Journal of Applied Sciences

ISSN 1812-5654

science alert

ANSInet
an open access publisher
http://ansinet.com

Journal of Applied Sciences 13 (14): 2825-2830, 2013
ISSN 1812-5654 / DOI: 10.3923/jas.2013.2825.2830

Research on the Evolution of Urban Logistics Networkig Motives, Paths and Model Construction

[1,2]Guoqi Li and [1]Sijing Liu
[1]Department of Logistics Engineering, School of Transportation and Logistics,
Southwest Jiaotong University, Chengdu, 610031, People's Republic of China
[2]Circular Economy Research Center, Southwest University of Science and Technology,
Mianyang, 621010, Sichuan Province, People's Republic of China

Abstract: The factors that affect evolution of urban logistics network include external indirect factors such as: Geographical environment, urban nature, land classification and composition, stage of industrialization, urbanization, economic development level, technological progress and innovation and the inner direct factors such as: Logistics demand, logistics supply and logistics enterprises. ased on the analysis of influence and connected relationship for the key nodes and corridor in the network, this study put forward the evolution path which follow the rule from point-point network, corrdior-concentration network, hub-and-spoke network to territory-concentration. the model of the evolution of urban logistics network is built which is able to reflect the growth and degeneration, priority connection rule of the nodes and corrdior, the change of the type conditions. Finally, a case study of sichuan chengdu is done and the results show the effectiveness of the proposed the evolution path and method which can provide theory support of logistics plan planning work.

Key words: Location network, evolution path, hub-and-spoke network

INTRODUCTION

Urban logistics network consists of nodes and lines. the nodes contian logistics parks, logistics centers, freight station, warehouse facilities, etc., the lines contian all kinds of transport corridors, supply chain and information flow. Along with the development of urban social and economic development, the size, functions, space layout and traffic network can change that affect the evolution of urban logistics network. As a key point of the development of transportation, the evolution of ports get the wide attention of scholars both at home and abroad. For example, Bird (1971), Mayer (1978) and Slack (1990) analyze the the formation differentiation mechanism of Container hub port and feeder port. Hayuth (1988) explored evolution model of port system. Hesse and Rodrigue (2004) propose the model of logistics geographical evolution and studied logistics location, the research result showed that the hub and gateway cities are the location of large logistics nodes at the region level, the suburban district and boundary areas is the optimal choice of logistics enterprises. The formation and evolution mechanism of Container port system and netwok subject is the hot spot (Maihepula and Yang, 2012). As for a specific urban or region lostics network, Wang and Han (2004) researches the formation and operation mechanism of the Bohai Rim logistics network. Yang (2010) propose the formation mechanism of structure evolution and evolution of the structural evolution stage. Based on the spatio-temporal evolution, nodes in the growth and logistics territory in the growth, three evolution models are set up respectively in his doctoral thesis.

Overall, the formation and evolution mechanism of urban logistics network have received wide attention of scholars both at home and abroad, In port container transport system evolution, our scholars have made more fruitful results in the evolution of container port system, the formation and operation of regional logistics network, the evolution of logistics network structure logistics spatial structure. But, the urban logistics network evolution impact factors and the understanding of the mechanism of action are not enough comprehensive and integrity which restricted the formation and evolution mechanism of the logistics network to developed to the depth.

EVOLUTION DYNAMICS ANALYSIS OF URBAN LOGISTICS NETWORK

The factors that affectted evolution of urban logistics network include external indirect factors. The indirect factors include geographical environment, urban nature, land classification and composition, stage of

Corresponding Author: Guoqi Li, Department of Logistics Engineering, School of Transportation and Logistics, Southwest Jiaotong University, Chengdu, 610031, People's Republic of China

