GIULIA – A Spatial Decision Support System for Urban Logistics Interventions Analysis

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Abstract. *Decision in urban planning involves an understanding of complex interactions between different aspects of the city. The use spatial decision support systems (SDSS) became an important tool to support decision-making, given its capability to integrate spatial and descriptive data and allow simulation of alternative scenarios. In this work, we present a new tool that reproduces the dynamics of e-commerce and urban logistics and that supports decision making for urban planners. The tool allows for assessment of alternative logistics interventions, considering the efficiency aspects from the supply side and overall environmental and travel time savings benefits from the demand side.*

1. Introduction

Decision-making is an essential and vital part of human life and planning process. Real world problems can be very complex, and as argued by Simon (1955) humans have a bounded rationality. Contrary to what is assumed by mainstream economic theory, decision-making is not a perfectly rational decision, due to humans' limited cognitive system and the complexity of the environment.

In the urban space, the process of decision-making is even more complex due to its land heterogeneity and the conflicting interests from several different stakeholders. A variety of analytical techniques have been developed to help decision makers to solve problems. Spatial decision support systems (SDSS), are a particular case, designed to provide decision makers with a problem solving environment within, which they can explore structure and solve complex spatial problems (DENSHAM, 1991).

Aware of these systems' potential, the World Bank, through the Multi-donor Sustainable Logistics Trust Fund, supports a project with the objective to create a platform to analyze the impacts of benchmark urban logistics initiatives and support decision-making. The Project aims to look into the impacts of public policies on e-commerce urban logistics, and the potential of e-commerce to replace consumers individual trips and generate overall positive results in terms of vehicles-mil reduction.

In the last decades, due to technological improvements, on-line shopping has been growing and becoming an important player in the delivery of goods in urban areas, with a potential to grow even more, given the prospects of an increase in internet access[1]. In Brazil, e-commerce is in full expansion; the Webshoppers Report (2016) shows that between 2011 and 2015, e-commerce accumulated a growth of 98.3%, going from about 53 million requests in 2011 to 106 million in 2015.

In traditional retailing, a marketplace is a physical place in which the consumer needs to visit to complete the transaction, resulting in the movement of individuals. With the e-commerce development, this individual displacement of consumers is being replaced by freight deliveries. According to Visser, Nemoto and Browne (2014), the impact of the changes remains uncertain. On one hand, this retail channel could increase vehicle movements within the cities; on the other hand, e-commerce could change the consumers' travel behavior, which could lead to fewer car journeys.

From the point of view of sustainable cities, the growth of e-commerce implies a higher number of freight transportation circulating within the city, which is often associated with congestion problems, noise and air pollution. Further, urban logistics related to e-commerce has some particularities when compared to traditional logistics, with high impacts for cities: parking, more concentration in downtown areas, smaller size of vehicles (thus more), the fact that they are "disguised" as normal commuters. Thus, it is difficult to manage.

In order to reach urban sustainability, the understanding of transportation logistics in the city becomes a strategic issue. In addition, it is important to address in which way some policies and operational initiatives could promote an efficient last-mile delivery in urban areas.

This paper presents a new tool, called GIULIA - Geographic Information for Urban Logistics Interventions Analysis – designed to provide a decision-making environment that relies on the visualization and the modeling of the interrelationship between e-commerce and generated urban logistics, and enables the analysis of selected policies and interventions.

The rest of this paper is organized as follows. Section 2 discusses works that developed systems in the context of urban logistics. Section 3 presents the structure of the proposed system and describes the database. The model is defined in section 4 and section 5 presents the interventions that are analyzed. To complete the presentation of the platform, the section 6 shows an overview of the GIULIA interface. Section 7 concludes and present future steps associated to this work.

2. Related Works

In the last decades, the field of transportation and urban logistics proved to be quite fruitful with many studies and solutions developed to model and treat interventions. In this section, we review some projects related to the creation of the GIS platform and SDSS in the context of urban logistics, which were useful as a reference to this work.

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[1] About the growth of internet use in last decades and prospects for next years, see: Global Internet Report, 2015. Internet Society; and specific to Brazil: ICT Households, 2014. Brazilian Internet Steering Committee, São Paulo, 2014.

The KM2[2] project was developed at the Massachusetts Institute of Technology (MIT) to function as an urban logistics atlas with information collected in megacities around the world. It consists of rich datasets of relevant and detailed logistics information and includes the factors that impact delivery performance in general. The project was a pioneer in providing a georeferenced logistics data in a web server, free of charge, for selected cities around the world.

