdots, \Delta_i(n))$, $i = 1, 2, \cdots, m$

Step 5. Determine the maximum differential and minimum differential, which are denoted as

$$M = \max_i \max_k \Delta_i(k) \quad (3)$$

$$m = \min_i \min_k \Delta_i(k) \quad (4)$$

Step 6. Calculate the grey correlation coefficient as following.

$$\gamma_{0i}(k) = \frac{m + \xi M}{\Delta_i(k) + \xi M} \quad (5)$$

where $\xi \in (0,1)$, $k = 1, 2, \cdots, n$; $i = 1, 2, \cdots, m$.

The smaller ξ , the greater differential between correlation coefficient. The value of ξ is often taken as 0.5.

Step 7. Calculate grey correlation degree by means of arithmetic average method.

$$\gamma_{0i} = \frac{1}{n} \sum_{k=1}^{n} \gamma_{0i}(k) \quad ; \quad i = 1, 2, \cdots, m$$

Step 8. Conclude the evaluation results. The evaluation criteria are listed as following.

TABLE II. EVALUATION CRITERIA FOR GREY CORRELATION DEGREE

Numerical range	Correlation degree
$0 < \gamma_{0i} \le 0.35$	Weak
$0.35 < \gamma_{0i} \le 0.65$	Medium
$0.65 < \gamma_{0i} \le 0.85$	Strong
$0.85 < \gamma_{0i} \le 1$	Very strong

From the Table 1, the data of volume of freight traffic and 11 manufacturing industries are gotten, based on which difference sequences are calculated to get the maximum differential and minimum differential. Let the resolution ratio be 0.5, the correlation coefficient and correlation degree between volume of freight traffic and its influencing factors are gotten, as is shown in Table 3. It can be gotten from the Table 3 that 11 indicators of manufacturing and the volume of freight traffic are closely correlated. Wherein, textile ranks the top with the value of 0.973647 which falls into the category “very strong”, and the least closely correlated indicator is non-ferrous metals melting and rolling industry with the value of 0.750489, which is categorized into “strong”. Other indicators such as non-ferrous metals mining and dressing, ferrous metals melting and rolling, ferrous metals mining and dressing, petroleum processing, coking, and nuclear fuel processing

has higher correlation degree than non-ferrous metals melting and rolling processing industry. By contrast, non-ferrous melting ad rolling ranks below, but the correlation coefficient is 0.75 and still categorized as "strong" correlation. It is also shows that non-metal mining and dressing industry and non-ferrous melting and rolling industry contribute little to the development of logistics in Xinjiang.

TABLE III. CORRELATION COEFFICIENT AND CORRELATION DEGREE BETWEEN VOLUME OF FREIGHT TRAFFIC AND ITS INFLUENCING FACTORS

Manufacturing industry	2008	2009	2010	2011	2012	2013	Grey correlation
Coal mining and dressing industry	1	0.930126	0.912498	0.864283	0.815986	0.82629	0.891531
Petroleum and natural gas exploration	1	0.925853	0.949117	0.966648	0.937443	0.922879	0.950323
Ferrous metals mining and dressing	1	0.956963	0.966967	0.941428	0.921198	0.871786	0.943057
Non-ferrous metals mining and dressing	1	0.958613	0.972901	0.938174	0.934135	0.946549	0.958395
Non-metal mining and dressing	1	0.990632	0.823028	0.765403	0.825298	0.73076	0.855854
Farm and sideline food processing	1	0.984737	0.930038	0.913245	0.882987	0.829392	0.9234
Food manufacturing industry	1	0.962284	0.928232	0.935197	0.930188	0.82751	0.930568
Textile	1	0.975149	0.945489	0.960443	0.966264	0.994536	0.973647
Petroleum processing, coking, nuclear fuel processing	1	0.983338	0.951143	0.906964	0.910867	0.916064	0.944729
Ferrous metals melting and rolling	1	0.982233	0.952099	0.915636	0.913067	0.933986	0.949504
Non-ferrous metals melting and rolling	1	0.949026	0.917663	0.747265	0.555648	0.333333	0.750489

In the similar way, fig. 1, and Table 4 shows the correlation coefficient and correlation degree between rotation volume of freight transport, and communication and total output value of transportation, storage and mail business and their influencing factors respectively.