Table 1: Factors of urban logistics network evolution

Indexes	Factors	Assessment index
Direct factors	Logistics demand	Total logistics amounts
		Social logistics costs
		Social logistics costs in percentage of GDP
		Added value of logistics industry
	Logistics supply	The No. of logistcs park and center, Logistics land area
	Logistics enterprise	Total No. and tpye of logistics enterprises
Indirect factors	Geographical environment	Geographical location, Land, resources and water conditions
	Urban nature	National, regional, local, central city, county town and so on
		Transport hub, industrial, commercial, leisure urbanization and so on
	Land classification and composition	Construction area, roads and traffic facilities area, logistics and storage area
		The proportion of construction area to total area, the proportion of roads and traffic facilities area to construction area, the proportion of logistics and storage area to construction area
	Urbanization level	Population urbanization level
		The variation between the city and countryside resident income the variation between the city and countryside resident Engel's coefficient
	Industrial stage	Pre-industrial stage, the initial, middle and later stage of industrialization the post-industrialization
	Social economic development level	GDP, Real GDP per capita, the proportion of the tertiary industry in the GDP. The proportion of the number of employees in the tertiary industry to total employment
	Technological progress and pattern innovation	R and D in GDP the No. of S and T achievements, the No. of patent applications and grants, the number of S and T personnel

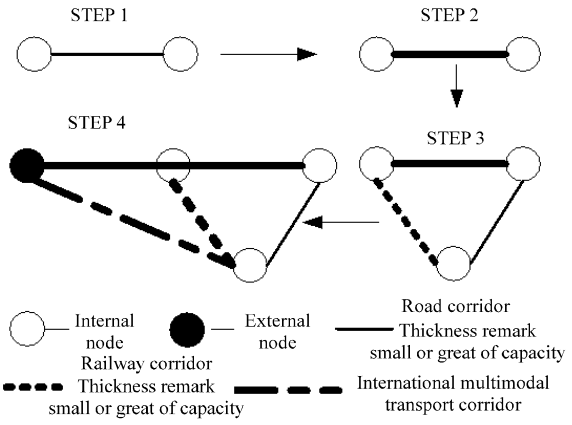

Fig. 1: General process of logistics corrodir evolution

industrialization, urbanization, economic development level, technological progress and innovation. the tinner factors include logistics demand, logistics supply and logistics enterprises. The measurement index and evaluation criterion of every factors can ben shouwn in Table 1.

Various factors that affect the evolution of urban logistics network is embodied in three aspects

Influence of logistics corrodir in logistics network: With the development of social economic, The rapid development of logistics industry benefit an increase in the number, improvement in the capacity and diversification in the type which can be shown in Fig. 1.

In the process of logistics corrodir evolution, the first to show signs is the lack of ability. And secondly, the connection degree of corrodir is not high. At last, the mode and type of corrodir are increasing in order to meet the space and time of logistics demand.

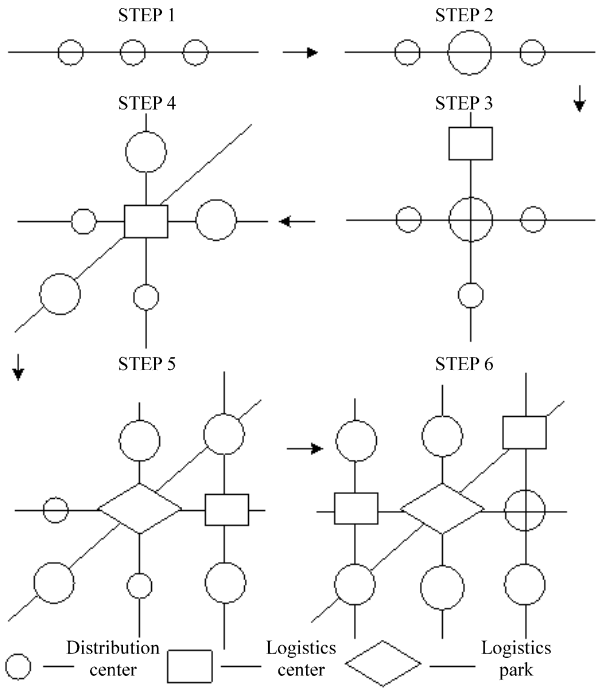

Fig. 2: General process of logistics node evolution

Influence of logistics node in logistics network: As shown in Fig. 2, with tthe increase of Logistics demand and growth of logistics enterprises, the number of nodes gradually increase, the scale of nodes increasingly expand, the type of nodes increasingly diverse.

