Intelligent transportation system for city logistics

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Abstract. *Intelligent Transportation System integrates Information technology, communications (wireless, etc) and location (GIS, satellite navigation) based technologies into roads, vehicles, traffic and transport management systems. ITS ensures more informed travelers, planners, managers, buses and commercial vehicle operators, emergency response services…thereby facilitating safety, equity, efficiency and environmental protection. The situation in major cities of Europe, particularly in new EU member-countries, in the sphere of intensity of urban traffic becomes heavier every year because of the increasing number of vehicles in city streets.*
The city logistics can be defined as "the process of totally optimising urban logistics activities by private companies in urban areas while considering the traffic environment, the traffic congestion and energy consumption within the framework of a market economy".
This research presents ITS not only as a set of technologies and services, it presents ITS for city logistics that ensure more benefit to people, it helps to plan and manage safer mobility for pedestrians, cyclists and vulnerable groups; as well as more reliable and dependable public transport services.

Keywords. ITS, city logistics, traffic system development

1 Introduction

City Logistics is a relatively new field of investigation brought by the challenges of moving growing quantities of freight within urban areas. Cities have always been important producers and consumers of freight, much of these activities were taking place in proximity to major transport terminals with limited quantities of freight entering the city per se. The functional specialization of cities, the global division of production as well as increasing standards of living are all correlated with larger quantities of freight coming from, bound to or transiting through urban areas. City logistics is "the process for totally optimizing the logistics and transport activities by private companies in urban areas while considering the traffic environment, the traffic congestion and energy consumption within the framework of a market economy"[1]. Simplistically, it concerns the means to achieve freight distribution in urban areas, by improving the efficiency of urban freight transportation, reducing traffic congestion and mitigating environmental impacts.

2 Transportation, ITS and logistics

Without well developed transportation systems, city logistics could not bring its advantages. Besides, a good transport system in city logistics activities could provide better efficiency, reduce operation cost, and promote service quality. Transport system is the most important economic activity among the components of business logistics systems. Figure 1 shows the components of logistics costs [2]. This analysis shows transportation is the highest cost, which occupies 29.4% of logistics costs, followed by inventory, warehousing cost, packing cost,

management cost, movement cost and ordering cost. The ratio is almost one-third of the total logistics costs. The transportation cost here includes the means of transportation, corridors, containers, pallets, terminals, labours, and time. This figure signifies not only the cost structure of logistics systems but also the importance order in improvement processing. It occupies an important ratio in logistics activities. The improvement of the item of higher operation costs can get better effects. Hence, logistics managers must comprehend transport system operation thoroughly.

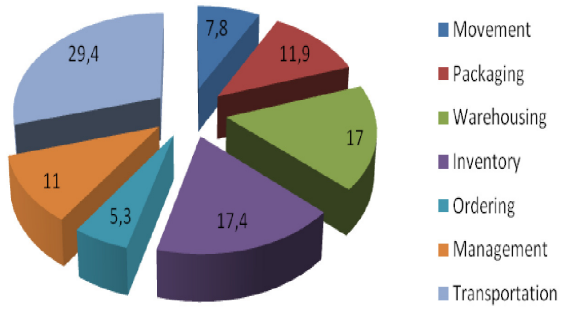

Figure 1 Cost ratio of logistics items

Applications of ITS in transport systems are widespread. The most common techniques for city logistics include Global Positioning System (GPS), Geographic Information Systems (GIS) and advanced information systems. GPS provides the service of vehicles positioning. It could help the control centres to monitor and dispatch vehicles. GIS provides the basic geographic database for the deliverers to enable to organise their routes better. Advanced traveler information systems (ATIS) provide the real-time information for both managers and deliverymen. The integration of GPS, GIS and advanced information systems provides a high manoeuvrability of transport systems providing a better service quality, reduced unnecessary trips, and increased loading rate.

There are many examples where ITS with different approaches has improved city logistics [3,4,5,6,7]. One of city logistics schemes that involves ITS is night delivery scheme (implemented in Paris, Barcelona, Rome etc.).

3 Night delivery scheme

By increasing the proportion of deliveries at night unrestricted access to loading/unloading facilities without traffic interference is possible. This ensures faster delivery service and minimizes the impact of freight on city congestion. Scheme also promotes use of cleaner and quieter vehicles for deliveries e.g. compressed natural gas (CNG) engines. The problems linked with night deliveries are noise for the residents, as well as theft and security for both the drivers and the goods. Major advantages of night delivery schemes are less traffic and higher road speeds during the day, improved fuel consumption and reduced emissions.

Also, this scheme implements different VRP (Vehicle Routing Problem) algorithms for vehicle routing, reducing the need for complex congestion prediction modeling.

3.1 Vehicle Routing Problem

The VRP is a generic name given to a whole class of problems in which a set of routes for a fleet of vehicles based at one or several depots must be determined for a number of geographically dispersed cities or customers. The objective of the VRP is to deliver a set of customers with known demands on minimum-cost vehicle routes originating and terminating at a depot.