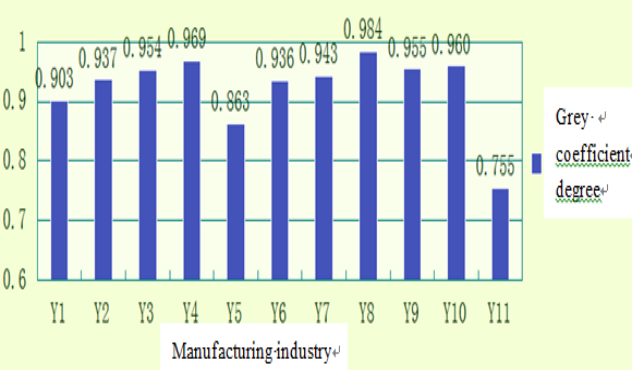

Figure 1. Grey correlation degree between rotation volume of freight transport and its influencing factors

From Fig.1, it can be concluded that 11 indicators of manufacturing and the rotation volume of freight transport x2 are much higher than those with volume of freight traffic x1. It can be gotten from Table 4 that the total output value of transportation, storage and mail business x3 and the indicators of manufacturing have relatively close correlation, of which non-ferrous mining and dressing industry has the highest correlation coefficient 0.971562, and non-ferrous metal melting and rolling industry have the lowest correlation coefficient 0.75205.

TABLE IV. CORRELATION COEFFICIENT AND CORRELATION DEGREE BETWEEN TOTAL OUTPUT VALUE OF TRANSPORTATION, STORAGE AND MAIL BUSINESS AND THEIR INFLUENCING FACTORS

Manufacturing industry	2008	2009	2010	2011	2012	2013	Grey correlation
Coal mining and dressing industry	1	0.932994	0.912895	0.873894	0.879245	0.905453	0.917413
Petroleum and natural gas exploration	1	0.915277	0.9408	0.944688	0.853111	0.828677	0.913759
Ferrous metals mining and dressing	1	0.947529	0.97084	0.957959	0.989213	0.963829	0.971562
Non-ferrous metals mining and dressing	1	0.949243	0.977178	0.954392	0.973874	0.944797	0.966581
Non-metal mining and dressing	1	0.982549	0.818604	0.767688	0.890716	0.78617	0.874288
Farm and sideline food processing	1	0.991404	0.931509	0.927124	0.962603	0.9094	0.953673
Food manufacturing industry	1	0.967337	0.92959	0.95113	0.978458	0.907004	0.955587
Textile	1	0.96643	0.947942	0.978844	0.939385	0.898942	0.955257
Petroleum processing, coking, nuclear fuel processing	1	0.974953	0.953964	0.920272	0.997869	0.979247	0.971051
Ferrous metals melting and rolling	1	0.973802	0.954982	0.929735	0.999334	0.958425	0.96938
Non-ferrous metals melting and rolling	1	0.939291	0.918371	0.748391	0.57291	0.333333	0.75205

According the methods, the correlation degree between 5 indicators of logistics and 11 indicators of manufacturing industry can be gotten, as is shown in Table 5. It can be seen clearly that the correlation degree falls within the range between 0.752484 and 0.965036, so all of them can be categorized into "strong" group and "very strong" group. Non-ferrous melting and rolling processing industry has the least correlation relationship with influencing factors of logistics with the coefficient 0.752484. From the aspect of average value, the average coefficient of coal mining and dressing industry y1 and the indicators of logistics is 0.897001, the average coefficient of the petroleum and natural gas exploration industry y2 and the indicators of logistics is 0.941092, and the average coefficient of the ferrous metal mining and dressing industry y3 and the indicators of logistics is 0.953855. it is thus clear that the rank order in accordance with coefficient is textile industry (0.965036) > non-ferrous metals mining and dressing industry (0.962729) > ferrous metal melting and rolling processing industry (0.954671) > (0.953855) > petroleum processing, coking, and nuclear fuel material processing (0.952344) > petroleum and natural gas exploration industry (0.941092) > food manufacturing industry (0.93656) > farm and sideline food processing industry (0.930005) > coal mining and dressing industry (0.897001) > non-metals mining and dressing industry (0.859366) > non-ferrous melting and rolling processing industry (0.752484).

Textile industry, as an indicator of manufacturing industry, has the highest coefficient with tonnage mileage and volume of freight traffic, and it has the highest coefficient with logistics among 5 indicators of manufacturing, which means that textile industry is the most significant factor influencing logistics development. In fact, agriculture technological level in Xinjiang has improved substantially with the development of economy, the cotton yield in white industry increases continually which drives the development of textile industry in Xinjiang. The correlation coefficients of non-metal mining and dressing industry, and non-ferrous metals melting and rolling processing industry with the development

indicators of logistics are 0.859366 and 0752484 respectively. The correlation degree is relatively low compared with other factors, which reveals that the interactive development between metal smelting industry and mining industry and logistics has not been formed. Therefore, the development of the two industries has limited facilitation to the development of logistics, and there is a room for improvement.