Influence of the relationship between logistics corrodir and node in logistics network: As shown in Fig. 3, with tthe increase of the number, scale and capacity, tpye of logistics corrdior and logistics nodes, the connection of

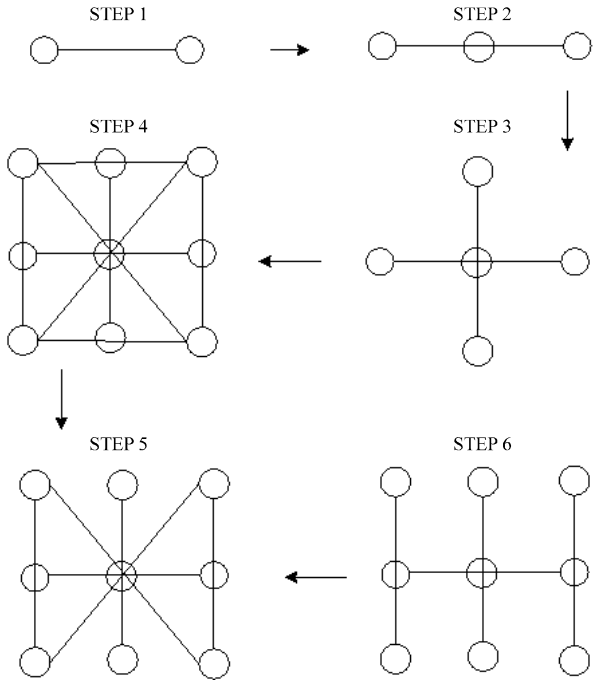

Fig. 3: Relationship between logistics corrodir and node

each other are manifested as freestyle, agglomeration type and priority connection type.

ANALYSISI ON THE EVOLUTION OF URBAN LOGISTICS NETWORK

The evolution of urban logistics network is influenced by the principle of dynamic balance of the logistics supply and demand, the principle of agglomeration and diffusion of the logistics network, the principle of antinomy of the logistics system and the benefits and risks equilibrium principle of the process of logistics network operation. the evolution path follow the rule from point-point network, corrdior-concentration network, hub-and-spoke network to territory-concentration which can be shown in Fig.4-7.

MODEEL OF THE EVOLUTION OF URBAN LOGISTICS NETWORK

On the basis of the increase and decrease of the number of logistics node, transformation and upgrading of the type of logistics node, the increase and change of the various types of logistics corridor, the priority connection characteristics of logistics node and corridor, the evolution of urban logistics network model is established.