The Luxembourg Institute of Science and Technology developed and hosted the Smart Cities Logistics[3] platform. It is a spatial decision support platform for urban logistics in European cities and depicts information on transportation networks, access restrictions, traffic measures, delivery and transport facilities, administrative units, population, land use and emissions. This information can be overlaid, allowing for cross-analysis. The system also offers a set of modules for hypothetical cost calculations, optimal meeting point, shortest path, sums layers, surface generations by Spline interpolation and traffic measurements to surface along road segments. The platform is for registered users-only, and enables scenario analysis on current nuisances associated to the urban delivery activity, highlighting the variations in CO^2 emission.

Eindhoven University of Technology developed a similar study with the scope of this work in collaboration with the World Bank Group and Agence Marocaine de Developpement de la Logistique (AMDL), entitled "Modelling Traditional City Logistics in Low and Middle Income Countries - Case Study Casablanca".

The goal of the project was to design a method and an associated decision support tool for city logistics policy and regulation making, considering the traditional channel of logistics, improving the livability and competitiveness of the city (BROFT, 2015).

The city was divided into zones, classified by assigned function (terminal, logistics zone, manufacturing, commercial or residential) and logistical characteristics (traditional, modern or mixed). The types of products were grouped into three categories: Fast Moving Consumer Goods, Consumer Goods and Materials. The model input consists of socioeconomic data and drivers observations, and the outputs are emission, congestion and logistics costs indicators.

The above projects created platforms to understand and analyze urban logistics, which enhance our understanding about the dynamics in the complex system of urban logistics. Nevertheless, to the extent of our knowledge, the above tools do not take into consideration demand-related aspects, in particular associated with e-commerce urban logistics. GIULIA platform incorporates these aspects and explores the roles and interrelationships between e-commerce, public policies and urban logistics.

3. Tool Architecture

Densham (1991) defines five elements that compose an operational spatial decision support system (SDSS): 1) the data subsystem; 2) the model subsystem; 3) display generator; 4) report generator; and 5) the user interface. The database provides storage of all the spatial and operational information in the system. The model subsystem specifies a number of mathematical models to manipulate the e-commerce demand, the logistics

[2] Available at: http://lastmile.mit.edu/km2.

[3] Available at: http://iguess-sl.tudor.lu/maps.

demand as well as parameters estimations and interventions results. The display and report generator refers to thematic maps, graphics and tables that report the results of the model. Finally, the user interface regards the visualization and how the user interacts with the system.

Before going deeper into those elements, we list some functional specifications and system language programming: The operational system used for servers is the *Windows Server* with *Internet Information Server* framework. The codes were created using C#.Net, Active Server Pages (ASP.Net) and JavaScript. To perform the georeferenced operations and support the presentation of maps, a free software component called *LeafLet* is adopted, complemented with *MapServer* tool, which work together with Geoservers like *OpenStreetMaps*, combined with specific geographic data layers in Shape File format.

3.1. Database

The database created is relational and georeferenced, including electronically stored data sets in a structured way, with update and recovery resources. The data needed as input in the system was organized in seven groups, according to the subject of the data and are presented in Table 1.

Table 1. Groups of Data Inputs

Group	Input Data
Zoning	Number of zones
	Zone area
Network	Transfer (inter-zone) average speed
	Local average speed
	Internode distance
	Real/straight distance factor
	Path distance between origin-destination zones
Socioeconomic	Population for base scenario
	Coincidental addresses factor
	Specific shopping trips factor
	Commercial address distribution factor
	Average travel time for buy
Commercial	Delivery average weight
	Delivery average volume
	Delivery deadline (days)
	Consumption factor
	Commercial address delivery factor

Group	Input Data
Vehicle	Fixed daily vehicle cost
	Variable vehicle cost per distance
	Vehicle weight capacity
	Vehicle volume capacity
	Vehicle delivery units capacity
	Vehicle daily journey time
	Interval between routes of the same vehicle
	Efficiency factor
Logistic	Zone origin probability
	Residential delivery sucess factor
	Commercial delivery success factor
	Number of shippers
	Vehicle usage factor
	Average stop time
Environment	Pollution factor

All spatial structure of the model is based on the adopted zoning areas. For this reason, it is important to adopt a consistent zoning with the granularity of the other parameters in the model, in order to allow the analysis of results at reasonable levels. It is also interesting to adopt divisions that may be compatible with other related studies.

