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An integrated logistics decision support model for city logistics

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***Extended abstract*: Today, more than 50% of the world's population lives in cities; the urban population is projected to reach 85% by 2100. Mainly due to urbanization and e-commerce, the demand for urban freight transport (both forward flows and reverse flows) is clearly growing. But, transport is also responsible for a large share of urban air pollution as well as noise nuisance. Thus, an integrated logistics system to optimize transport network and service design, as well as vehicles routing of a variety of modes has to be developed. The objective is to determine how to efficiently move freight by means of these services and vehicles, while reducing negative environmental impacts. The topic includes research questions related to the demand to be serviced, the type and number of facilities needed to store and consolidate freight, the better utilization of vehicle capacity (fill rate and fewer empty trips: on average, 25% of goods vehicles in Europe run empty) and the reduction of energy consumption.**

I. INTRODUCTION

Urban freight issues are not new but research has been focusing, for a long time, on passenger and not on freight transport. The increasing complexity in urban areas is mainly due to (1) the dynamic inventory management (continuous replenishment strategies and just-in-time deliveries); (2) e-commerce that leads to more home deliveries and increases the number of returns; (3) evolving environmental awareness and (4) growing urbanization [1]. Among their key findings, the authors state that only few publications focus on consolidation facilities.

The aim of this project is to build an integrated logistics system with consolidation of freight flows, to increase transport efficiency and to reduce its related environmental damages inside urban areas. An overview of relevant models for externalities within freight transportation can be found in the literature [2]. The integration and the management of these externalities in optimization models and decision-support systems are an open issue and involve other scientific.

In this context, Urban Consolidation Centers (UCCs) at the periphery of cities are considered as interesting solutions to implement. Reasons for success or failure of UCCs initiatives ([3], [4]) can be attributed to the location of the UCCs and to the characteristics of the used fleet of vehicles. The support from local authorities and the acceptance of the project by stakeholders also play a key role in the successful development of such initiatives. Issues related to the network design, services and characteristics of the used vehicles can be examined through operations research methods.

Our contribution attempts to elaborate a research agenda for the development of an integrated logistics system to optimize transport network and service design, as well as vehicles routing of a variety of modes

II. DECISION-MAKING

City logistics is a complex transportation system involving planning at the strategic, tactical and operational levels of the decision-making process.

A. Determine the optimal city logistics network design

At the strategic level, the main objectives of city logistics network design are efficiency, equity or maximization of the minimum distance between any pair of UCCs. The purpose is to identify, among candidate sites, an optimal number of UCCs and the location of these facilities, where freight may be transshipped from heavy trucks to smaller cleaner vehicles, for distribution inside the city. The reverse operation, i.e. moving freight from the small and clean vehicles to heavy trucks for transportation out of the city, is also performed at those optimal UCCs locations. Indeed, city logistics is characterized by both inbound and outbound flows.

B. Determine the optimal city logistics service design

At the tactical level, the UCC's competitiveness depends on the determination of the right service tariffs. An approach that explicitly addresses UCC service prices as decision variables within an optimization problem has to be considered. In particular, the promoter highlights the non-trivial tradeoff between the generated revenues through the collected tariffs and the cost expenses through the operated services; a service performance can be increased, and thus more customers attracted, at the expense of additional operating costs, and vice versa. Two main categories of joint decisions are tackled. First, the decision of the planner relates to his/her interest in profit maximization and consists in determining the frequency, design and price of the services. Second, the decision of each customer is driven by the minimization of his/her total logistics costs, by choosing to perform either a direct trip or to use a specific UCC [4].

C. Designing efficient vehicle routes

At the operational level, efficient vehicle routes have to be designed. Due to the short driving range, long battery recharging times and the limited availability of charging infrastructure, routing algorithms for electric vehicles (EV) need to be developed. The objective is to maximize the driving range of the vehicles. It leads to an examination of the main factors in energy consumption, i.e. vehicle mass and payload, engine efficiency, vehicle speed, driving pattern, road grade, and vehicle recharge ability while driving [6]. City logistics has to deal with the issues in reverse logistics (such as returnable transport

item management [7]), since each customer receives a delivery originating at an UCC and sends a pickup quantity to the UCC. In the literature this problem class is referred to as one-to-many-to-one (1-M-1) Pickup and Delivery Problem (PDP). Turning to EV, due to the pattern of electricity consumption, this problem is non-linear.

III. CONCLUSION

City logistics research is an emerging research field. Operations research can be used for various strategic, tactical and operational problems. Due to the type of problems or size and complexity of problems, further development of OR techniques and heuristics are needed in order to develop an integrated logistics system to optimize transport network and service design, as well as vehicles routing of a variety of modes.

REFERENCES

[1] Wolpert, S., Reuter, C. (2014) Status Quo of City Logistics in Scientific Literature: Systematic Review, Transportation Research Record

[2] Demir, E., T. Bektas, G. Laporte. 2014. A review of recent research on green road freight transportation. European Journal of Operational Research 237 (3) 775-793.

[3] Allen, J., Browne, M., Woodburn, A., and Leonardi J. (2012). The role of urban consolidation centres in sustainable freight transport, Transport Reviews, 32(4), 473-490.

[4] Browne M., Allen J., Nemoto T., et al. (2012). Reducing social and environmental impacts of urban freight transport: A review of some major cities, Procedia-Social and Behavioral Sciences 39, 19-33.

[5] Tawfik, C., Limbourg S. Bilevel optimization in the context of intermodal pricing: state of art, Transportation Research Procedia 10, 634-643.

[6] Bay, M. and Limbourg, S. (2015) TSP model for electric vehicle deliveries, considering speed, loading and road grades, Sixth international workshop on Freight Transportation and Logistics (ODYSSEUS 2015)

[7] Iassinovskaia, G., Limbourg, S., Riane, F. (2016) The inventory-routing problem of returnable transport items with time windows and simultaneous pickup and delivery in closed-loop supply chains, International Journal of Production Economics, 183, 570-582.