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Understanding the Roles of Different Transport Modes in Logistics Market: Content Analysis for an Online Logistics Forum

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Abstract: For the purpose of meeting customer requirements at minimum cost, different transport modes need to be coordinated to make full use of their respective advantages in logistics market. A critical challenge lies in the lack of understanding for the roles of different transport modes in the dynamic logistics market with uncertainties. Online logistics forums provide user-generated content representing real-time market information. In this paper, a content analysis based method is presented to explore the logistics market. Text content in logistics forums is processed by word segmentation and stop word filtering. Then the LDA topic model is derived representing the most probable words for each transport mode. On this basis, the market areas and the cargo types can be investigated for the different modes of transportation. The method is demonstrated using a case study.

Keywords: transport modes; logistics market; content analysis; latent Dirichlet allocation (LDA); word frequency analysis

1. INTRODUCTION

Multiple transport modes participate in logistics activities with the purpose of meeting customer needs at minimum cost [1, 2]. In most cases, railways provide customized logistics services for stable cargo transportation demand of long-term contracts. The truckload carriers, by contrast, respond to stochastic demands in a highly dynamic market environment. Coastal or river navigation is characterized with long duration and variations in travel times, causing huge dynamics and uncertainties in waterway transportation [3]. Air transportation, the fastest mode of transport with high operational cost, is another vital component in international logistics. Overall, different transportation modes are expected to be utilized appropriately in the logistics market for developing more environmental friendly and sustainable logistics [4, 5].

However, it has been observed lack of coordination among different transportation modes in the logistics market. There are negative statistics about high percentage of empty trucks on road. Due to the high customer dispersion and the short lead time, road freight accounts for much higher transportation market share than it should be, leading to more serious accidents and pollution [1]. As the most carbon-efficient transport mode [2], rail and ocean carriers need to increase their market share in terms of market areas and the types of cargo. Therefore, policy makers attach great importance to the coordination of different transport modes to make full use of their respective advantages in the logistics market [6]. In this circumstance, an important research question arise: *How do we understand the roles of different transport modes in logistics market?*

Online logistics forums offer an important communication platform for gathering logistics service providers as well as customers in the logistics market. This allows collecting and analyzing the user-generated content as real-time market information [7]. The abundance of text available in online forums builds the basis for content analysis [8] for understanding the highly dynamic logistics market with uncertainties [9]. As such, a method based on content analysis techniques is presented in this paper to explore the roles of different transport modes in logistics market. Specifically, latent Dirichlet allocation (LDA) [10], a hierarchical Bayesian model, is employed to model the text corpora extracted from an online logistics forum. The most probable words are

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identified for each transport mode through topic modeling. Word frequency analysis is then performed to investigate the market areas and the types of cargo for different transport modes in the market.

The paper is organized as follows. In Section 2 we introduce related work in terms of the multiple transport modes in logistics market and content analysis techniques. The method is presented in Section 3 and demonstrated using a case study in Section 4. Next, the results is discussed in Section 5 with regard to market areas and cargo types for different transport modes in logistics market. Finally, Section 6 concludes the paper.

2. RELATED WORK

Related work is presented in this section. We first explore the multiple transport modes in logistics market. Subsequently we discuss content analysis techniques as the basis of our method.

2.1 Multiple transport modes in logistics market

With a history as long as mankind, different transport modes have developed for freight transportation as a major part of logistics [1], each with their own strengths and weaknesses. For the five basic transport modes [11], we will consider only railway, waterway, highway and air transportation in this paper.

- *Railway transportation* is fast and fits well with long-distance transportation for heavy or large capacity cargo. Usual weather changes has the minimum impact on rail transport, enabling certain and regular logistics services. Flexible door-to-door services are nevertheless not suitable for rail transport due to the fixed tracks as well as the high cost of intermediate loading or unloading [12].
- *Waterway transportation* provides river or ocean navigation services most suitable for carrying large capacity cargo at a low cost. Compared to road trips, waterway transport has a larger variation in travel and loading/unloading times, which leads to poor service flexibility [3]. Waterway transportation normally is utilized for the transportation of containers or bulk cargo of low value over a long distance.
- *Highway transportation* takes up a large portion in current logistics market with the increasing cargo volumes produced by e-commerce activities. Truckload carriers provide fast flexible delivery services in short distances in response to the changing customer demands at an acceptable price [13]. However, highway freight transportation is less carbon-efficient compared to rail and ocean transportation [2].
- *Air transportation* is the fastest mode of transport with the most expensive price. In the logistics market, air transport usually provides services for high-valued goods delivery in long distances or short supply times [13]. Additionally, it is the most cargo-intensive means of transport.