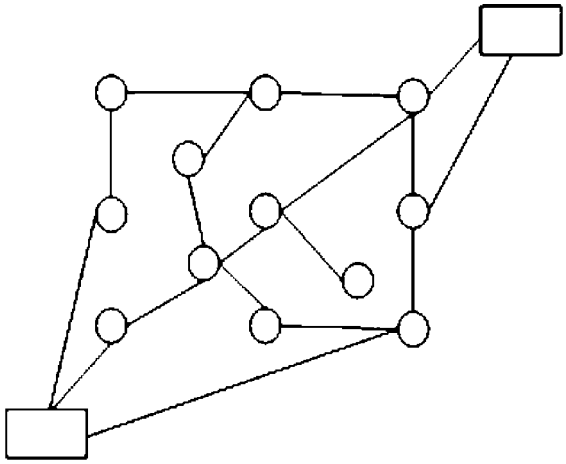

Fig. 4: Point-point logistics network

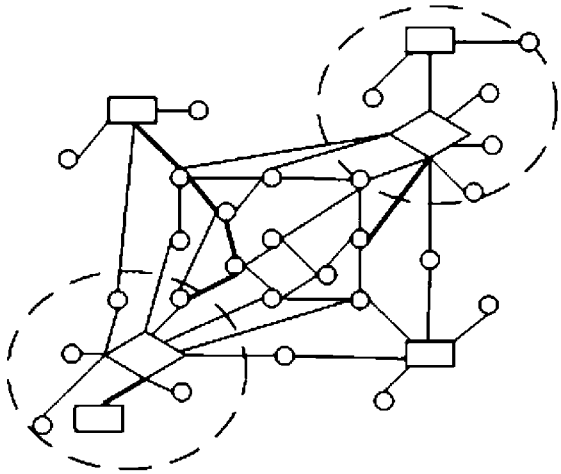

Fig. 5: Corridor-concentration logistics network

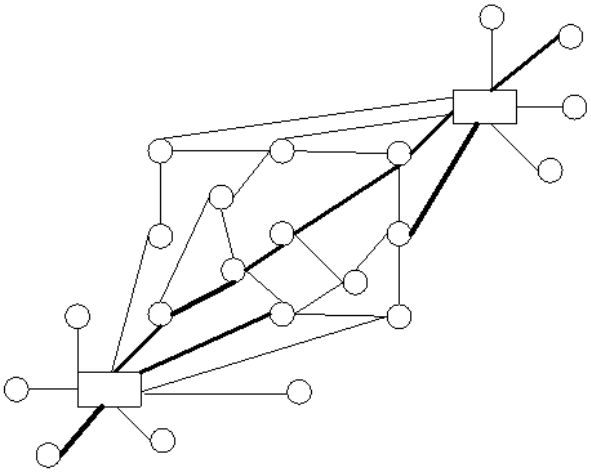

Fig. 6: Hub-and-spoke logistics network

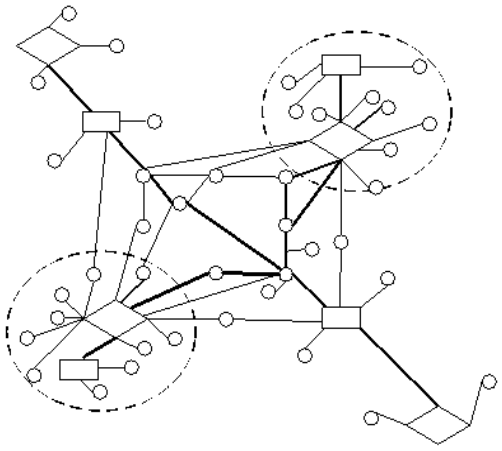

Fig. 7: Territory-concentration logistics network

Suppose that the initial urban logistics network is consist of M nodes and N edges, M = 1, 2,···, m, N = 1, 2,···, n the degree distribution of node k_m is expressed as $k_m \geq \alpha$, when $\beta \leq k_m < \alpha$, the type of node is logistics park, when $\gamma \leq k_m < \beta$, the type of node is logistics center, when $k_m < \gamma$, the type of node is distribution center, when $k_m < \gamma$, the type of node is general logistics demand point.

The degree of importance of edge n is divided by international logistics corridor, regional logistics corridor, inter-city logistics corridor, urban rapid distribution road, urban main distribution road and general road which are expressed as z_n. when the type of edge n is international logistics corridor, z_n = a. Similarly, regional logistics corridor, inter-city logistics corridor, urban rapid distribution road, urban main distribution road and general road are expressed as z_n = b, z_n = c, z_n = d, z_n = e, z_n = f in sequence, $a \geq b \geq c \geq d \geq e \geq f$. Algorithm are achieved as follows:

Increase and decrease of the number of logistics nodes and corrdiors: Starting from a urban logistics network which is consist of M nodes and N edges, a new node join which is connect to a existing node or directly is connect to an edge according to a specific connection rule. A new edge generate at the same time or an original edge is changed into two. The node m degrade according to a specific connection degrade probability-particularly the less the degree distribution of node, the more the node tend to peter degrade, the probability equation is:

$$\Pi_m = \frac{\left| \sum_M k_m / M - k_m \right|}{\sum_M k_m} \quad (1)$$

Once the nodes which are connected by the top and bottom of edge almost degrade, the edge degrade in the netwrok.

Change of the type of logistics nodes and corrdiors: In the process of increase and decrease of the number of logistics nodes and corrdiors, the degree of the node m which is connect to the new node increases an unit. When $\gamma \leq k_m < \beta$, the type of node is changes to distribution center, By that analogy, the type stability in logistics park.When a general logistics demand point is connect to every other points in the network, the type of formed edge is general road. When the two nodes which are the type of distribution center nodes are connected, the type of formed edge is urban main distribution road. When the node which is the type of distribution center is connect to the node which is the type of logistics center in the network, the type of formed edge is urban rapid distribution road. When the two nodes which are the type of logistics center nodes are connected, the type of formed edge is inter-city logistics corridor.When the node which is the type of logistics center is connect to the node which is the type of logistics park in the network, the type of formed edge is regional logistics corridor. When the two nodes which are the type of logistics park nodes are connected, the type of formed edge is i international logistics corridor.

