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Procedia Manufacturing 17 (2018) 1128–1135

Procedia MANUFACTURING

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28th International Conference on Flexible Automation and Intelligent Manufacturing (FAIM2018), June 11-14, 2018, Columbus, OH, USA

Sustainable Logistics and mobility in cities: Paris South-East Area

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Abstract

According to COP21, COP22 & COP23 recommendations, and European commission policy in terms of mobility for growth and sustainable development, many experiences are tested in Europe for reducing road transportation, congestions, CO2 emission, and increasing people quality of life, environment protection, and company performance by proposing alternative solutions (rail, waterborne, bike…) in urban logistics and mobility.
This paper presents collaborative concepts developed for reducing road transportation and congestion and improving urban logistics and mobility by implementing alternative solutions (combination of road with waterborne and rail) in a region.
A simulation tool is used for describing actual situation of a city. Then this model is analyzed and scenarios containing alternative solutions are proposed. The specifications of a software tool being developed for implementing co-creative and co-innovative solutions on a city or region is presented.
This tool will be deployed in website, mobile and public terminal (Human/Machine Interface) for capitalizing citizens opinions and propositions for improving their city.
An illustration is proposed by explaining in detail how they are being used in the area of GPS (Grand Paris Sud), the south-east of Paris region. The "Grand Paris Sud" region, is composed of 24 small cities with 342 000 peoples and 19 000 companies. This conglomeration is attractive for logistic companies, due to its proximity with Paris, Orly Airport (second airport of Paris) and highways.

Keywords: Mobility, sustainable Logistics, road transportation optimization, congestion, co-creation and co-innovation

10.1016/j.promfg.2018.10.025

1. Introduction

All big cities are confronted to the problem of road transportation and city congestion. Indeed, European cities are concerned by this situation and European commission has defined policy for improving mobility and urban logistics in these cities. The reasons are related to CO2 emissions, quality of life improvement, company performance improvement, etc. Alternative solutions to road have to be explored. Thus, Supply chain, logistics and transport 4.0 are could be used for taking into account collectivities, companies and citizen points of view in the elaboration of a sustainable and better organized city.

This paper presents collaborative concepts for reducing road transportation and city congestion. The idea is to improve urban logistics and transport by proposing alternative to road and in the same time improve company performance and people quality of life.

After the presentation of methodology and concepts defined and used for solving this problem, an illustration example will be presented. The region chosen in the example is "Grand Paris Sud" region. The specificity of this region is to be just near Paris center and one of the main logistics area in Paris region. Then, the specifications of a collaborative tool being developed for managing all the project of city improvement will be presented. Two transport and logistics flows simulation tools will be used for showing the impact of the alternative solution.

2. Literature review

The density of big cities is high, then flows associated to daily life are important. Most of them have decide to reduce strongly road transportation, because of noise, carbon management, quality of life, congestions, etc. For solving these problems, many tests and experimentations were made: for instance, the approach of London based on increasing of the city access tax and reduction of road access or forbidding of gasoil trucks in Paris. In this paper, a city is considered as a system. Then complex system modelling could be applied for improving the existing system and defining alternative solution for road transportation. The methodology used for defining the adapted concepts is GRAI Methodology. GRAI Methodology is one of the three main methodologies (with CIMOSA and PERA) for enterprise modeling as explained in [1], [2] and [3].

In GRAI Methodology, the company is considered as a system that could be entirely described by using 5 models: functional, physical, informational, process, and decisional. The global approach consists in:

- Enterprise context acquisition
- Existing system modeling
- Models analysis for finding inconsistencies
- Design of the future models by improving the existing system
- Implementation of solutions proposed.