For developing sustainable logistics, the importance has been recognized for coordination of different transport modes, which is expected to generate economic, social and environmental benefits [1, 14]. Existing researches mainly focus on technical implementations to support information sharing among different carriers. For example, collaborative transportation management platforms were developed by means of Web Services implementation [15] or multi agent technology [16]. However, the lack of understanding of the logistics market in the real world remains a key challenge for policy makers.

2.2 Content analysis for online forums

Content analysis refers to the techniques for "identifying specified characteristics of messages" [17] especially through textual analysis, in which the corpus of text is categorized into several content categories [8]. Latent Dirichlet allocation (LDA) [10], for example, is a widely used tool of topic modeling. Words of each document are represented as a mixture of topics, each characterized by a distribution over words.

Nowadays, many logistics online forums have been developed to provide an interacting platform for customers and carriers. Tremendous amount of online information represented the situation of logistics market

on a real time basis can be obtained from online forums. Researches have demonstrated that content analysis for the online data offers a viable method for understanding markets [18, 19]. Based on the above analysis, we propose our content analysis method for exploring the logistics online forum to understand logistics market.

3. THE METHOD

In this section, we present our content analysis based method for exploring the roles of different transport modes in logistics market, as illustrated in Figure 1.

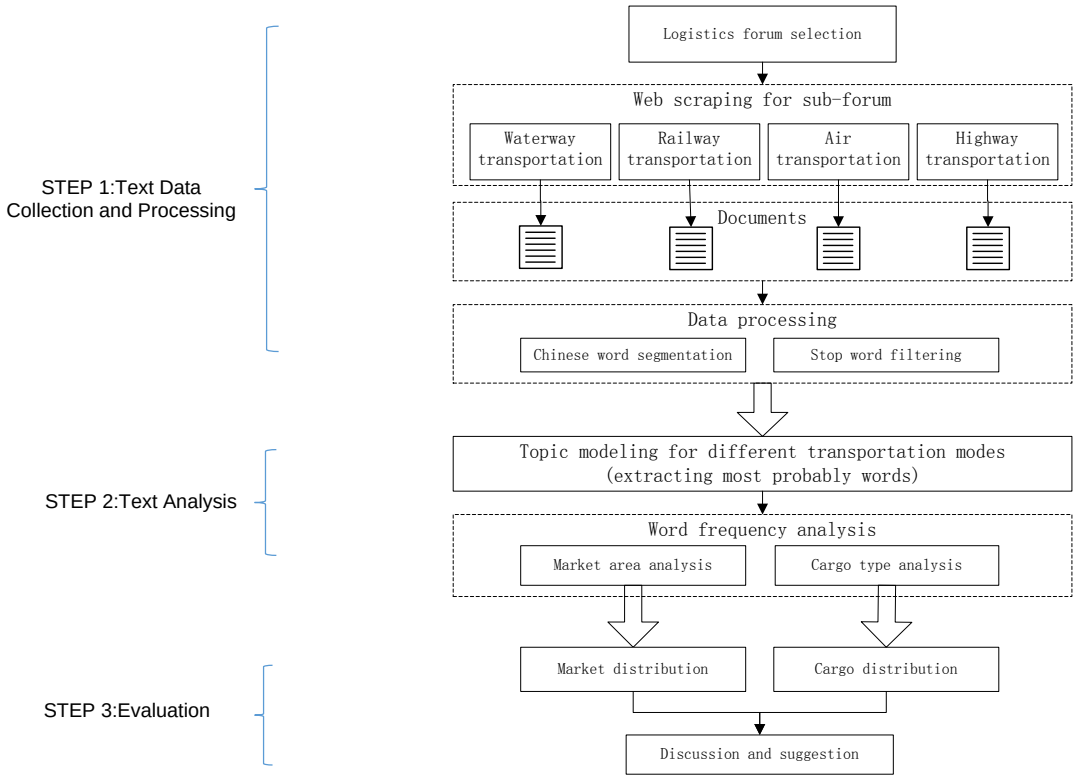

Figure 1. Content analysis based method for exploring the roles of different transport modes in logistics market

First, text data is collected and processed from the logistics online forum. In our study, the selected logistics forum has four sub-forums concerning waterway transportation, railway transportation, air transportation and highway transportation. Web scraping is carried out for these sub-forums and text data is obtained as documents. Chinese word segmentation and stop word filtering are then performed for the data processing.