TABLE V. CORRELATION DEGREE OF MAIN MANUFACTURING INDUSTRY AND LOGISTICS

logistics / manufacturing	X1	X2	X3	X4	X5	Summation	Average value	ranking
Y1	0.891531	0.902545	0.917413	0.913901	0.859617	4.485007	0.897001	9
Y2	0.950323	0.937045	0.913759	0.917795	0.986538	4.70546	0.941092	6
Y3	0.943057	0.953716	0.971562	0.982316	0.918625	4.769276	0.953855	4
Y4	0.958395	0.969437	0.966581	0.987212	0.93202	4.813645	0.962729	2
Y5	0.855854	0.862998	0.874288	0.874623	0.829069	4.296832	0.859366	10
Y6	0.9234	0.935741	0.953673	0.949171	0.888041	4.650026	0.930005	8
Y7	0.930568	0.943493	0.955587	0.95832	0.894836	4.682804	0.936560	7
Y8	0.973647	0.984441	0.955257	0.970939	0.940899	4.825183	0.965036	1
Y9	0.944729	0.954992	0.971051	0.978832	0.912117	4.761721	0.952344	5
Y10	0.949504	0.959909	0.96938	0.97777	0.916796	4.773359	0.954671	3
Y11	0.750489	0.755467	0.75205	0.762979	0.741435	3.76242	0.752484	11
Summation	10.07149	10.15978	10.20060	10.27385	9.819993			
Average value	0.915590	0.923616	0.927327	0.933987	0.892726			
Ranking	4	3	2	1	5			

Integrate Fig. 2 with Table 5, we will draw the conclusion that freight volume and tonnage mileage which have the highest coefficient with logistics industry have high coefficient with textile, non-ferrous metals mining and dressing industry, ferrous metals melting and rolling processing industry, petroleum processing, coking, nuclear fuel processing industry, and non-ferrous mining and dressing industry. The bottom two industries are non-metal mining and dressing industry and non-ferrous melting and rolling processing industry.

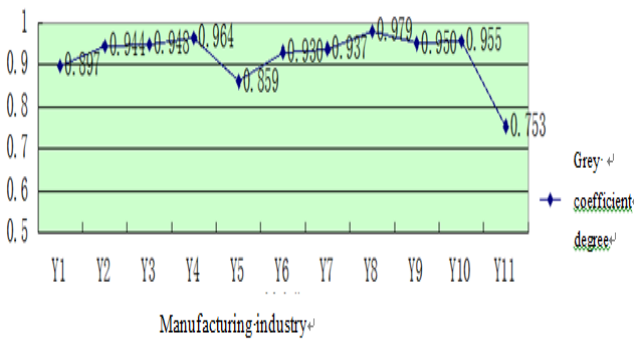

Figure 2. Grey Correlation Degree of volume of freight traffic and rotation volume of freight traffic, and main manufacturing industry

It can be concluded that the output of cotton and rich minerals contribute mainly to the interactive development of manufacturing industry and logistics, because the development of textile and metal mining and smelting industry accelerate the circulation of goods and promote the development of logistics. The development of tertiary industry and foreign trade improve the logistics in Xinjiang. Manufacturing is an important factor that facilitates the development of logistics, but it is not the primary one. In conclusion, logistics and manufacturing industry in Xinjiang is disjointed to some extent, and the interactive development has a long way to go.

IV. STRATEGIES AND SUGGESTIONS FOR THE INTERACTIVE DEVELOPMENT O LOGISTICS AND MANUFACTURING INDUSTRY

A. Emphrasize on planning guidence, and make overall plan for interactive development of the two industries

Xinjiang, as an important gateway for "open up of the west", has an edge on strategic resources, and is equipped with the advantages of developing modern logistics. [9] Industry especially manufacturing industry has a great role for raising the service quality and standard of logistics and promoting the upgrading of industrial structure. The development of manufacturing industry in Xinjiang should concentrate on industry chain extension, which drives the development of relevant industries by means of its radiation effect. It is recommended that introduce technology introduction, optimize the industrial structure, support high and new technology industry, agglomerate resource-related industry, and improve overall competitiveness of the manufacturing. As an action agenda which is proposed by more than a hundred academician and experts, "Made in China 2025" put forward a "three-step" strategy for manufacturing development, [10] in which innovation-driven, intelligence transition, foundation-strengthened, green development and talent-oriented are concentrated and finally a powerfully manufacturing country will be established.