Data concerning the commercial aspects are model parameters to characterize the products, consumers and respective consumption. The first thing that need to be considered, in the case of logistic modeling, is that the market needs to be segregated based on the categories of products. The reason it is that logistics deliveries depend heavily on the characteristics of the product and the deadline required. However, it is practically impossible to input each product. Therefore, based on its characteristics, the products can be grouped; the proposed classification is: Fashion and accessories; Cosmetics, perfumes and health; Home appliances; Home decor; Electronics, computing, telephony and mobile; Books, magazines and subscriptions; Sports and leisure; and Food and beverages.

Finally, in order to build a more consistent baseline scenario, it is interesting to divide the population based upon their social class. The objective here is to create homogeneous groups of consumption. Several studies show a direct correlation between social class and consumption. Warner (1960) states that each social class has unique motivations and buying behaviors. Surveys have shown a large disparity among social classes in the online shopping (ICT Households, 2014). Moreover, the configuration of urban spaces is, in general, heterogeneous and organized by clusters of similar groups in certain locations and it usually has a strong correlation with social classes. The consequence is that the delivery flow will not to be similar in all zones of the city.

4. Modelling Specification

4.1 E-commerce demand modeling

Modeling the demand for e-commerce products, is an essential part of the model. This computation is going to determine the amount of deliveries needed in the city and serve as a base for the logistics transportation modeling.

The first step it is to determine the quantity of orders (*DE*) for each zone (*z*) and by product segment (*p*). The total of orders will be the sum of the population of each social class (*c*) in the zone *z* ($P_{z,c}$), multiplied by a consumption factor ($fc_{c,p}$) by the social class *c* in the segment *p*.

$$DE_{z,p} = \sum_{C} [P_{z,c} \times fc_{c,p}] \tag{1}$$

The number of orders must be transformed into demand deliveries. Another issue considered in the model is the unsuccessful deliveries. Sometimes, more than one delivery attempt is needed, since it is mandatory the presence of someone responsible for receiving the goods. As a result, the total amount of supply operations exceeds the total of orders.

Another issue is that part of the deliveries is to commercial addresses, since some consumers prefer, by convenience, to receive their orders at their work place, instead at home. Thus, the demand is divided according to the address delivery type in residential (*DH*) or commercial (*DC*). The demand deliveries are determined by:

$$DH_{z,g} = \frac{(1 - fa_g)}{fsh} \times \sum_{p \in g} DE_{z,p} \tag{2}$$

$$DC_{z,g} = \frac{fa_g}{fsc} \times fcd_z \times \sum_{p \in g} \sum_{k}^{NZ} DE_{k,p} \tag{3}$$

Where, the index *g* indicates a group of joinable products, that is, they may be grouped for delivery in the same loading; fa_g indicates a factor of deliveries in commercial addresses, while fcd_z is a factor of the location of these commercial addresses in each zone; finally, fsh and fsc indicate the success factor in residential and commercial deliveries, respectively.

Finally, one more aspect was considered, related to matching addresses. The goal here is to determine the amount of stops performed in the delivery operation. Frequently, the delivery carries different orders, but it is targeted to one place, requiring only one stop to deliver more than one order. This becomes quite common in densely populated areas, with the presence of horizontal condominiums. Therefore, the number of delivery addresses indicator it is reached as:

$$DP_{z,g}^{m} = DG_{z,g}^{m} \times fac_{z} \tag{4}$$

fac_z represents the coincidental addresses factor in the zone *z,* and DG refers to consolidation of demand deliveries (*DH e DC*), that can be expressed by zone and product group for individual delivery (*I*), pick-up points (*P*) or last mile deliveries (*L*), for (*m = {I,L}*).