Second, text analysis techniques is employed for the online forum content analysis. In particular, topic modeling is conducted using the LDA topic model. The most probably words are extracted for each sub-forum about different transport modes in the market. Through word frequency analysis, the market areas and cargo types are discussed for each means of transportation.

Third, evaluation and discussion for the text mining results is performed with regard to the market distribution and cargo types of different transport modes. This will lead to suggestions for better coordination of the multiple transportation modes in the logistics market.

4. CASE STUDY

In this section, a case study is carried out to illustrate our method. We first introduce the logistics online forum selected in our case study, and then build the topic model for the sub-forums.

4.1 Case scenario

We select FOB Business Forum (FOB), one of the largest professional foreign trade forum in China, for our case study. In total, 51209 pieces of comment text data was obtained through web scraping for the period from 2013.01.01 to 2018.10.19. Table 1 describes the content of the text data.

Table 1. Description of the text data obtained from the four sub-forums

Sub-forum	Description of the sub-forum	Text sample
Waterway Transport	Users post their own requirements for water transportation (e.g. cargo or routes) on this sub-forum.	'寻求越南广宁到广州或者深圳在散货船 1-6 万吨，长期需求'
Air Transport	Users search for air transportation channels on the forum, and look for reliable transportation companies for restricted goods (e.g. batteries or cosmetics).	'能走水银空运代理请联系'
Rail Transport	This sub-forum contains information of many kinds of railway transport lines. Users posts in this sub-forum to find railway transport agents.	'需要哈萨克斯坦到大连的回程铁路运输'
Highway Transport	This sub-forum provides highway transportation information concerning the location, the time table, or the contact information of potential customers and service providers.	'车队哪里找，想要找能长期合作的车队，货物承运商，地标厦门，欢迎介绍！感谢！'

4.2 Topic modeling

We use the LDA topic model to identify the most probable words for different transport modes. For each topic of transport mode, the text data from the corresponding sub-forum forms one document. Ten words are identified for each document as the most probable words, representing the focus of different transport mode in the logistics market. Table 2 and Table 3 elaborate on the derived topic model.

Table 2. The most probable words for each topic

Topic	Sub-forum	Most probable words
T1	Waterway Transport	company, ship, forwarder, maritime transportation, international, logistics, routes, Shanghai, price, transportation
T2	Air Transport	air transportation, contact, service, transportation, agency, Hong Kong, demand, international, import, Guangzhou
T3	Rail Transport	train, China-Europe, Zhengzhou, international, railway, one Belt-one Road, logistics, achieve, transportation, development
T4	Highway Transport	trailer, fleet, logistics, contact, Shanghai, professional, company, transportation, service, Shenzhen

Table 3. Analysis about most probable words for different topics

Word	Topic	Analysis
routes	T1	People pay more attention to the route of water transportation.
price	T1	Water transport prices are more volatile.
demand	T2	User demand is unstable for air transportation.
import	T2	Air transportation plays a major role in international logistics market.
China-Europe, one Belt-one Road, achieve, development	T3	The national policies have much influence for transportation.
professional	T4	Many highway transportation companies are small and scattered in location.
contact, service	T2,T4	Facing individual customers, air and highway transportation pay more attention to customer communication and service.
International	T1,T2,T3	Highway transportation is more domestically focused.
agency/forwarder/Company	T1,T2,T4	Railway transportation faces stable customers with limited need for agents.
logistics	T1,T3,T4	Air transportation is not recognized as a means for logistics in most cases.
ship/air transportation/train/fleet	T1,T2,T3,T4	All the transport modes are major focus for discussion.
Shanghai/ Hong Kong /Zhengzhou/Shenzhen	T1,T2,T3,T4	These cities represent the major market range for different modes of transportation.

The results of topic modeling show that the transportation mode is a key focus for discussion. Additionally, different characteristics can be found for different transportation modes in terms of customer requirements, price, or range of logistics markets.

5. DATA ANALYSIS AND RESULTS

In this section, data analysis and the results are presented in terms of the market areas and cargo types for different transport modes in the logistics market.

5.1 Market area analysis

Considering the current situation of logistics in China and the user needs, this paper takes the market area for different transport modes as a research object. The result of topic modeling indicates that city information is involved in the forum content frequently. Therefore, we performed analysis for the situation of cities which are most frequently mentioned in the forum.

Globalization and World Cities Study Group and Network (GaWC) released the 2018 ranking of global Cities, based on international influence, transportation, economy, education, communication and other factors. Accordingly, 361 cities were selected in our study from GaWC's ranking list, forming a city dictionary. We then identified these cities from the forum content and counted their occurring frequencies for different transport modes. Table 4 provides an analysis for the situation of 15 cities which were most frequently mentioned in the forum.

