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A THEORETIC MODEL OF TRANSPORT LOGISTICS DEMAND

ABSTRACT

Concerning transport logistics as relation between transport and integrated approaches to logistics, some transport and logistics specialists consider the term tautological. However, transport is one of the components of logistics, along with inventories, resources, warehousing, information and goods handling. Transport logistics considers wider commercial and operational frameworks within which the flow of goods is planned and managed. The demand for transport logistics services can be valorised as highly qualitative, differentiated and derived. While researching transport phenomenon the implementation of models is inevitable and demand models highly desirable. As a contribution to transport modelling this paper improves decision making and planning in the transport logistics field.

KEY WORDS

transport logistics, equilibrium of supply and demand, theoretic model, national TLD

1. INTRODUCTION

Transport logistics, as one of the major functional branches of logistics, owes its particularity and authenticity as a science and as an activity to the fact that transport manipulation costs represent one of the major physical distribution cost factor, to the tendency of their continuous growth, to the modern transport technology development, to the introduction of telecommunication equipment and computers into the transport company business, to the transport deregulation and liberalisation. [1]

The last decade of the 20th century and the very beginning of the 21st century were designated by revolutionary development in the information and the communication technology. These trends have caused big changes in business and consumers' habits towards in-

creased globalisation in the business world, and consequently also in traffic and transport systems. [2]

Transport logistics today is more challenging than ever; it is one of the crucial areas, which make the distinction of business success. The study of transport logistics demand – TLD concentrates on one specific aspect of freight logistics and transport - their relationship with industrial location decisions - asking two key questions:

- What are the main driving forces behind the changes in the location of economic activities?
- How, and to what extent, are these decisions influenced by transport logistics demand considerations?

The most important recent trends in transport logistics are towards smaller, more frequent, more reliable deliveries, more varied delivery patterns related to product shelf life, product customization, production/retailing strategy, and the reliability of short-term forecasting and outsourcing of logistics to third party logistics managers (TPLMs), which allows companies to share distribution facilities.

The demand for transport logistics is focused on availability of transport logistics that is defined in terms of specific criteria such as: [3]

- frequency, minimum consignment size, door-to-door collection and delivery times, security and reliability;
- the use of vehicles and rolling stock which satisfy the technical requirements of the cargo flows they are intended to handle;
- response times to customer queries and changes in shipping instructions;
- provision of information about cargo status and the use of cargo tracking systems;

- willingness to accept liability, and offer compensation, when things go wrong;
- a commercial and flexible approach to the negotiation of price and quality of service;
- willingness to provide freight consolidation services, or work closely with other companies in this area;
- resolution of problems relating to the movement of goods across national frontiers.

2. CHARACTERISTICS OF TRANSPORT LOGISTICS DEMANDS

The fact that TLD model is not based on statistical inference means that it has the important capability of examining the implications of structural changes in underlying markets.

According to Friesz [4] the specific parameters needed to articulate the constituent sub-models of any transport logistics are obtained by statistical and time-series methods; yet, the behaviours of individual demand agents on the TLD are not based on trends or historical conduct. Rather, these behaviours are modelled mathematically using the results from mathematical programming and game theory. The resulting mathematical models are the basis for numerical calculations with modern high-speed digital computers, which determine the end result of various forms of cooperation and competition among those agents.

Transport demand takes place over time. This seems a trivial statement but it is the distribution of activities over space that make for the transport demand. In the vast majority of cases, the explicit treatment of space is unavoidable and highly desirable. Transport demand has very strong dynamic elements. [5]

Time-variable and space-variable characters of transport logistics make it more difficult to analyse. One approach to handle the space variable is to divide research areas into zones defining transport logistics network in a form suitable for processing (simulation modelling). Research areas can be simplified assuming that the zones of interest form a corridor which can be collapsed in transport logistics analysis. The spatiality of TLD demand can lead to problems of lack of coordination which may strongly influence the TLD and transport logistics supply – TLS equilibrium.

