SAŠA PETAR, Ph.D.
E-mail: sasa@sasapetar.com
Status Prosper d.o.o.
Šamačka 41, HR-10000 Zagreb, Croatia
MORANA IVAKOVIĆ BABIĆ, B.Eng.
E-mail: morana@fpz.hr
University of Zagreb,
Faculty of Transport and Traffic Sciences
Vukelićeva 4, HR-10000 Zagreb, Croatia

Distribution Logistics
Review
Accepted: Oct. 26, 2009
Approved: May 17, 2011

UNIFICATION OF LOGISTIC DEMANDS OF SMALL-SCALE ENTERPRISES AS SOLUTION OF URBAN ROAD TRAFFIC CONGESTION PROBLEM

ABSTRACT

The development of information and telecommunication technologies, apart from accelerating the information flows, increasing efficiency on the market and other business changes, results also in the reduction of the number of employees in companies. With the application of new information and telecommunication technologies even companies with a single employee in certain activities (publishing, counselling, tourism, etc.) can successfully compete with larger companies, which leads to an increased number of logistic service demands. A large number of small enterprises create a large number of small orders which have to be delivered in the same unit of time, thus causing increased congestion of roads, especially in urban areas.

Although information transport, due to the mentioned technologies, has become to a large extent virtual, the transport of people and cargo continues to operate in a three-dimensional space (recognizing the time dimension as an important factor for calculating the business efficiency). The application of the model from the paper makes it possible to confirm the thesis of increased traffic congestion as consequence of the technological development and to emphasise the need to find a solution in the form of logistic and distribution centres for small and mid-size enterprises. The companies that offer logistic and distribution services may become centres for small and mid-size enterprises, thus offering a solution that maintains the speed and efficiency and avoids costs of congestions and delays.

KEY WORDS

congestion, logistics, logistic-distribution centres, urban traffic, efficiency

1. INTRODUCTION

The technological development, especially in the field of telecommunications and informatics has made possible an extremely important change in industry – the concept of a successful company with a single employee has become today business reality, which exists successfully among large companies with a large number of employees. Owing to the mentioned technologies, the individuals (and their companies) have easier access to the market, and networking possibilities with similar companies, including successful business operation.

A company with a single employee can solve today all its needs by *outsourcing* services or products of other networked companies, resulting in their business efficiency. However, higher speed and flexibility of such companies has resulted in the following problem: large number of small companies has created a large number of small orders that need to be delivered within the same unit of time. The theoretical model considering the relation of road surfaces and vehicles may indicate the solution that can lead to higher operative efficiency – companies that offer logistic and distribution services to smaller companies. Thus, the telecommunication and information technologies are not only the cause, but may at the same time represent a part of the solution of the problem.

The reasons for the necessity of optimising the transport are becoming more and more emphasised. The optimisation of road transport, as part of logistic operations and activities, is topical for several reasons, and first of all because of:

- ever increasing demands for logistic services and transport of cargo due to the increasing number of companies,
- inefficiency and disintegration of fragmented logistic activities,

- insufficient coordination of logistic activities at certain locations due to increased demands of an ever increasing number of companies,
- selection of investment programs into certain traffic infrastructure elements,
- environmental protection,
- ever increasing technical and technological changes.

2. RATIONALISATION OF OPERATION AND LOGISIC ACTIVITIES

Rationalisation of transport does not result only in measurable savings that are expressed by physical indicators in transport, but influences also the economic subjects through standardisation of packaging, application of cargo handling technologies, transport means, infrastructure, etc. The essential thing in all this is that the transport effects are achieved only through transport process performance, i.e. by technology implementation, and the fact that the traffic increase on the roads requires greater supervision and control. Therefore, obviously, the increase in the transport share in the social reproduction structure increases also the need to control the functioning of the respective transport[1].

Essentially, the basic task of transport optimisation is the reduction of "resistances" in the movement process. Resistances conceived in this context can refer to time, space, finances, safety, etc.

The transport optimisation can be observed as a logistic concept in the transport process. It is a procedure of establishing an optimal structure of the traffic system. The spatial issues of reproduction (production and consumption) are solved by transport means, and time-based imbalances between production and consumption are solved by storage. Time requirements in the logistic concept (logistics) can be more strict than the spatial ones (goods in short supply, flowers, newspapers, perishable goods, etc.). This means that there are time limits which have to accommodate all logistic services.