The idea is to use this methodology for improving City general performance and reorganize the city according to sustainable criteria applied on cities. A city is considered as an artifact and the improvement of this system is obtained through transformation and refinement processes according to general theory of design as explained in [4], [5] and [6]. Then according to GRAI methodology global approach, a new city design could be described as a process for transforming functional requirements (FR) corresponding to people, companies and authorities' expectations, into design parameters (DP) by defining new ways of improvement for attaining city objectives as presented in Fig. 1. If FRs is the vector of functional requirements and DPs the vector of design parameters, then A corresponds to the design matrix): {FRs} = [A] *{DPs. For obtaining the solution, the matrix A has to be transformed into diagonal matrix:

$$\begin{bmatrix} FR1 \\ FR2 \\ FR3 \end{bmatrix} = \begin{bmatrix} A11 & 0 & A13 \\ A21 & A22 & A23 \\ A31 & A32 & A33 \end{bmatrix} \times \begin{bmatrix} DP1 \\ DP2 \\ DP3 \end{bmatrix} \quad (1)$$

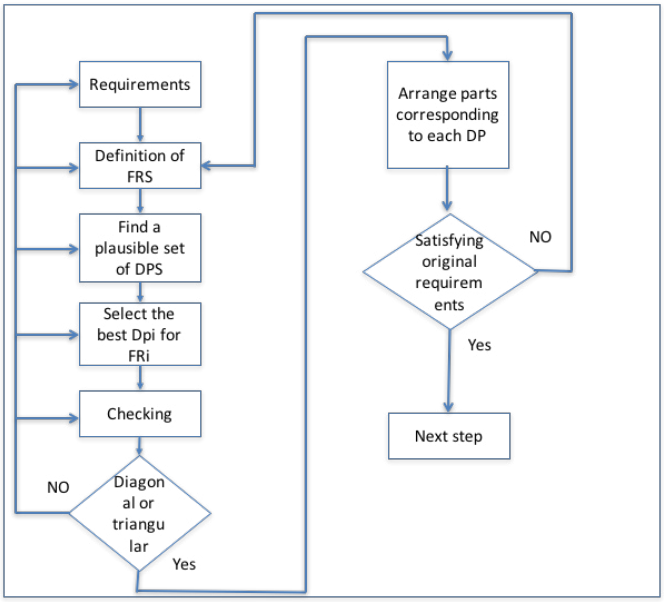

Fig. 1. Design process

For transforming the city considered as a system, a metamodel as shown in Fig.2. could be defined for characterizing the existing state of this city and then and transforming progressively this metamodel into order to obtain future state as presented in [7]. Then a metamodel is a kind of knowledge management for improving a system. At each step, explicit and implicit knowledge have to be analyzed for defining exactly characteristics of the metamodel (corresponding to the city) Mi. The state of the metamodel will change at each step with addition of information or knowledge (Mi+1). Then, the best solution could be obtained progressively from requirement to the future solution. Two types of knowledge are required for obtaining a good design (improvement)as presented in [8]:

- The knowledge of the object to transform (in this case a city, specifically transportation in the city)
- And the knowledge of processes needed for transforming this object.

For realizing successfully, the city improvement by using the previous concepts, a global framework has to be defined for integrating all parameters and being sure to take them into account in the definition of the adapted new city organization. This framework has to use reasoning combining qualitative and quantitative values for elaborating models of the system (city). A problem-solving method is defined by combining decomposition, transformation, generalization and CBR (Case Based Reasoning) as exposed in [9].

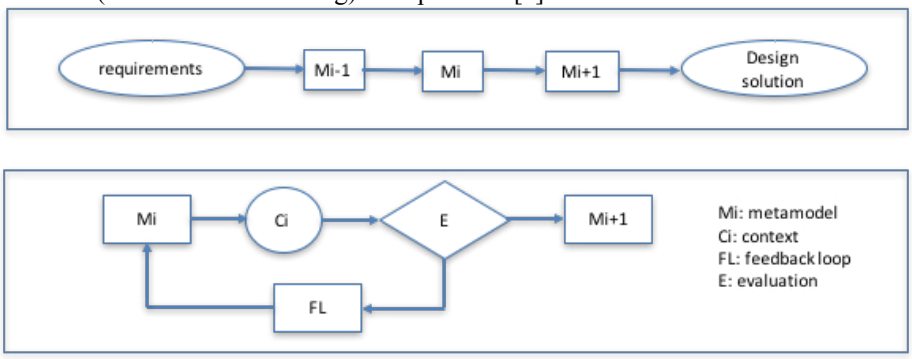

Fig. 2. Gradual refinement of the metamodel

Then a collaborative tool is being developed for capitalizing city knowledge and processes knowledge for city improvements. This tool uses multi-agent systems and particularly learning agent as explained in Fig. 3. for realizing tasks and improving progressively its knowledge. The approach used for elaborating is agile.