Mathematical defining of the TLD can be presented as:

$$\text{TLD} = (T_1, T_2, O, C, E, R)_{s,t} \quad (1)$$

where:

- T_1 – technical aspect,
- T_2 – technological aspect,
- O – organizational aspect,
- C – commercial aspect,

- E – ecological aspect,
- R – regulatory aspect,
- s, t – space & time parameters.

Implementing the principle of satisfying TLD aspects an alternative option in functional sense is defined:

$$\mathcal{P}(\text{TLD})$$

$$\text{tldi}(\text{F}) = \mathcal{P}i(\text{TLD}) = \text{FA}(\text{TLD}), i = 1, \dots, N, \quad (2)$$

where:

- \mathcal{P} – satisfying principle,
- $\text{tldi}(\text{F})$ – alternative option in functional sense,
- $\text{FA}(\text{TLD})$ – functional aspect of transport logistics demand.

3. CHARACTERISTICS OF TRANSPORT LOGISTICS SUPPLY

A transport logistics service must be consumed when and where it is produced, otherwise its benefit is lost. Therefore, it is very important to define transport logistics supply and to estimate transport logistics demand with as much accuracy as possible in order to save the resources by planning the supply of transport logistics services to it. As it is often the case that infrastructure and vehicles are not owned nor operated by the same group or company, the separation between supplier of infrastructure and the provider of the final transport logistics services (including transport, warehousing, value added services, management of logistics chain, etc.) generates a complex set of interactions between government authorities, construction companies, developers, transport operators, shippers. All these subjects according to their functionality can be titled as transport logistics stakeholders.

Transport logistics supply is directly defined by transport logistics infrastructure, organizational and functional parameters and by the possibility of establishing Trans-European networks. According to the European Parliament [6] the Trans-European network must:

- ensure the sustainable mobility of persons and goods within an area without internal frontiers under the best possible social and safety conditions, while helping to achieve the Community's objectives, particularly in regard to the environment and competition, and contribute to strengthening economic and social cohesion;
- offer users high-quality infrastructure at acceptable economic terms;
- include all modes of transport, taking account of their comparative advantages;
- allow the optimal use of existing capacities;

- be, insofar as possible, interoperable within modes of transport and encourage intermodality between the different modes of transport;
- be, insofar as possible, economically viable;
- cover the whole territory of the Member States of the Community so as to facilitate access in general, link insular, landlocked and peripheral regions to the central regions and interlink without bottlenecks the major conurbations and regions of the Community.

4. EQUILIBRATION OF SUPPLY AND DEMAND

There are two aggregate techniques most used in this research area: a gravity model and a linear programming approach.

In the case of the gravity model it is relatively simple to re-interpret its functional forms as: [5, p. 435]

$$T_{ij}^k = A_i^k B_j^k O_i^k D_j^k \exp(-\beta^k C_{ij}^k), \quad (3)$$

Where:

- k – commodity type index,
- T_{ij}^k – tonnes of product k moved from i to j ,
- A_i^k, B_j^k – balancing factors with their usual interpretation,
- O_i^k, D_j^k – supply and demand for product at zone i or j ,
- β^k – calibration parameters, on product k ,
- C_{ij}^k – generalised transport cost per tonne of product k between zones i and j .

Consider a set of volumes on a network V , a corresponding set of speeds S , and an operating capacity Q , under management system M . The speed on the network can be presented by: [5, p. 7]

$$S = f\{Q, V, M\}, \quad (4)$$

The speed can be taken as an initial proxy for a more general indicator of the level of service (LOS) provided by the transport logistics. The capacity Q depend on the transport logistics management and on levels of investment I , thus:

$$Q = f\{I, M\}, \quad (5)$$

The logistics transport management can be used to redistribute capacity among the infrastructure, producing Q' and/or giving priority to certain types of users over others, either on efficiency or environmental issues. The level of demand D is dependent on the level of service provided by the transport logistics and on the allocation of activities A over space:

$$D = f\{S, A\}, \quad (6)$$

By combining the equitation (4) – (6) the set for equilibrium points between supply and demand of transport logistics can be defined. Furthermore, transport logistics system will probably change as levels of

services change over space and time, also two different sets of equilibrium point should be estimated: short-term and long-term ones. The task of transport logistics planning is to forecast and to manage the evolution of these equilibrium points over time.