The time-related transport services can originate, exist, grow and fall (become obsolete). The relevant objectives of the logistic concept of transport may be diverse. They depend also on the aspect of observation. General objectives that are often mentioned include[2]:

- reduction of transport relation,
- reduction of transport costs,
- reduction of travel time,
- reduction of environmental "inconveniences" (noise, air pollution, water pollution),
- increase of availability,
- increase of safety, etc.

This means that the logistic task in the transport process is diverse. It encompasses all the activities that influence the production, ranging to those that are related to the customer delivery.

Elementary logistic activities can be studied as functions of loading activities, transport activities and unloading activities, with the logistic concept processing not only the normal conditions but rather the special conditions as well. In some cases this may result also in selecting a variant which is not the most economical one, but still an optimal one because certain safety criteria or continuity criteria or some other criteria have been built into it. Until now, the logistic processes in transport dealt exclusively with the cargo, raw materials, auxiliary and power materials, semi-products and finished products, but the logistic concept needs to be analysed in the passenger transport as well.

The efficiency of logistics has become one of the central issues of the economy of company operation in general. The influencing activities here are very different, and they include:

- standardisation of the packaging,
- standardisation of the transport devices,
- optimisation of the manipulation and transport unit,
- unification of transport demands,
- introduction of scheduled transport in order to reduce waiting times,
- reduction of stocks to optimal quantity, and
- establishment of an advanced information system which reduces the time of unproductive waiting.

The optimisation of the manipulation and transport unit, and unification of the transport demands may represent the solution of the problem faced by small-scale enterprises, which results from their growing number. The problem of the need for optimising the manipulation and transport units, and for unifying the transport demands is studied in the model that follows.

3. OPTIMISATION OF LOGISTIC ACTIVITIES BY UNIFYING LOGISTIC DEMANDS OF SMALL COMPANIES

The theoretical assumption of the model is the change from one form of organisation to another due to the technological changes and the capital transfer. If time period t**0** (which designates the initial state) and time period t**1** (after the technological and economic changes) are studied, then, in time period t**0** a simple scenario may be defined, whereas in time period t**1** a network scenario of networking the supply and demand can be found[3].

In an assumed office building in time t**0** there is one company with a hundred offices, from Ur**1** to Ur**100**, for which the supply and distribution activities are performed by an internal logistic department of the ilo**X** company. According to this theoretical assumption, all the orders are grouped in a single point and then the order is sent to a single supplier that can be designated as D**0**.

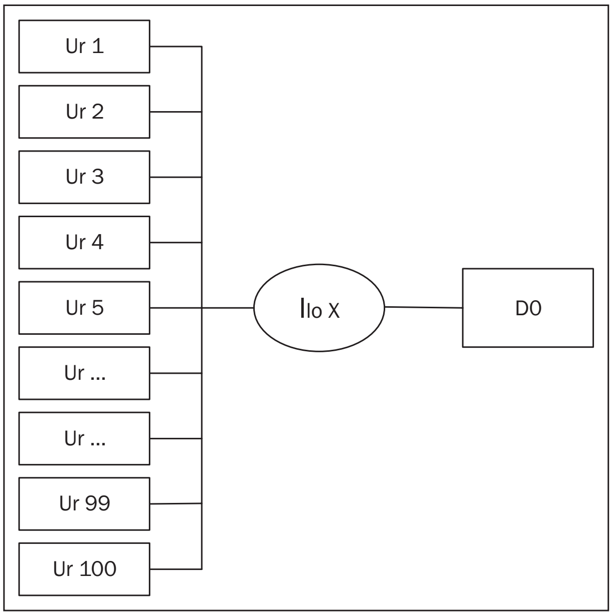

Figure 1 - Simple distribution model

The delivery according to this order, as model requirement, fits into a single transport means (cargo vehicle) which occupies an area of X**k** of the road. During the delivery for all the hundred offices, the cargo vehicle of the supplier D**0** arrives in front of the building and, occupying an area of Dp**0** proceeds with the delivery of cargo. The remaining road space (access road, parking space, etc.) at the moment of delivery remain unoccupied.