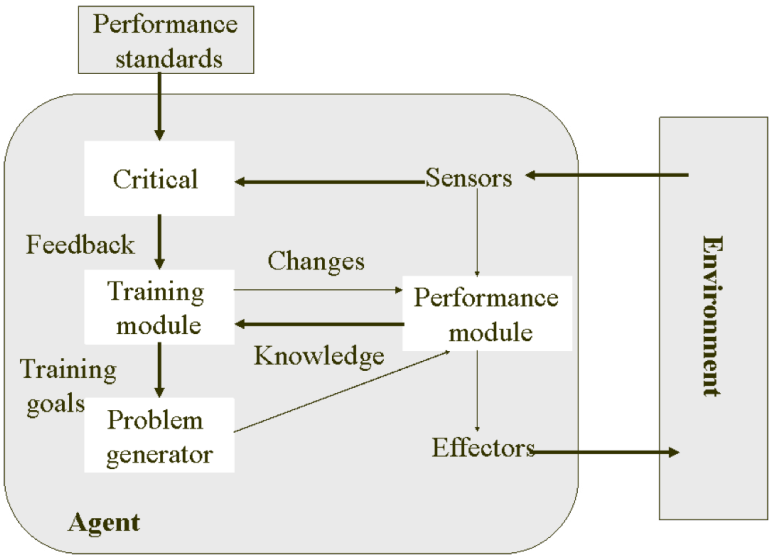

Fig.3. Learning agent

The collaborative tool being developed will allow to manage the existing system (city) description, the analysis of this system, and the proposition of alternative solutions.

3. Sustainable Urban logistics 4.0 concepts and architecture of the collaborative tool

The objective is to analyze existing city organization and define a sustainable urban logistics 4.0 concepts for proposing sustainable alternative solutions to road transportation. The objective is clearly to optimize urban logistics and city mobility. The study of the city as a system allows to define three kinds of improvement:

- Improvement of road transportation based on flow optimization by using algorithms of operational research (public transportation policy, grouping personal transports (Blabla car), bike policy, etc.)
- Railway transportation: train, metro and tram (and multimodality)
- Fluvial transportation (barges or boats for transporting people (Hambourg city) or containers)

The reference model associated to city transportation would be realized including all parameters needed for organizing city transport. Then, for a chosen city, the process would be to use people, companies and authorities' expectations and requirements for elaborating the best solution for the corresponding city.

This tool is essentially composed of modules which are being developed by using Agile methodology. The global architecture of the collaborative tool (DIGICCOLDT as shown in Fig. 4.) is composed of:

- HMI module manager: it manages the liaison with the users: the site, the apps, the information to the users and the ones that the users return.
- Expert data analysis system: it performs data processing and analysis. It includes rules of management, decision, design, modeling ...
- Knowledge capitalization module: it allows the registration of a case (here rather the package of information related to a user). The idea is to be able to propose to another user designs that have been made by a previous user to facilitate its design.
- Modeling tools module: a graphical representation tool that will make it possible to represent a model
- Dashboard Performance Measurement Module: a kind of dashboard to measure the level of each indicator that has been defined, this will evaluate for example the impact of proposals, models etc ...

- Database: it contains all the information retrieved as part of the project.
- Coordination module: it manages the interactions between the different modules. It serves as a link between them and could allow to make the final synthesis.
- Simulation tools module: it includes the simulation tools used in the project. PTV Vissim is one of them. We can add others, such as FlexSim or Anylogic for the internal flow part of the company.
- Expert system learner: it is a tool that from all the changes and proposals, builds a kind of ideal model as the project progresses.
- Module scenarios builder: it is a link with the two expert systems to exit scenarios proposals. These proposals can then be simulated.
- Co-creation module: it is a graphic editor that allows the user to try different possibilities.
- Problems solver module: it is a mathematical tool that is supposed to help after the detection of problems by the expert system. It must be able to solve the problems found and feed the learning expert system, the scenario builder module, etc.