4.2. Logistics Distribution Modeling

The interrelationship between demand and logistics is represented by a set of stops (S). The number of delivery addresses($DP_{z,g}^{m}$) will determine the number of deliveries needed and the stops, conditioned by different vehicle types (*v*), which are parameterized by the division factor (*fv*) which may vary by time of day (*t*) and, product group (*g*). Hence, for (*m = {I,L}*), a set of stops is:

$$S_{z,t,v}^{m} = \sum_{g} [DP_{z,g}^{m} \times fv_{t,v,g}^{m}] \tag{5}$$

In the case of deliveries in pick-up or concentration points, the stops are estimated by the number of concentration (*NC*) and pick-up points (*NP*) in each zone *z*, divided by interval of supply measured in terms of day:

$$S_{z,t,v}^{P} = \frac{(NC_z + NP_z)}{si} \times \sum_{g} fv_{t,v,g}^{P} \tag{6}$$

The vehicles usage factor, expressed in the division factor, must total 100% for operations $m = \{I, P, L\}$, i.e., $\sum_{t,v} fv_{t,v,g}^{m} = 1$. The total load in terms of weight (*W*) and volume (*V*) can be calculated by adding the average weight value (*wm*) and volume (*vm*) in a multiplicative form in equation 5.

Finally, in order to structure the results it is required to measure the amount of vehicles needed, the cost of transport and the emissions during delivery processes. Thus, more than the amount of supplies/stops, one needs to know the traveled route, both in terms of distance and in terms of time spent.

To measure the number of routes needed for transport (*R*), it must be considered the maximum constraint between the weight capacity (*CW*) of the vehicle type (*v*), volume capacity (*CV*) and delivery unit's capacity (*CU*) or a function of travel time (*Rt*). Using also an efficiency factor (*fe*) since, in practice, vehicles do not have their full capacity used:

$$R_{z,t,v}^{m} = fe_v \times \max\left\langle \frac{W_{z,t,v}^{m}}{CW_v} \middle| \frac{V_{z,t,v}^{m}}{CV_v} \middle| \frac{U_{z,t,v}^{m}}{CU_v} \middle| Rt_{z,t,v}^{m} \right\rangle \tag{7}$$

The travel time restriction should consider the maximum trip journey (*J*) and stop times (*ts*), travel time for path between stops (*tt*), travel time from origin (*ta*) and travel time to return (*tr*), for final deliveries:

$$Rt_{z,t,v}^{m} = \frac{S_{z,t,v}^{m} \times \left(ts_{z,t,v}^{m} + tt_{z,t,v}^{m}\right)}{\left(J_v - ta_{z,t,v} - tr_{z,t,v} + tt_{z,t,v}^{m}\right)} \tag{8}$$

In the case of routes serving concentration/pick-up points, it should only consider the capacity of the vehicle and not the time, since the carriers may use more appropriated vehicles.

In order to evaluate the travel route times, it is considered an estimation obtained by Daganzo (1984) method, based on the number of stops in each area and the zone dimension. In addition, it was considered a correlation with the network density in each zone. With this method, it´s possible to calculate the distance and time between consecutives route stops.

Another portion of the route time is the distance and time to access the zone. For that, it is taken into account the probability of the zone for supplying the destination zones. It is used a previous calculated origin-destination matrix of routes between zones that give the estimation of route distance and time for each flow between zones.

4.3 Indicators Calculation

The model seeks to provide four indicators as a way to give an overview of transport logistics impacts related to urban e-commerce in the simulated scenarios.

The first indicator refers to the transportation cost (C). The cost needs to be viewed only as an estimation for operational vehicles costs in the logistics for e-commerce goods; this model was not structure to be a distribution cost analysis tool. For each vehicle type ($CV_{z,v}$), the cost is based on fixed the cost (cf_v) times the number of routes needed to transport$\left(R_{z,t,v}\right)$, plus the variable cost (cv_v) that varies in terms of the travelled distance ($D_{z,t,v}$).

$$CV_{z,v} = \sum_{t} \left(R_{z,t,v}\right) \times cf_v + \sum_{t} \left(D_{z,t,v}\right) \times cv_v \tag{9}$$

It is considered important to measure, even if in a simplified way, the direct benefits for e-consumers, when compared to the conventional alternative shopping in physical stores. The proposed indicator calculates the hours saved by the buyers (B), considering the total number of e-commerce purchases ($DE_{z,p}$) multiplied by the average time of travels with shopping purpose.

$$B_z = \left(\sum_{p} DE_{z,p}\right) \times tb_z \tag{10}$$

Where, tb_z is the average travel time for buying.