In Table 4, text with shading refers to foreign cities, including Singapore, Hamburg and Dubai. Text in bold represents the northern cities of China. It can be found that Zhengzhou is the most frequently mentioned for railway and highway transportation. In addition, most northern cities are in the middle or west China. Text in normal font indicates cities in south China, which occupy a major part in the logistics market for all types of transportation modes.

Table 4. The 15 most frequently mentioned cities for different transport modes

NO.	Waterway Transport	Air Transport	Rail Transport	Highway Transport
1	Shanghai	Shanghai	**Zhengzhou**	**Zhengzhou**
2	Shenzhen	Hong Kong	Shanghai	Shanghai
3	Chengdu	Shenzhen	Hong Kong	Shenzhen
4	Hong Kong	Guangzhou	Shenzhen	Hong Kong
5	Ningbo	**Zhengzhou**	Guangzhou	Guangzhou
6	Guangzhou	Chengdu	Chengdu	Chengdu
7	**Qingdao**	Ningbo	**Beijing**	Ningbo
8	**Tianjin**	**Qingdao**	Ningbo	**Beijing**
9	**Zhengzhou**	**Tianjin**	**Qingdao**	**Qingdao**
10	Xiamen	**Beijing**	**Tianjin**	**Tianjin**
11	Singapore	Xiamen	Xiamen	Xiamen
12	**Dalian**	Singapore	Dubai	**Urumqi**
13	Hamburg	Dubai	Singapore	Dubai
14	Nanjing	**Dalian**	**Dalian**	Hamburg
15	Fuzhou	Hamburg	**Urumqi**	Chongqing

5.2 Cargo types for different transport modes

We then performed an analysis of cargo types for different transport modes. Specifically, words indicating

different types of cargo were identified and counted for their total word frequencies for different transport modes.

To this aim, a cargo classification dictionary was built according to the Chinese standard "Classification and codes of transport cargo" [20]. We then divided text words according to the dictionary (see Table 5), and extracted the word frequency in terms of each cargo type. In order to eliminate the data differences for different dimensions, the original data was standardized by scaling it to a small, specific interval, using min-max normalization.

Table 5. Cargo types and the representing symbols

ID	Cargo type	ID	Cargo type	ID	Cargo type
A	Coal products	G	Timber	L	Mechanical equipment, electrical appliances
B	Petroleum, natural gas and products	H	Non-metallic ore	M	Chemical raw materials and products
C	Metal ore	I	Fertilizers and pesticides	N	Nonferrous metals
D	Steel	J	Salt	O	Light industrial and pharmaceutical products
E	Mineral building materials	K	Cereals	P	Products of agriculture, forestry, animal husbandry, fishery
F	Cement			Q	Other types of cargo

5.2.1 Cargo type clustering

The cargo types were then divided into five groups through cluster analysis. Similarities were calculated according to the word frequency of different cargo types. Concretely, hierarchical clustering was employed using different distance metrics including ward (i.e. sum of squares of all variables), single (i.e. the shortest distance), average and median method. The clustering results are illustrated in Figure 2. It can be seen that the results are largely consistent for different distance metrics. Moreover, the clustering results fit well with our common sense. For example, the cluster including cargo types of A (coal products) and C (metal ore) are mostly heavy industry goods, while another cluster involving cargo types of M (chemical raw materials and products) and P (products of agriculture, forestry, animal husbandry, fishery) are for daily necessities.