Assuming, for the model requirements, that due to the transfer of capital and development of technology there have been changes in the company, and due to privatisation the company has been divided into a hundred small companies designated from pvt**1** to pvt**100**. Which most important technological and capital change is the essential assumption for this model?

The development of telecommunication and information sciences has enabled networking of small companies, so that today a company with a single employee can function successfully working networked with other suppliers and customers, and similar to small companies for selling, legal, accountancy, marketing, financial and other services. These companies can be in the same building, but may also be at a distance of hundreds of kilometres one from another. Thus, it is assumed that in the time period t**1** in the same building there are now a hundred companies out of which each has its own office and each orders the goods independently from the others.

Assuming, for the sake of the model, that within time period t**1** all the hundred companies order at a time cargo from their suppliers that are all different and designated by numbers from D**1** to D**100**. It is also assumed that the ordered cargo will be delivered by the suppliers at the same time using small vehicles occupying a total area of Dp**1**+Dp**2**+Dp**3**+Dp**4** ....+Dp**99**+Dp**100**, so that the occupied area is the sum of ΣDp**n** (where *n* stands for numbers from 1 to 100).

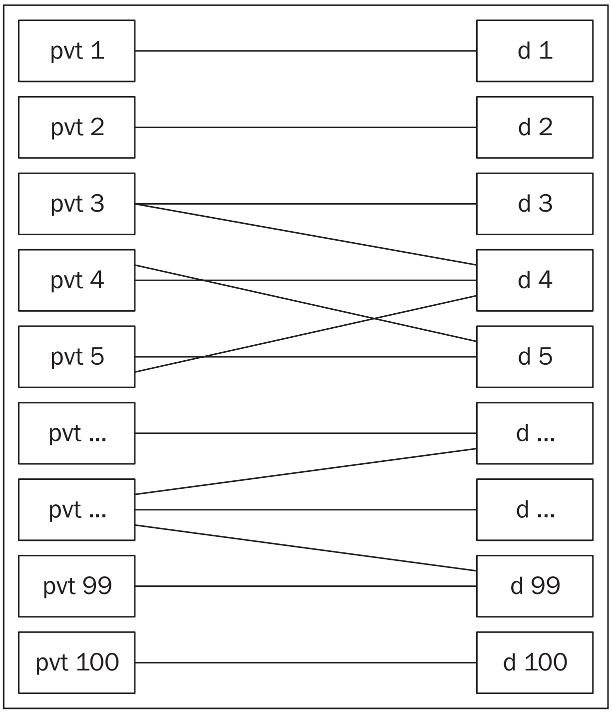

Figure 2 - Network distribution model

Assuming that the road area occupied by one average large cargo vehicle D**0** = $20m^2$, and that the road area occupied by one small delivery van is Dp**n** = $8m^2$ one comes to a simple formula which shows that the cost of space congestion occupied by logistic activities defined in this way is as many times greater than the road area occupied by the sum of areas of small delivery vans in relation to the cargo vehicle.

In this case this is 40 times - namely (Dp**n** x 100): Dp0 = ponder of the difference in the occupied space, which in this particular case means 8x100=800:20=40. This means that in this case the space occupancy of roads used by small delivery vans in order to reach the assumed building (which houses the small companies) were 40 times greater in relation to the previous condition, in which the logistic procedure was performed using one cargo vehicle.

The model can also include the time interval of unloading the cargo from tiv1 to tiv100, during which it can be assumed that the vehicles arrive and leave in regular intervals, so that the cost of unloading time of the first vehicle tiv**1** and the last vehicle tiv**100** is identical. In this case the unloading space ip equal to the area of the vehicle of $8m^2$ is sufficient for unloading of all the 100 vehicles within the same space. This means that ip1 = d1, d2, d3, ...d100, and also tiv**1** = tiv**100**.

However, for the model requirements it is assumed that all the vehicles arrive at once, and the requirement for the unloading space piv1 is a hundred times smaller than piv100. This means that the total space has to equal the number of vehicles (in this case 100) and the product of their square area 100 x d1-d100 (100 x $8m^2$=$800m^2$). If the parking area is pp<d**1**-d**100** the vehicles that do not fit into the parking / unloading space piv**1** will remain on the road. The greater the difference pp<d**1**-d**100** the greater the road congestion.