The other two indicators are related to the environmental impact. The model calculates the energy efficiency (EE) and total emission (E) generated by transport. Both the energy efficiency and emission considered the total travelled distance ($D_{z,t,v}$) by motorized vehicles (M), and are multiplied by a factor of fuel consumption in the case of energy efficiency and by a pollution factor in the case of emissions.

$$EE_z = \sum_{v \in M} \sum_{t} \left(D_{z,t,v} \times ff_v \right) \tag{11}$$

$$E_z = \sum_{v \in M} \sum_{t} \left(D_{z,t,v} \times fp_v \right) \tag{12}$$

5. Interventions to be Analyzed

As stated by Arampatzis et al. (2004) a characteristic of the decision support tool is that it pre-defines some “abstract” interventions and incorporates them as “methods” into the system, which are algorithms and procedures for each intervention type.

Seven benchmark interventions were taken into consideration to be applied in the scenarios using the proposed model: pick-up points; night/off-peak delivery; non-motorized delivery; unassisted delivery; joint delivery systems; redefinition of load/unload areas; and urban consolidation centers. The impacts of each intervention can be modeled by changing the functions incorporated in the system. Table 2 shows the relationship between the parameters and interventions.

In the case of the pick-up point intervention, the goal is to modify the transport mode in the last mile, replacing the freight transport by an individual transportation, which could potentially be non-motorized. The model includes some pick-up points based on density by zone and reallocates part of the e-commerce demand to this delivery option.

The night/off-peak delivery action concerns the change in the distribution operating hours. The idea is to avoid high traffic hours and difficult parking for unloading. This interference affects the vehicle travel speed and reduces the parking time, and consequentially makes the deliveries more efficient. Nevertheless, it may encounter difficulties in finding someone to receive the product, which can increase the unsuccessful deliveries and generate problems regarding noise and security concerns.

An interesting intervention discusses the use of non-motorized deliveries instead of motor vehicles deliveries. The deliveries can be implemented in the last mile using bicycles, cargo tricycles and other vehicle adaptations, as well as deliveries on foot.

The unassisted deliveries intervention seeks to achieve deliveries without the mandatory presence of a receiver. This intervention can be modeled simply by changing the success rate of the deliveries function and the average stop time.

A promising alternative to optimize the distribution of loads generated by e-commerce is the joint delivery system. In the model, this intervention simply changes the number of shippers operating in the logistics, which reduces the number of route origins and allows delivery consolidation to each delivery zone. From the city’s point of view, the joint logistics operation provides the best use of employed vehicles; consequently it reduces traffic interferences and environmental impacts.

The interference of loading and unloading stops in urban areas is quite relevant, considering the lack of parking places available in the area. The absence of parking can generate greater movements of vehicles in search of vacancies, or even lead to the practice of using undue areas and traffic violations. The intervention establishes specific areas for loading and unloading within the urban area and is modeled by a change in the stop time per zone.

Table 2. Interventions characteristic and impacts

Parameters		Interventions Types						
		Pick-up points	Night/off-peak delivery	Non-motorized delivery	Unassisted deliveries	Joint delivery systems	Redefinition of load/unload areas	Urban consolidation centers
fsh	Deliver success factor at home		●		●			
fsc	Deliver success factor for commercial address		●		●			
fi	Pick-up points density	●						
fap	Pick-up point deliver factor	●						
fcp	Consolidation deliver factor (non-pick-up deliveries)							●
NC	Number of consolidation centers							●
NS	Number of shippers					●		
si	Supply interval (days)	●						●
fv	Vehicle usage factor		●	●				
ts	Average stop time		●	●	●		●	

The urban consolidation center is a smart solution with the aim of creating storage points or intermediate transshipment in the city where it can be switched from one type of vehicle to another smaller or even complete the operation at different times.

Furthermore, the model also predicts changes in demand, in order to give more flexibility to the proposed model, to tune the demand and allow simulating future scenarios in terms of population variation.

6. Visualization and Scenarios

Figure 1 illustrates the initial page of the system, where the user has some initial information about GIULIA and has the main menu options. In Studies and References, the user can get extra information about the theme, where publications are available grouped according to the following themes: e-commerce, urban logistics, information systems and interventions experiences. Another option in the main menu is the consult of basic geographic information, socioeconomic and infrastructure characteristics and other available layers of interest (Figure 2). Each geographic information layer has a set of metadata information available for consultation.