The optimized routes have a significant impact on the transport organization by reducing the costs and travelling duration. Practical experiences from literature show that by improving the transport organization by optimizing the routes a reduction of transportation costs of even up to 20% may be achieved.

To solve the VRP problem the exact, heuristic and meta-heuristic algorithms are in use. The exact algorithms, based on linear programming techniques are limited to solving simple practical problems. With heuristic algorithms, e.g. Clark and Wright, Sweep, the acceptable solutions can be achieved relatively fast. The algorithms of improving the heuristic solutions, e.g., 2-opt, try to further optimize an already existing solution by route modifications. The meta-heuristic methods, e.g. simulated annealing, genetic algorithms, tabu search, ant colonies, simulate natural processes and they have proven as very successful optimization methods.

3.2 Case study

Problem of delivering goods to 45 costumers with capacity and time window demand is solved with Clark and Wright algorithm. The distributional centre is situated in industrial area outside of city center. Costumers are served during day (Figure2) and with night delivery scheme (Figure 3).

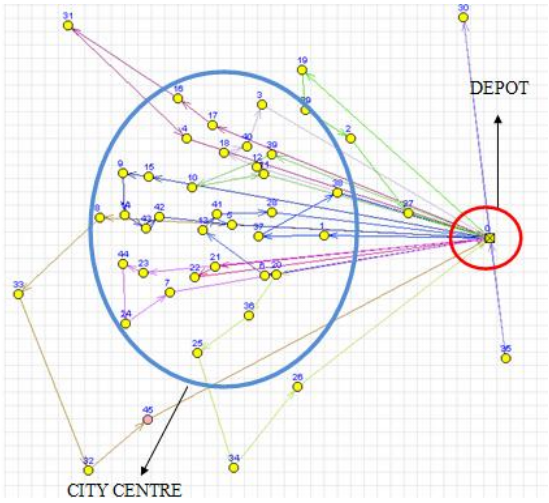

Figure 2 Day delivery

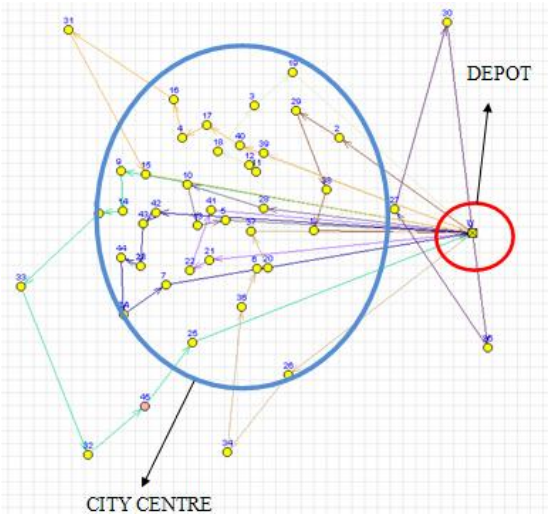

Figure 3 Night delivery scheme

Substantial savings (25% vehicles less needed and 17,8% distance less traveled) are made by application of night delivery scheme (Table 1).

Table 1 Results

Scheme	No of vehicles	Distance traveled
Day delivery	12	9739,75
Night delivery	9	8006,17

4 Conclusion

During the last decades freight transport movements have increased enormously. The EU White paper "European transport policy for 2010: time to decide" forecasts a 38% increase in the demand for goods transport by 2010, and predicts that heavy goods traffic alone will increase by nearly 50% over its 1998 levels (OECD, 2003). Currently, number of vehicles used for freight deliveries in European urban areas represent the 10% of all the vehicles circulating in the cities [8].

References

[1] Institute for City Logistics, available at http://www.citylogistics.org/, Accessed: 27th April 2009

[2] Chang, Y.H. (1998) Logistical Management. Hwa-Tai Bookstore Ltd., Taiwan

[3] Dablanc, L., 2003, Night delivery: a further option in urban distribution , Bestufs, Workshop in Budapest, January 2003

[4] Debauche, W., 2003, A Study on the setting-up of lorry dedicated routes in the Brussels capital region, Proceedings of the 3rd International Conference on City Logistics, Madeira, Portugal, June 2003, pp 333-348

[5] Nemoto, T., 2003, An experimental cooperative parcel pick-up system using the internet in the central business district in Tokyo, Proceedings of the 3rd International Conference on City Logistics, Madeira, Portugal, June 2003, pp 309-320

[6] Ruesch, M. and Eugster, J., 2001, Strategic development of freight transport in the canton of Zurich, Study on behalf of the Canton of Zurich, Zurich , Final Report, 8.10.2001

[7] Taniguchi, E., Kawakatsu, S., Tsuji, H., 2000, New co-operative system using electric vans for urban freight transport, Urban Transport and the Environment for the 21st century VI, WIT Press

[8] Special issue – City Logistics, European Transport \ Trasporti Europei n. 28 (2004): p.1.