Priority connection beween logistics nodes and corridors
Connection way 1: A new node join which is connect to a existing node m or directly is connect to an edge n according to the degree distribution of node or degree of importance of edge, the connection probability follow the Eq. 2:

$$\Pi_i = \frac{k_m}{\sum_M k_m} \text{ or } \Pi_i = \frac{z_n}{\sum_M z_n} \quad (2)$$

Connection way 2: A new node join which is connect to a existing node m according to the actual distance between the new node and m, degree distribution of node m the connection probability follow the Eq. 3:

$$\Pi_i = \frac{k_m \times d_{im}}{\sum_M D \sum_M k_m} \quad (3)$$

CASE ANALYSIS

Chengdu is one of the first city to organize the professional logistics planning in the western provinces. In 2005, the first round of modern logistics industry

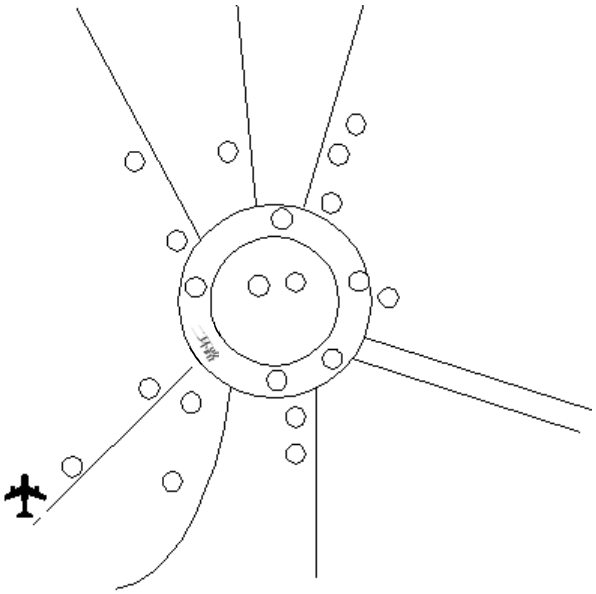

Fig. 8: Two ring and eight radiation logistics network before logistics planning in 1995 (stage 1)

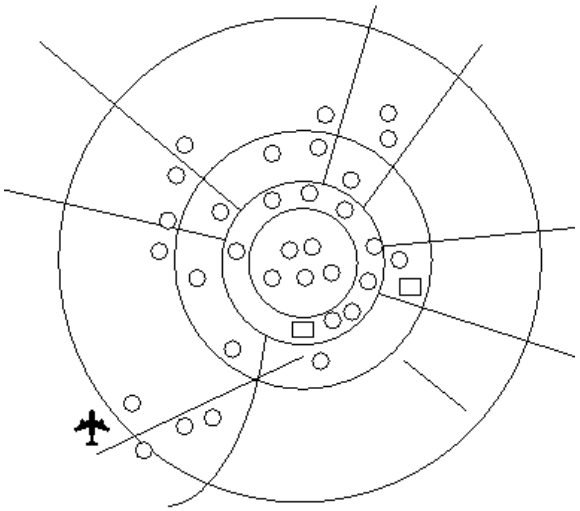

Fig. 9: Three ring and nine radiation logistics network before logistics planning in 2003 (stage 2)

development plan start implementation. In 2009, the new turn revision of modern logistics industry development plan is being carried on according to the new city development strategy. With the "the twelfth Five-year Plan", the chengdu 12th plan of modern logistics industry is introduced in 2013. During this procedures, the logistics land area has changed, logistics node system has worked for its improvement, the scale and function of all kinds of logistics nodes is optimized. The internal and external logistics corridor get a fast development. In the face of the

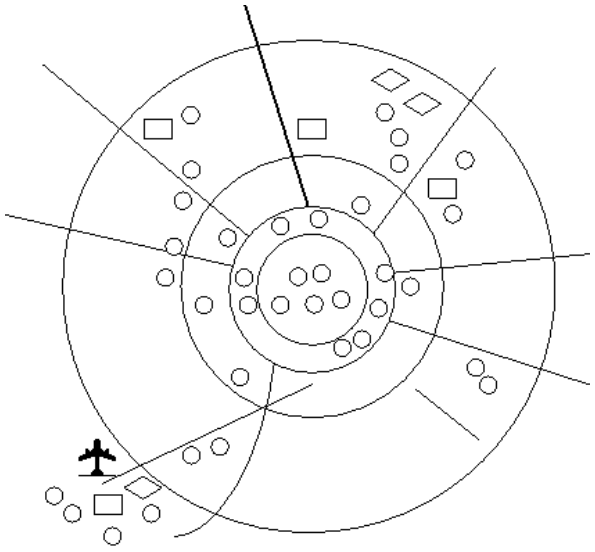

Fig. 10: Four ring and nine radiation logistics network after logistics planning in 2005 (stage 3)