Figure 1. Initial Page with Menu Options

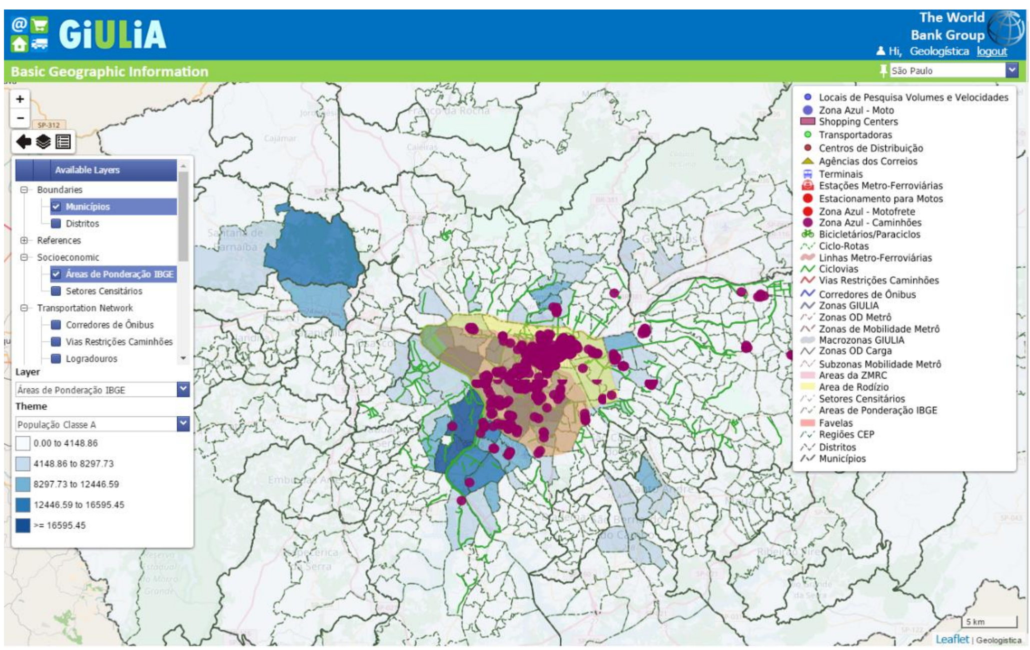

Figure 2. Consult of Basic Geographic Information

As stated before, what differentiates a DSS is the model element that allows the user to construct alternative scenarios. In this aspect, the interface becomes an important tool as it allows the user to interact with the environment, manage scenarios, analyze and compare them. In the menu Impact Analysis, all the interventions considered in the model are listed to the user. The program has a baseline scenario for each locality that is always present and serves as base parameters settings for new scenarios creation and comparison. The management of scenarios is done by changing the proportion of deliveries to a specific intervention (Figure 3). The results come through thematic maps and graphics, which display a set of indicators (Figure 4).

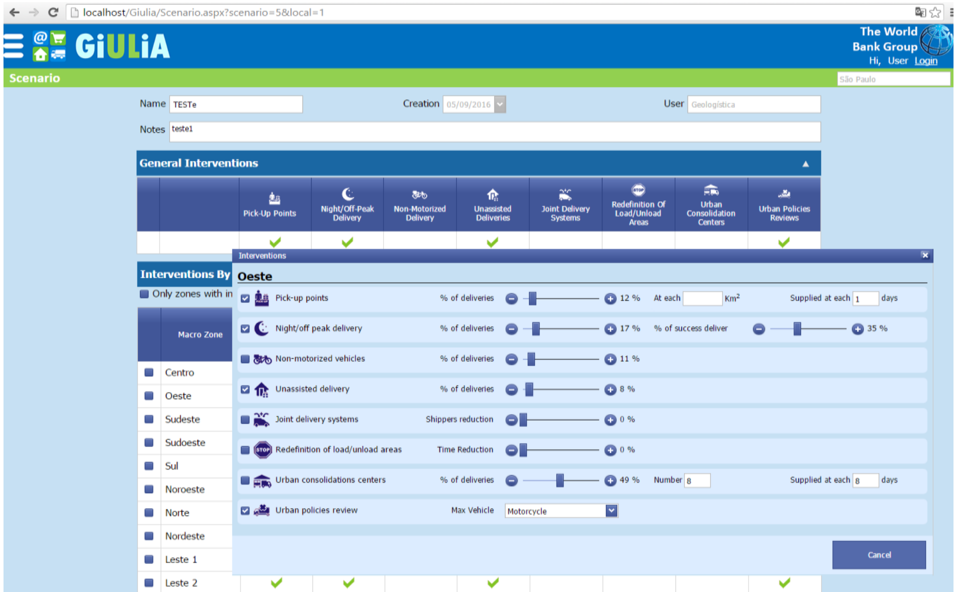

Figure 3. Page for alternative scenario construction.