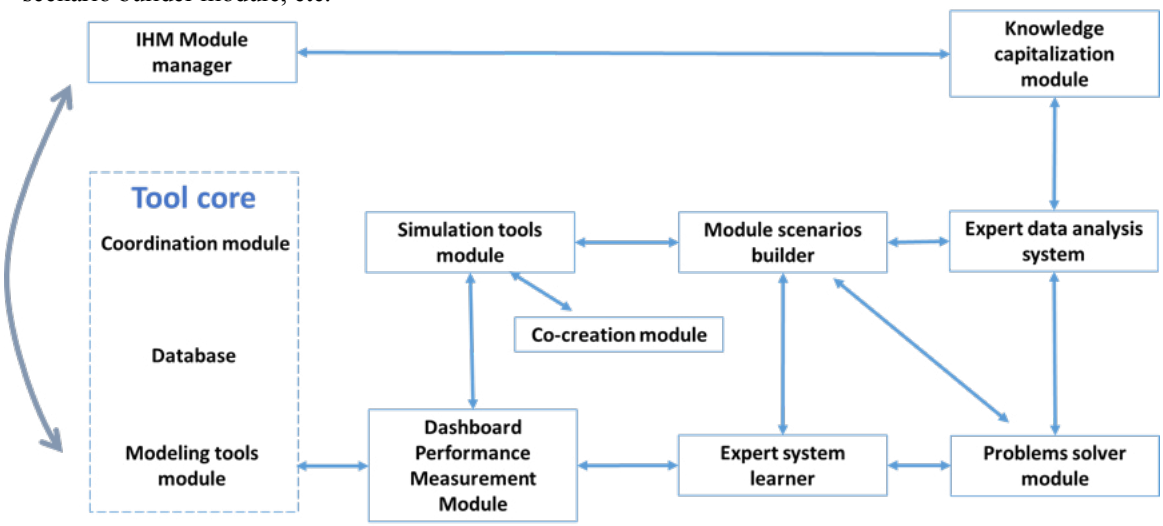

Fig. 4. Architecture of DIGICCOLDT, the city collaborative design tool

This tool would be connected with flow simulation tools for:

- representing the city flows existing system,
- analyzing the existing system
- proposing sustainable scenarios
- and testing the scenario chosen by a city.

PTV VISSIM, ANYLOGIC and FLEXSIM are tools chosen for these simulations, but another tool could be added. The “Grand Paris Sud SES” agglomeration has chosen to collaborate with Icam team on this research project and is available for being associated at all steps of the project, from the city existing system analysis, to the elaboration of DIGICCOLDT and choice and implementation of sustainable solutions.

4. Illustration: “Grand Paris Sud” optimization flow project

4.1. Project Context

“Grand Paris Sud SES” is one of the main logistics company areas of Paris region. The proximity with Paris center and the availability of square meters for implementing logistics platforms are important reasons for companies. Local authorities decide to collaboration with Icam Paris-Sénart for defining and implementing best improvements for this area. The idea is to point out benefit of logistics company implementation and find how to solve inconsistencies due to these companies on the territory. This policy impact on local employment has to be shown and quality of life

improvement realized according to user expectations. A first zoom is made on Sénart area (Part of "Grand Paris Sud SES"). Sénart is composed of 10 cities split on two departments of Paris region as shown in Fig. 5. A large part of these companies is specialized in transport, logistics and warehousing. Nowadays, this sector accounts 20% of Sénart jobs. However, city users and people are not happy because of Truck traffic. About 500 000 trucks per year (2000 trucks per day) are going through the area and provoking congestions, noises, CO2 increasing and so on.

Road traffic is quite important in Sénart. Especially on the axis of the highway A5, because of logistics platforms presence. The project objective is clearly to show positive and negative impacts of logistics companies on the territory and propose sustainable alternative solutions for improving quality of life, company performance, and make Senart city attractive.

Then, this case is appropriated for illustrating the research presented above and allowing to show how to use the tool being developed in the frame of co-innovation and co-design organization.