In establishing the equilibration between transport logistics demand and transport logistics supply it is important to find out the answers on the following issues:

1. an increase in transport efficiency, as it allows small and irregular flows to use shared facilities,
2. a reduction in the importance of location as transport costs and quality of service become more uniform throughout Europe,
3. acceleration of the trend towards E-commerce.

5. NATIONAL TLD MODELS

National transport logistics models as procedure for forecasting traffic at a national scale have been constructed for a number of European countries in recent years. [7]

A national model for the given county covers the demand for transport logistics mode that are relevant for the county, for example, air travel is important in Norway, but not for travel within the Netherlands.

Logistics in theory and practice in Croatia appeared much later than in the rest of the world, i. e. Europe. The very beginning was at some of the Croatian universities. The faculties covering the area of logistics have successfully and promptly followed the development and implementation of logistics. Also, various research projects tend to introduce in practise and to implement logistics in industry, for the realisation of concrete process and business. [8]

In the case of the Republic of Croatia, the importance of all transport mode usages is rising according to the defined corridors (V_c and V_b), Trans-European Transport Network (TEN), combined transport establishment and integration into unique European transport network. Therefore, while speaking about Croatian national TLD model, all the transport modes should be taken into account and attention should be restricted to models that are capable of forecasting the use of specific transport infrastructure (roads, railways, airports, seaports) rather than projecting gross statistics. In practise, this implies the incorporation of a fair amount of details. According to Daly [7] setting up any good model of transport demand in any detail requires input of data, staff time, and computer facilities, and at national scale this cannot be done without the investment of considerable resources. National TLD model can be defined in a way that it considers only strategic transport demand i. e. transport demand on the major roads. However, the model can be extended to cover regional and local transport also,

where this is required to address national transport logistics planning issues.

Finally, it can be concluded that it is always essential to recognize the limitations of a model system, and for national models this means that local detail is omitted and the value of having a national planning instrument, once it has been created, has been sufficient to maintain the model in operation.

6. CONCLUSION

Transport logistics is a very important element in the welfare of nations. The main emphasis in transport logistics modelling is to enrich their behavioural content and improve data-collection methods as a means to enhance its measurements of goodness according to W. Wymore [9] The task of transport logistics planning is to forecast and to manage the evolution of equilibrium points over time and space. Modelling these equilibrium points should assist in the development and implementation of the management strategies and investment programmes. In establishing the equilibration between transport logistics demand and transport logistics supply i. e. planning, it is essential to ensure an increase in transport efficiency, as it allows small and irregular flows to use shared facilities, a reduction in the importance of location as transport costs and quality of service become more uniform throughout Europe, especially from the aspect of the Republic of Croatia and the processes of integration into the European Community.

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SAŽETAK

TEORIJSKI MODEL POTRAŽNJE ZA TRANSPORT- NOM LOGISTIKOM

Promatrajući transportnu logistiku kao međuodnos transporta i integriranih pristupa logistici, pojedini autori i specijalisti logističke struke smatraju pojam transportne logistike taustologijom. No transport je jedan od elemenata logistike, uz inventare, resurse, skladištenje, rukovanje informacijama i teretom. Pojam transportne logistike obuhvaća komercijalnu i operativnu okosnicu koja determinira planiranje i menadžment toka tereta. Potražnja za uslugama transportne logistike valorizira se kao visoko kvalitativna, diferencirana i izvedena. U istraživanju prometnog fenomena implementacija modela je

neophodna, a modela potražnje vrlo poželjna. Ovaj rad kao prilog modeliranju transporta unapređuje proces odlučivanja i planiranja u području transportne logistike.

KLJUČNE RIJEČI

transportna logistika, ekvilibrij ponude i potražnje, teoretski model, nacionalni model potražnje za transportnom logistikom

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