In accordance with resource superiority, cultivation and development of specialty industry in Xinjiang is the driving force of economic development and the vital basis for sustainable development of logistics. Specialty industry focuses on the development of product and service with local features and form unique production technology, production low and organizational management pattern. In Xinjiang, the specialty industry includes coal mining and dressing industry, petroleum and natural gas industry, non-ferrous metal and ferrous metal mining and dressing industry, agriculture and sideline food processing industry, food manufacturing, textile industry, and petroleum processing and so on.

B. Innovate institution and policy

In combination of the practical situation of Xinjiang, a medium and long term development plan for manufacturing industry and logistics should be set up. Industry cluster of industrial parks should be planned avoiding repeated construction of industrial parks and industrial cluster. Logistic service system for manufacturing agglomerate areas is planned so that radiation effects of the logistics parks give a full play. It should be noticed that modern logistics covers many industries like transportation, warehousing, freight forwarding, and information industry, but it needs a mutual integration and convergence of those industries instead of a simple connection between those industries. The innovation of institution and policy can be conducted from the following ways.

On one hand, institution innovation should be deepened to break through the administrative partition and mechanism impediment. The industry and sector monopoly should be broken and multi-model transport system and new-type logistics enterprises will be established. On the other hand, logistics policy system should be improved. On the basis of related planning and supportive policies and measurements of Chinese government, policy recommendations for the development of modern logistics industry should be introduced. For example, supportive measurements for logistics park, terminals and logistics project can be implemented. Industrial management authorities can cooperate with each other and form a joint force to support the development of logistics. Positive development environment will alleviate the burden of logistics enterprises. Finally, investigation and statistics and information management system for logistics should be established and perfected.

C. Emphasize on infrastructure building, equipment technology improvement and human capital accumulation

- Increase the investment on logistics infrastructure building, especially in central cities, transportation junctions, distribution centers, and port areas. The emergency logistics system for bulk commodities and necessities of life should be established, the transportation networks covering railway, highway, aviation and pipeline and modern logistics bases and logistics parks integrating storage, transport, packing, distribution processing, and delivery should be built as well.
- Logistics equipment technology in Xinjiang is characterized as low networking and information level. Intermediary agents can be established for example, simplified custom system, modern sales exhibition system, communication system, and so on. Logistics infrastructures directly serving manufacturing companies, distribution companies should be strengthened, for instance, logistics warehousing facilities, hauling equipment, handling equipment, and sorting and packing facilities.
- Introduce and cultivate logistics talents in the fields of enterprise planning, consultancy service, scientific research and educational organization. Logistics operational personnel, logistics site managers and advanced logistics management personnel are badly needed.[11] A sound modern logistics talent supportive system should be established, which covers the fields of logistics talents introduction, on-the-job training, basic education, and higher education.

D. Cultivate logistics market players and develop manufacturing industry with features

- It is critical to explore logistics needs, so such service projects as inventory financing, impawning supervision, internet of things can be developed. A socialized and specialized logistics service system dominated by the third-party logistics enterprises can be set up to integrate small and medium-sized logistics enterprises.
- Make use of double market tension from Central Asia and inland to develop the manufacturing industries with Xinjiang specialties. In view of geographic position, the development of logistics in Xinjiang has been limited by high transport cost and long transport time. It is difficult for processed products and high-value-added products to enter inland market, which weakens the competitive advantages of manufacturing industry. However, Xinjiang is close to 5 countries in Central Asia and has large market potential. Therefore, the further interactive development of logistics and manufacturing industry in Xinjiang should be orientated towards both inland market and Central Asia market, namely bi-directional market strategy. Labor-intensive industries are encouraged to transform to technology-intensive ones, in order to improve the whole competitiveness of manufacturing industry in Xinjiang.
- Modern logistics modes such as chain operation, logistics distribution, e-commerce, and agency through transport are established to integrate resources and perfect service functions. Third-party logistics distribution services are developed to help manufacturing companies reconstruct production work flow. In addition, optimal configuration of logistics factors are encouraged such as merger, share, and joint venture of substantial enterprises and groups are supported.