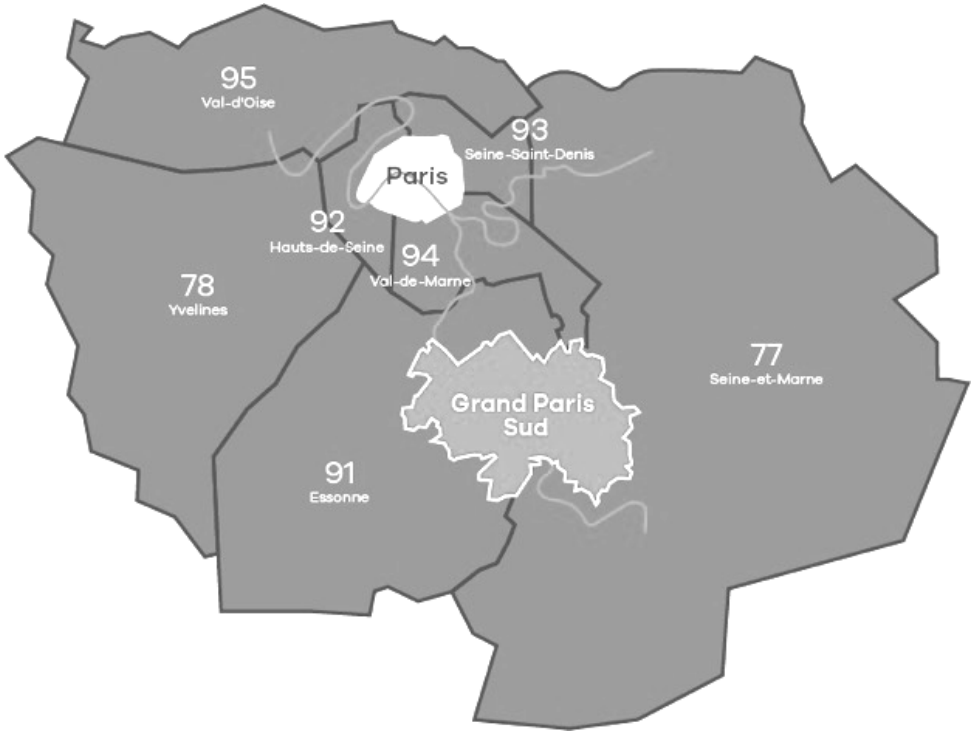

Fig. 5: Area of Grand Paris Sud SES

4.2. Modelling of the existing system flows

For realizing modelling of the existing system, two simulation tools were chosen:

- Flexsim for representing process flows in companies and in platforms of the area
- And PTV VISSIM for representing traffic in the area.

These tools are related to the collaborative design tool being developed by Icam Paris Sénart. PTV designs, sells and make the support of these software solutions for traffic and transport, mobility and logistics. And one tool of this company is named Vissim and is able to show in real time traffic flow in a city. Vissim could compare crossroads geometries, analyze priorities given to public transport or identify effects of signals.

The real existing system model simulation will be presented during Faim 2018 conference. The goal here was to model road networks of highways (130km/h and 110km/h), express roads (90km/h), logistics hub roads (50km/h) and roads allowing access to them (between 50km/h and 90km/h) in the area of Sénart. This modeling must be perfectly realized in order to measure exactly increasing due to changes in future models. Technically, an error in a junction

modeling, (for instance, the number of lanes or speeds on the network) could radically change the traffic simulation result. OpenStreetMap base map was used for defining route location, during the network elaboration.

Data were acquired by making company interviews but also by measuring input and output flows directly on main axes of the area. This is the most critical and complex point of this model. Indeed, the traffic is composed of several types of users:

- Travelers: vehicles crossing through the territory (example: Melun - Orly road).
- Temporary residents: vehicles coming in the area for the day (example: Fontainebleau – Villaroche road (platform)).
- Leavers: vehicles leaving the territory for the day (example: Savigny-le-Temple – Paris road).
- Interns: vehicles staying in the territory (example: Cesson - Combs-la-Ville road).

It was very complex to model all these vehicle flows. In the existing system simulation, it was chosen to generate vehicles around the territory and check these values by counting at the same times (8am, every day).

Although based on real data, it was necessary to take in consideration these counting points. It was complicated to determine precisely route followed by each user. For each real data measurement at 8 am, more than 3000 vehicles (trucks and cars) were counted per hour, at different points of Sénart (then Grand Paris Sud) and the result was integrated into the software.

For finishing, the existing system modeling, real logistics and transport company traffic data have to be collected in order to refine the simulation as presented in Fig. 6.

