A modelling approach of pooled urban consolidation centers

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1 Context and motivation

City logistics are the last link of complex supply chains which involve numerous stakeholders: carriers, inhabitants, public administration, etc. It is a small part of the total traveled distance, nevertheless it can represent up to 28% of the total transport cost [1]. Moreover, air pollution emissions related to urban freight transport is estimated between 16% and 50% of the overall pollution made by transport activities in a city [2]. Most of time, communal decision-makers do not have enough knowledge to take adapting local public policy to face these stakes [3]. As aforementioned, designing efficient transport facilitates small businesses, shops and boutiques, and therefore improve livelihood and livability of cities [4]. Hence, it is necessary to provide sustainable solutions to relieve the traffic congestion on the city center and reduce the environmental impact of urban freight transport.

City logistics' solutions available in literature [5,6] seem to be based on the use of two principles: multi-modal and pooling. Two research questions emerge. The first, how could the use of multi-modal facilities address city logistics issues? The second which is the purpose of this paper: which impact would the use of pooling concept have on urban logistics?

Our approach is to develop a "What if" decision support system to provide pertinent information beforehand when designing a city logistics project. Indeed, there is a pressing need to establish models allowing *ex ante* assessment [7,8].

2 Methodology

The first step for *ex ante* assessment is to establish the cartography of a current urban situation. The second step is to evaluate the impact caused by the implantation of one, or more, city logistics actions.

A lot of publications suggest indicators for transport and city logistics [1,2,9–12]. We decided to select there key performance indicators (KPIs) among these indicators.

The first indicator is accumulated travelled distance. Distance is taken into account when calculating total transport cost. In addition, it can also be interpreted as a social indicator of working conditions for drivers.

The second KPI is the total rounds time. Certainly, time can be turned into costs, but it is also a sign of customer service quality either for the receiver or sender. From the perspective of the last mile, the most beneficial organization is to deliver a maximum of stops per delivery rounds in a minimum time.

Finally, the last chosen KPI is, environmental, specifically the CO2 emissions quantity, which is the primary source of greenhouse gases.

3 Results

Our method was applied on a schematic and conceptual example. Our choice is to describe the city as an ellipse with delivery points like shops, factories, inhabitant(s)… For study, we considered that more than one carrier can deliver the city and a delivery point can receive freight from more than one carrier. In the example of Figure 1, 7 different carriers entering the city are considered and represented by different colors. Each carrier can enter the city through a unique access point close to its platform. Each delivery round is made by considering two parameters: the logic of delivery order and the quantity of freight which has to be deliver at different points.

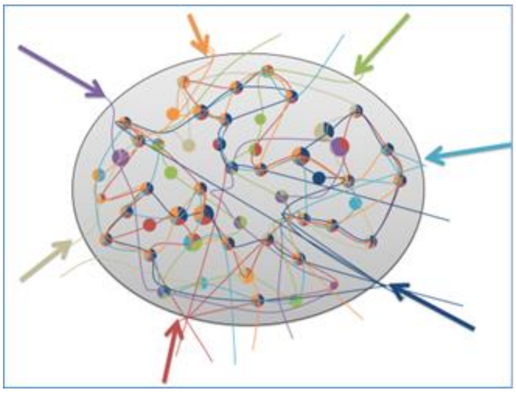

Figure 1: The base of our example: a multi-sources and multi-destinations logistics

Our approach is not based on the construction of an optimal but feasible round. No optimization algorithm is used but delivery points are grouped together with the logic of proximity. We used city adapted trucks and assume that it is not possible to split a delivery in several rounds. By exploiting this method values for each KPI were obtained.

These values are the basis of comparison to evaluate the opportunities offered by the use of a city logistics action. We decided to study the incorporation of a Urban Consolidation Centers (UCC), which is the most popular pooling solution [13,14], in the south of our simplified city (Figure 2, left). On the whole, all indicators are improved. One explication is that UCC constructs pools of delivery points very close to each other. Nevertheless, some carriers make a detour.

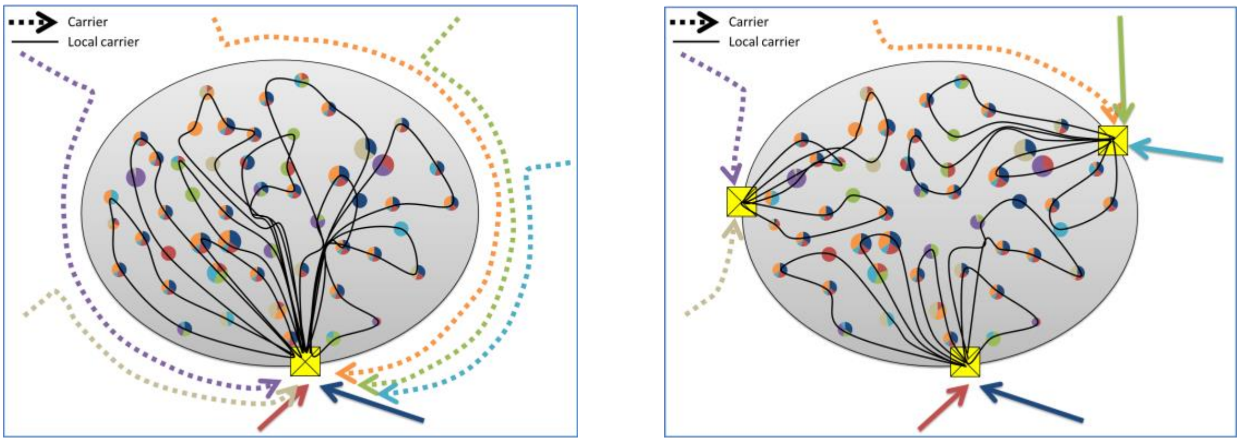

Figure 2: The described city with the implantation of one UCC (on the left) and three UCCs (on the right)

In a second step two other UCCs have been implanted around our conceptual city (Figure 2, right). Our idea is to multiply the number of UCC introduced in such way that each vehicle can drop off the freight on their round without an excessive detour.

In general, the situation is better than the initial (or current) one due to the pooling effect and a reduction of trips by drivers and vehicle. However, this three UCC solution is not better than the solution where there is only one UCC. Note that: the total distance is more or less the same but the repartition between carriers and local carrier is different. The round are shorter but more numerous, so finally the system loses some efficacy. Total time is also worst in this situation because it implies additional disruptions with loading and unloading moments. Finally, the CO_2 emissions are the same in both cases. These results can be explained by the introduction of some extraneous issues, as detours, to others actors.

4 Conclusion

A prototype modeling approach has been proposed to assess some city logistics actions. The Three key indicators are mobilized to evaluate social, environmental and economic issues. A paradigmatic urban plan was used to quantify the difference between two configurations in one particular case of a schematic and illustrative city. The results obtained give a first idea of potential advantages or drawbacks of collaborative solutions. Evidently, this comparison between different solutions is just an initial step and will be developed through further work.

This study is a part of the ANNONA project, which is an ANR project (French Agency for the Research), and so could be improved and dealt with in depth. In future work, it is necessary to simulate other urban contexts and especially apply this method to actual city centers with accurate traffic flow numbers, etc. Evidently, the prototype needs to be developed in a more sophisticated decision support system better able to obtain *ex ante* assessments of city logistics actions impacts and be used by researchers and urban decision makers alike.

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