E. Promote logistics development for key fields and industries and provide foundation platform for interactive development of the two industries

- Logistics for resource products such as petroleum, coal, main minerals, and bulk commodity should be emphasized. Moreover, logistics for agriculture should be improved. For instance, priority should be given to the logistics development for fresh agricultural products cold-chain logistics for food with Xinjiang features, cotton, vegetables, and fruits.
- Logistics distribution service between urban and rural should be developed. Chain store operation network for agriculture capital and consumer goods in rural areas can be improved, uniform distribution of logistics hubs can developed, and goods distribution centers and distribution logistics centers can be set up to form a multi-level and multi-type logistics distribution pattern.
- International logistics can be expanded by propelling the bi-lateral cooperation with the countries and areas in Central Asia in the fields of distribution, transportation, storage, goods forwarding. Joint ventures, cooperation and communication with leading logistics companies should be strengthened to introduce and absorb advanced experience and management methods through technical cooperation, technical assistance. Key ports such as Khorgos, Alataw Pass, and Bakhty should be improved, multi-model transportation between railway and highway can be strengthened and shipping markets at home and

abroad can be actively explored, in order to establish international logistics hubs.

V. CONCLUSION

Based on the current situation research on the interactive development of logistics and manufacturing industry, this paper conducts an empirical analysis on the further interactive development of the two industries. By virtue of depth grey correlation model, problems and reasons for the low level of the interactive development are analyzed and some constructive and scientific countermeasures are put forward.

Under the background of globalization and manufacturing transfer and reconstruction, both manufacturing industry and logistics face both opportunities and challenges. On one hand, emerging industries such as high technology, new energy, and new materials are replacing traditional labor-intensive industries and plays greater roles in the development of economy in Xinjiang. On the other hand, there are still problems in manufacturing and logistics, such as low innovative capability, lack of core competitiveness, and so on. It is an imperative problem to be solved that how to grasp the opportunity, meet the challenges, and improve competitive advantages. In general, there are some significant innovations in this paper. Firstly, based on the analyses of interactive development theories, this paper builds an interactive development model, and makes an empirical study taking Xinjiang as an example. Secondly, in view of research results, the problems and reasons for the low level of interactive development of logistics and manufacturing industry are analyzed and practical measures and strategies are proposed.

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REFERENCES

[1] Deng Julong. Grey Control System. Wuha: Huazhong University of Science and Technolgy, 1985.

[2] Liu Sifeng, Xie Naiming, etl. Grey System Theory and Its Application. Beijign: Science Press, 2008.

[3] Li Zhongcheng, Xu Lei, Duan Yali, etl. “Study on coordinative development between manufacturing industry and logistics industry based on grey correlation analysis”, Logitics Technology, vol.10, pp. 38-42, 2009.

[4] Wang Qunfeng, Jin Jiajia, Mi Chuanmin, Fang Zhigeng. “Maximum entropy configuration model of objecive index wight based on grey correlation deep coefficient”, Control and Decision, vol.28, No.2, pp. 235-240,2013.

[5] Xue Limin. “Research on interactive relationship beteen producer service industry and manufacturing industry”, Taiwan: Chung-Hua Institution for Economic Research, 1993.

[6] Liu Dan. “Empirical study on coordinated development of manufacturing inudstry and logistics”, Journal of Fuzhou University (Philosophy and Social Scienc), pp. 27-30, vol. 109, No. 3, 2012.

[7] Han Xiaoli, Wang Li, Tian Nengjin, Tong Fangting. “The quantitative analysis on coordinated development between manufacture and logstics”, Value Engineering, PP. 84-86, No. 1, 2009.

[8] Wang Zhenzhen, Chen Gongyu. “Emipirical analysis of interactive development between manufacturing sub-sectors and logistics industry: based on gray correlational model”, Journal of Shanghai Univeristy of Finance and Economics, pp.65-74, vol.12, No.3, June, 2010.

[9] Ding Junfa. “Logistics in China should break through from manufacturing industry”, China Buisiness and Market, pp. 7-11, vol. 5, 2008.

[10] Yi Zhenglan, Zhao Xin. “On joint development stratgy between manufacturing industry and logistics industry in Xinjiang”, Finance & Economics of Xinjiang, pp.41-45, vol. 3, 2011.

[11] http://baike.baidu.com/link?url=RNnoOlVFvkpZUfk9QipY3X7SvxMxZ-PkfUHjBCyDWpawAHlAj0m_JlUdEPulOtraVDmkFLIH1RpX5OkcsyNXXZNykue8m0FZUl962-Sf4jXmdQcvkWTw38MjVxXNoABS