If this formula is applied in calculating the road congestion in case of going to shopping centres by passenger cars in relation to public urban transport means, one may also obtain a result of greater congestion due to the usage of small passenger vehicles, rather than using, e.g. buses and trams. Here, the ratio will include the average number of people travelling by passenger cars (for the model requirements 2 persons are taken here), and the number of people occupying places in the bus (for the model requirements 60 persons are considered here). It is assumed that the area of the occupied road is the same as in the previous example. The ratio of passengers here will be 60:2=30, which means that bus passengers would occupy 30 passenger vehicles. Comparison of the given areas yields a ratio in which 30 vehicles would occupy $240m^2$ (30x8=240) of road, i.e. parking space (loading/unloading space), which is 12 times greater (240:20=12) than the area of road and parking (loading/unloading) space occupied by a bus as a vehicle of public urban transport.

This result shows that, due to technological changes that enabled miniaturisation of the company, in this model the congestion of roads and parking (unloading) space after the technological changes (telecommunications, computerisation, changes in the quality and availability of vehicles, etc.) has now increased more than 40 times, considering cargo delivery, and 12 times considering private shopping (and delivery of people and goods from the shopping centre home).

Assuming that the total roads area in city X is designated as X**pp** and that it is set into a relationship with the area of vehicle X**pv** occupying it. This means that, if the area of all the vehicles at one time on one road equalled the sum of vehicle areas, there would come to total congestion at that point of time and the vehicles would stop. Thus, at moment t**x**, when X**pp** equals X**pv**, there is complete congestion (standstill) on urban roads.

Now, at several levels, the difference between the number of computers within time period t**0** and t**1**, or the number of enterprises within time period t**0** and t**1** or some other indicator of the technological or economic changes can be put into relation to the result obtained by putting into relation the total surface of urban roads and the number of (e.g. delivery) vehicles, so that the comparison of ratios would be the indicator of state. Here, the span from complete availability of space (without any vehicle or X**pv**=0), through the availability of space considering the area of road vehicles in an assumed city, at an assumed moment of time (X**pp** > X**pv**) to complete congestion (X**pp**=X**pv**) has shown the extent of the available road space remaining until complete congestion.

4. CONCLUSION

As in all the economic branches, including logistics, the "economy of scale" has to be used, reducing the costs per product unit and thus increasing the competitiveness. As counter-balance to production concentration in multinational companies that dominate on the world market, small companies are evolving having one or several employees that offer in certain business areas *outsourcing* precisely having in mind to offer the customers certain elements of the integral product at more affordable prices.

Owing to the significance of the transport, transport logistics and implementation of informatics, globalisation has expanded to the area of transport. The aim of globalisation has been clearly determined – faster handling of cargo flows, thus enabling maximally fast distribution of cargo to the end customer.

The optimisation of logistic activities in a certain space by unifying the logistic demands of small-scale companies in planning the logistic and distribution processes is the answer to the ever increasing number of demands for ever decreasing quantity and values of goods per delivery. For small-scale enterprises with small orders to have positive results in business operations and to be competitive on the market, planning and unification of the logistic and distribution processes with other small enterprises is necessary, in order to increase the efficiency of the logistic and distribution activities and to reduce the congestion of the roads in the cities.

Dr. sc. **SAŠA PETAR**
E-mail: sasa@sasapetar.com
Status Prosper d.o.o.
Šamačka 41, 10000 Zagreb, Hrvatska
MORANA IVAKOVIĆ BABIĆ, dipl. ing.
E-mail: morana@fpz.hr
Sveučilište u Zagrebu, Fakultet prometnih znanosti
Vukelićeva 4, 10000 Zagreb, Hrvatska

SAŽETAK

SJEDINJAVANJE LOGISTIČKIH ZAHTJEVA MALIH TVRTKI KAO RJEŠENJE PROBLEMA ZAGUŠENJA U GRADSKOM CESTOVNOM PROMETU

Razvoj informatičkih i telekomunikacijskih tehnologija izaziva, pored ubrzanja prometa informacija, povećane efikasnosti na tržištu i drugih poslovnih promjena, također i smanjenje broja zaposlenih u tvrtkama. Primjenom novih informatičkih i telekomunikacijskih tehnologija i tvrtke s jednim zaposlenim, u pojedinim djelatnostima (izdavaštvo, savjetnički poslovi, turizam, itd.), mogu uspješno konkurirati većim tvrtkama, što dovodi do povećanog broja zahtjeva za logističkim uslugama. Veliki broj malih tvrtki stvara veliki broj malih narudžbi koje je potrebno dostaviti u istoj jedinici vremena, što stvara povećano zagušenje cestovnih prometnica, osobito u urbanim prostorima.