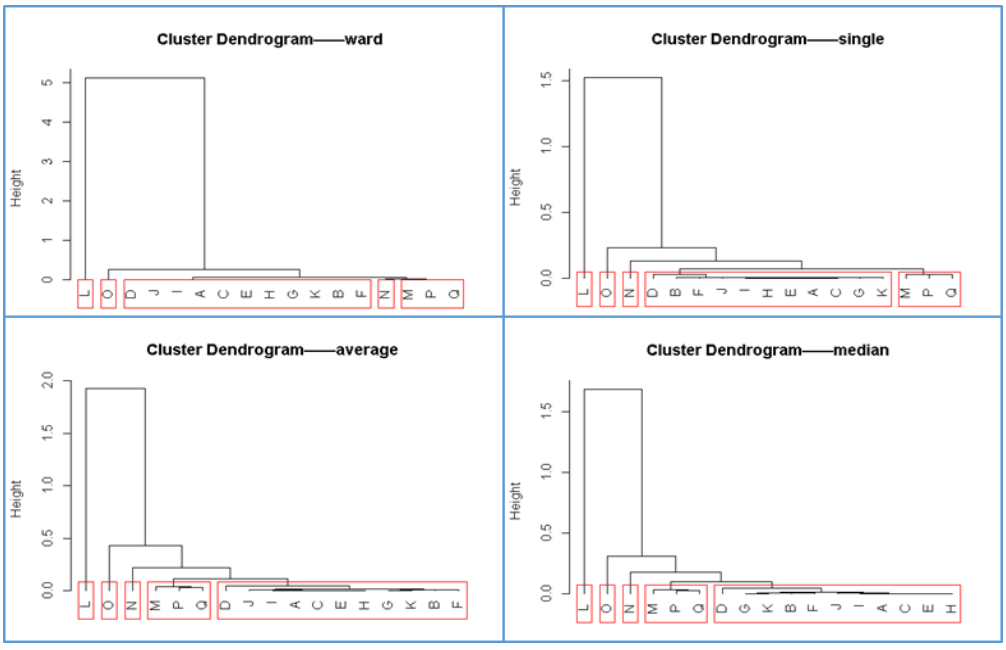

Figure 2. Clustering results for the cargo types using different distance metrics

5.2.2 Word frequency of different cargo types among transport modes

The word frequencies of different cargo types were then calculated for the text obtained from the four sub-forums (see Figure 3). The most frequently mentioned cargo type is L (mechanical equipment, electrical appliances), while the least mentioned cargo type is J (salt). To obtain a clearer observation for the other cargo types, the word frequency diagram was redrawn after removing the cargo types of L and J (see Figure 4).

Some interesting insights can be drawn from Figure 3 and Figure 4. Overall, people show little preference for a specific transport mode for most cargo types. Nevertheless, some distinctions exist for some specific cargo types when selecting the transport mode. For example, waterway transportation is seldom selected for daily necessities, whereas the ability to carry dangerous chemicals is paid more attention for air transportation. In addition, we observed little distinction for highway and rail transportation in terms of cargo types.

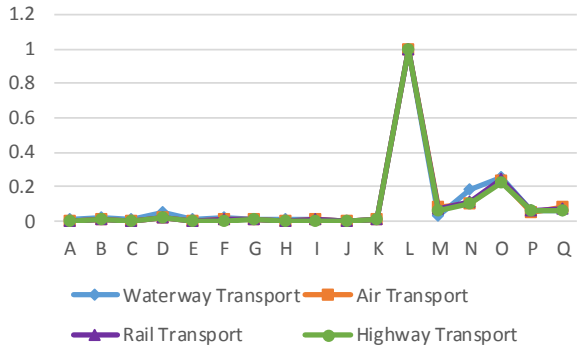

Figure 3. Word frequency of different cargo types among transport modes

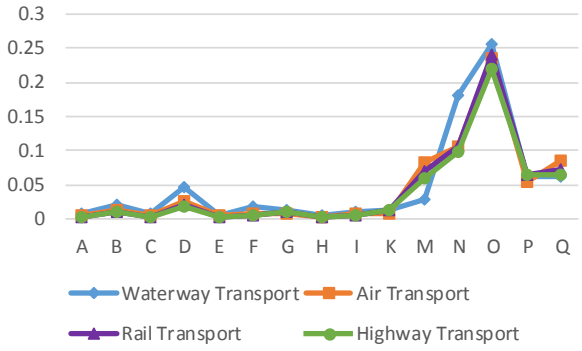

Figure 4. Word frequency of different cargo types among transport modes (removing L and J)

6. CONCLUSION AND FUTURE WORK

User-generated content has become a critical data source for analyzing online information on a real-time basis. To build sustainable logistics, an important question is for the understanding and coordination of different transport modes in logistics market. For this purpose, this study proposes a method for understanding logistics market through content analysis of online logistics forums. Topic modeling is performed for identifying the most probable words in the sub-forums concerning different transport modes. Word frequency analysis is then carried out to explore the market areas and cargo types of different transport modes in logistics market. The result indicates an unclear market segmentation by highly intersecting market area ranges and cargo types for the different modes of transportation. Our study offers insights for logistics carriers as well as policy makers.

There are limitations that need to be addressed in the future. On the one hand, we only selected one online logistics forum for our case study. Investigations for more forums is needed to obtain a more general results to understand the complex logistics market. On the other hand, we only used text data for the analysis and did not consider sentiment factors. Improvements can be made for the content analysis method.

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