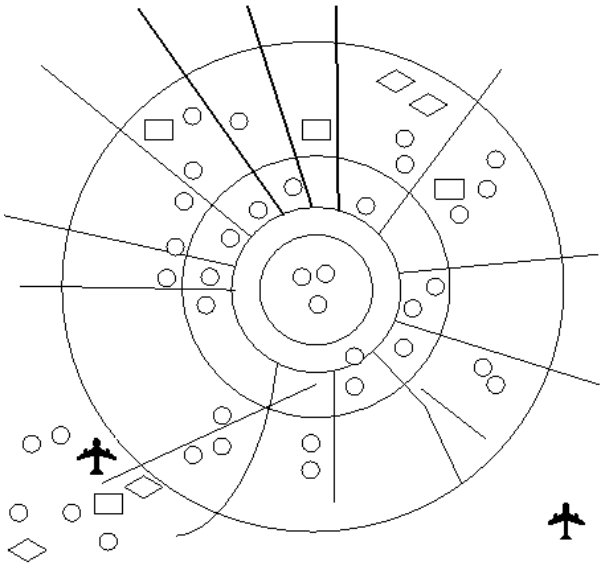

Fig. 11: Four ring and nine radiation logistics network after logistics planning extending to 2015 (stage 4)

above changes over time, the evolution of chengdu logistics network underwent a variety of developments. So, taking the evolution of Chengdu main logistics node and logistics corridor as the basis, we can find the regularity and characteristics of urban logistics network evolution, the validity of the path and the f evolutionary process are proved, the specific evolution network is shown in Fig. 8-11.

As you can see in the above figures, urban logistics demand present disordered distribution and concentrate on the city center area and major highways in under the conditions of poor urban traffic network and lack of unified logistics planning. With the constant improvement of the urban traffic network and the level of economic development, logistics demand has increased dramatically and the socialization of logistics nodes begin to emerge. After the logistics planning, logistics demand and logistics facilities began to gradually and orderly development, Concrete manifestation are the outmovement of logistics demand along the transportation corridors and outside of the city, emergence of professional logistics corridors. At last, Logistics demand and logistics facilities began to undertake adjustment and demonstrated a significantly positive multi-center agglomeration features.

CONCLUSION

This study focused on the evolution of urban logistics network and put forward the direct and indirect influencing factors. Through the analysis of the change rule of logistics nodes logistics corridors, The path of evolution have been put forward to explain the interaction of logistics network and social economic system. The effectiveness of the path and rule is proved via an example form chengdu, sichuan province. Further research will focus on the quantitative relation of influencing factors, find out the core elements of evolution path change by more empirical researches.

ACKNOWLEDGMENT

This study is financially supported by Project of the National Social Science Fund (N0. 11BJL054) and Circular Economy Research Center in Sichuan Province (N0. XHJJ-1105).

REFERENCES

Bird, J., 1971. Seaport and Seaports Terminals. Hutehinson and Co. Ltd., London.

Hayuth, Y., 1988. Rationalization and deconcentration of the U.S. container port system. Professional Geographer, 40: 279-288.

Hesse, M. and J.P. Rodrigue, 2004. The transport geography of logistics and freight distribution. J. Transp. Geography, 12: 171-184.

Maihepula, A. and D.G. Yang, 2012. Research progress of logistics geography in China. Process Geogr., 31: 231-238.

Mayer, H.M., 1978. Current trends in Great lakes Shipping. Geo J., 2: 117-122.

Slack, B., 1990. Intermodal transportation in north america and the development of inland load centers. Professional Geographer, 42: 72-83.

Wang, C.J. and Z.L. Han, 2004. The formation and operating model of the logistics net in the region around Bohai sea. Human Grogr., 19: 89-74.

Yang, G.H., 2010. Study on the evolution mechanism and optimization of regional logistics network structure. Ph.D. Thesis, Central South University, China.