Premda je transport informacija, zahvaljujući navedenim tehnologijama, u velikoj mjeri postao virtualan, promet ljudi i roba i dalje se odvija u trodimenzionalnom prostoru (uz uvažavanje dimenzije vremena kao važnog čimbenika izračunavanja poslovne efikasnosti). Primjenom modela iz rada moguće je potvrditi tvrdnju o povećanju zagušenosti prometa kao posljedice tehnološkog razvoja i istaknuti potrebu za rješenjem u obliku logističko-distribucijskih centara za mala i srednja poduzeća. Tvrtke koje nude logističko-distribucijske usluge mogu postati centri za mala i srednja poduzeća, te tako ponuditi rješenje kojim se zadržava brzina i efikasnost, a izbjegavaju troškovi zagušenja i kašnjenja.

KLJUČNE RIJEČI

zagušenje, logistika, logističko-distribucijski centri, urbani transport, efikasnost

REFERENCES

1. **Županović, I.**: *"Tehnologija cestovnog prijevoza"* (*Technology of Road Transport*), Faculty of Transport and Traffic Sciences, Zagreb, 2002, p. 7.
2. Ibidem, p. 30.
3. **Petar, S.**, **Babić D.** and **Bajor, I.**: *"Development Planning of City Logistics and Distribution Processes"*, ZIRP 2009, Zagreb, paper on CD.

LITERATURE

[1] **Brotchie, J.F.**, **Hall P.**, and **Newton, P.W.**: *The Spatial Impact of Technological Change*, Academic Press, New York, 1987.

[2] **Florida, R.**: *Cities and the Creative Class*, Routledge, New York, 2005.

[3] **Fujita, M.** and **Thisse, J-F.**: *Economics of Agglomeration*, Cambridge University Press, Cambridge, 2002.

[4] **Fujita, M.**, **Krugman, P.** and **Venables, A.J.**: *The Spatial Economy*, The MIT Press, Cambridge (Mass, USA), 2001.

[5] **Habersam, M.**: *Technology Centre Networks and Regional Development*, Witten / Herdecke University, Witten, 1994.

[6] **Sung-Jong, K.**: *Productivity of Cities*, Ashgate Publishing Ltd., Aldershot, 1997.

[7] **Se-Hark, P.**: *Linkages Between Industry and Services and Their Implications For Urban Employment Generation In Developing Countries*, Journal of Development Economics No. 2, Vol. 30, Berkeley, 1989,

[8] **Petar, S.**: *Location Conditions for Technology Transfer*; in International Conference "Investment Strategies and Management of Construction", u Society of Croatian Construction Managers, Brijuni/Zagreb, 1994.

[9] **Petar, S.**: *Restrukturiranje gospodarstva i investicijska privlačnost grada*; u "Grad kao složen sustav", Hrvatsko društvo za sustave i Nakladni zavod Matice hrvatske, Zagreb, 1996.

[10] **Petar, S.**, **Babić, D.** i **Bajor, I.**: «*Development Planning of City Logistics and Distribution Processes*", ZIRP 2009, Zagreb, papers on CD

[11] **Petar,** mr.sc. **S.**: *Situation, Challenges and Problems of Croatian Enterprises and the Role for Industrial Innovations*; u Lange, Siegfried and Jadranka Švarc (ed.) "Conceptual Approaches for an Industry-Related Promotion of Research and Development in Croatia: Workshop Proceedings, Fraunhofer-Institut für Systemtechnik und Innovationsforschung (ISI), Jülich, 1995

[12] **Županović, I.**: *Tehnologija cestovnog prijevoza*, Fakultet prometnih znanosti, Zagreb, 2002.