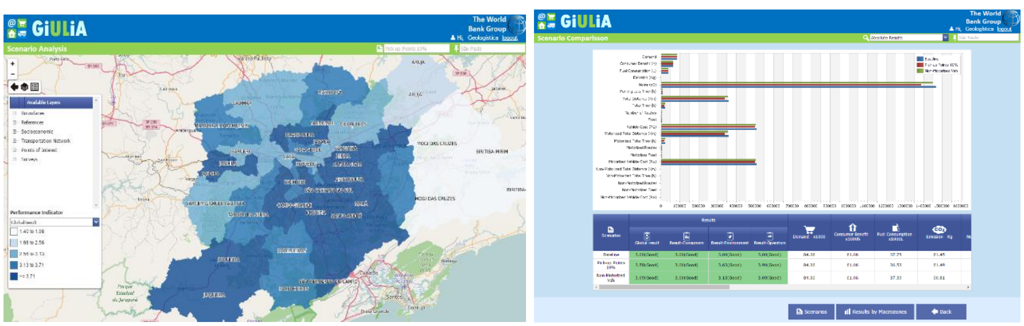

Figure 4. Example of impact analysis: map of scenario's indicator and graphic to compare scenario's results.

7. Conclusion

The aim of this paper was to introduce GIULIA, a spatial decision support system, designed to evaluate the relationship between online shopping and urban logistics, as well as the impact of interventions in urban logistics. The innovation brought from GIULIA was the modelling of a complex and important issue in urban areas with the objective to reach more sustainable cities.

Freight flows are fundamental in any city, but, usually, are associated with negative impacts on cities, such congestions, air pollution and noise. With the e-commerce consumption growth, there are expectations of an increase in logistical transport within cities. Nonetheless, freight transportation in urban areas is often missed in the public planning analysis, despite being a key factor to reach urban sustainability.

In light of this, the GIULIA system is an attempt to bring a more comprehensive analysis to the issue and help decision makers to analyze potential interventions. Not only may the system build urban logistics analysis from demographic data, but it may also spread good practices in urban logistics amongst its users, who will be mainly urban planners. As mentioned before, e-commerce is a fast-growing market in Brazil and well-prepared urban planners will make a difference in such complex scenario.

The software was built with the purpose to be applied to any city, requiring only the allocation of local data. This is perhaps the biggest challenge to its implementation. The problem in question requires a large amount of data and from different sources.

The next step it is the application of GIULIA in a real city to test its functionalities and the impact analysis. The city of São Paulo in Brazil was chosen for the first application, because it has the major e-commerce sales shares in the country and faces great problems in urban transportation.

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References

Arampatzis, G., Kiranoudis, C.T., Scaloubacas, P., Assimacopoulos, D. (2004), “A GIS-based decision support system for planning urban transportation policies”. In European Journal of Operational Research, 152, pages 465-475.

Broft, A. D. (2015) “Modelling traditional city logistics in low and middle income countries: a method and tool as decision support for policy makers”. Eindhoven: Technische Universiteit Eindhoven.

Daganzo, C. F. (1984), "The distance traveled to visit N points with a maximum of C stops per vehicle: An analytic model and an application". In Transportation Science 18(4), pages 331-350

Densham, P. J. (1991), “Spatial decision support systems”, In: Geographical information systems: Principles and applications, ed. J. Maguire, M. S. Goodchild, and D. W. Rhind. London: Longman Publishing Group, chapter 26, pages 403-412.

E-bit/Buscapé Company. (2016), “WebShoppers Report”, 33rd Edition, http://portal.ebit.com.br/webshoppers, June.

Simon, H. A. (1955), “A behavioral model of rational choice”. In Quartely Journal of Economics, 69, pages 99-118.

Survey on the use of information and communication technologies in Brazilian households: ICT households 2014. Brazilian Internet Steering Committee – CGI.br, São Paulo, 2015.

Visser, J.; Nemoto, T.; Browne, M. (2014), “Home Delivery and the Impacts on Urban Freight Transport: A review”. Procedia – Social and Behavioral Science, 125, pages 15 – 27.

Warner, W. L. (1960), “Social class in America: an evaluation of status”. New York: Harper and Row.