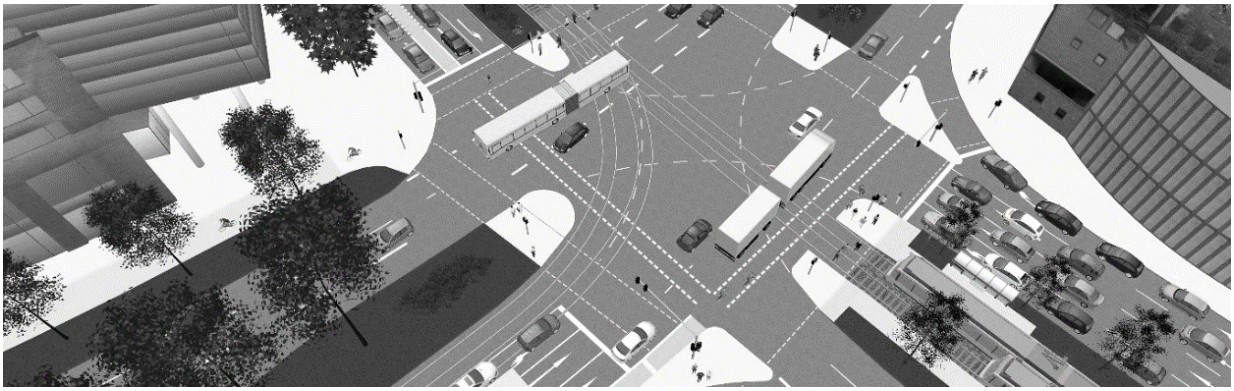

Figure 6: Sénart modeling by PTV VISSIM

The idea for solving this problem is to obtain precise circulation data by combining company data with a big user survey and real measured data on roads. The actual existing model will be improved after collecting all these data. But this existing model simulation already provides detailed numerical results that could be exploited for defining alternative solutions.

Then the existing model was analyzed by using adequate expert system integrated in DIGICOLTD tool. A dashboard containing flow, quality of life, CO2 impact, social and societal impact, and company performance parameters was elaborated.

4.3. Project perspectives.

After the project first phase, only the existing system simulation was done. According to concepts presented above, the project will continue with the other phases. For instance, the step of sustainable alternative solution creation has to be made. Then, specification of the collaborative tool was done and development (agile method) of modules are being progressively realized. The idea is to encourage people and user suggestions (and remarks) and take them into account in addition to local authorities and companies expectations.

Project perspectives could be summarized into the following points:

- Increasing the size of the simulation. Currently available on Sénart, the simulation can be improved by adding different routes and clusters of activities on the rest of the territory of Grand Paris Sud. The addition of Evry, Courcouronnes, etc. will undeniably require modeling and mailing work to companies but will ensure a robust study for future implementations and developments of the Grand Paris South Agglomeration.
- Proposing and testing alternative scenarios to reduce congestion. The main purpose of this software for our study is to be able to test in a few clicks, different options scenarios by moving masses of vehicles, especially heavy trucks and to reduce congestion. These scenarios, will be presented in the future, will be tested, analyzed, and submitted to the Agglomeration of Grand Paris Sud and the EPA of Sénart for final validation. An alternative solution, could be for instance, the use of barge for transporting containers trough the seine (fluvial transportation) until the port of Evry. Then, electric mobility vehicles could be used for last kilometers to platforms.
- Defining and measuring pollution of road traffic (existing system and alternative scenarios).
- Finalizing the collaborative co-design and co-innovation tool (DIGICOLDT)
- Implementation of the new alternative solution of an experimentation zone for validation.
- Capitalizing experience on this project for reuse or adapting it on other city improvement projects.
- Extension of the chosen solution to all “Grand Paris Sud SES” area.

5. Conclusion

This paper has treated logistics and mobility problems in cities. One aspect presented is related to traffic congestion and pollution in cities. Concepts and methods are developed for finding inconsistencies in actual city organizations and proposing adapted changes to increase quality life, company performance and making cities more attractive. A collaborative co-design tool is being developed for elaborating alternative solution to road. Combination for this tool with simulation tools (PTV VISSIM, Flexsim…) is proposed for testing solutions before their implementation.

Even if the project last step were not already realized, the modelling of the existing system of an agglomeration were presented in detail and the way to exploit it in the elaboration of an alternative solution to road suggested. Future work will validate hypothesis presented in this paper and test the alternative solution. A general framework for city logistics and mobility improvement will be completely validated and able to be reused on other areas.

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