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Data requirements for urban logistics decision support: case of loading and unloading operations in Bogotá, Colombia

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Abstract. The aim of this paper is to analyze, via a case study, the main issues related to data production in a preliminary step of defining and designing a Decision Support System (DSS) for urban logistics. The case study is that of Bogotá City, Colombia. We present in a first time a literature review concerning with the relevance of developments and application of DSS in urban areas, focusing on megacities. Then, the case study is presented, by identifying the context, the main stakeholders and the needs in information that would be used in a DSS for urban logistics. Finally, a discussion of those results and a set of practical implication are proposed.

Keywords: Urban logistics, decision support system, loading and unloading operations, stakeholders, logistics characterization

1 Introduction

Decision-making is a recursive process that usually involves multiple decision criteria and issues, which are often in conflict with each other. To bring rapport to this process decision support (DSS) and Group DSS (GDSS) can be a good way to assist decision makers in their choices. Both the DSS and GDSS should be integrated with a symmetrical approach to help the decision maker to simultaneously take into account all the decision criteria [1]. It is important to explore the effects of the characteristics of DSS, including system quality, quality of information, accompanied by perceived ease of use, utility satisfaction decision support and perceived net benefits [2].

Therefore, the issue of urban logistics has a great interference in the decisions made in the management of the supply chain. This coupled with the fact that many decisions cannot come from internal actors of the chain, but also external ones (such as government institutions and control), make decision-making process dependent on the particular information of each market as well as of the participation of the public policy on regulation and regulation of the supply chain [3]. As observed in the literature, there are many "best practices" but few simulation and decision support tools that are operational [4].Most works on decision support are mainly theoretical or conceptual and the construction of operable DSS remains at its beginnings. [5]

This paper is framed in the context of designing guidelines for loading and unloading operation management, focused in the area of information systems (IS). The aim of this paper is to characterize the data requirements that support a Decision Support Systems (DSS), taking into account the objectives and knowledge of each category of stakeholders involved. First, we present the background and context of this research. Then, we present the case study of Bogotá city, Colombia, identifying the main stakeholders involved in the guideline definition of a DSS for urban logistics as well as the suitable information for each of them. Finally, a set of recommendations are made regarding the conclusions drawn at the end of the study.

2 Background, context and motivation

DSS are interactive IS that help the planner and decision maker in an organization to use data and models to solve decision - not two or semi- structure. A DSS aims to support the process of decision making by generating and systematic evaluation of alternatives or decision scenarios, using models and

computational tools. DSS does not solve problems, as only supports the process of decision making. The responsible for making a decision, to choose it and carry it out is the users, not the DSS [6].

The DSS is one of the most emblematic tools of Business Intelligence because, among other properties, allow to solve many of the limitations of management programs. Its main features are [7]: (1) dynamic, flexible and interactive reports; (2) no technical knowledge required, i.e. a non-technical user can create reports and navigate among them; (3) fast response time, as the subjacent base data is usually a corporate data warehouse or DataMart; (4) each user having adequate access to the information he needs to make his work as efficient as possible; and (6) availability of historical data.

We can find DSS in many fields of application. Concerning urban logistics, three successful DSS examples are:

- PLUME [8]: The central theme of the PLUME project is to evaluate the impact on the organization of the delivery of goods carried out in the last mile. In particular, the aim is to develop a system of decision support (DSS) that can help both carriers and local authorities for their tactical decisions (locations platform, fleet size, clustering ...) and optimize the location of the platform and the size of the fleet for fast delivery in cities.
- ANNONA: This DSS takes an industrial research viewpoint. It covers the production of new knowledge in the field of urban logistics. This is a research program proposal driven by the real needs of policy-makers in their daily role implementation of innovative and sustainable logistics in city centers [9].
- CLASS (City Logistics Support Analysis and Simulation) : It is a software created exclusively for the store design and simulation. Used by the leading logistics companies, CLASS is the "tool of choice" to identify performance efficiency in the warehouse and as a test platform for the introduction of operational innovation. It is used for new buildings, to test designs before they begin the process of construction, and operational improvement to an existing site. CLASS allows users to design, complex storage solutions testing and re-design in a virtual computing environment by changing many different parameters and measure their impact [10].

All three examples are mainly SDSS (Spatial Decision Support Systems). Two of the three (ANNONA and CLASS) use geographic information system (GIS) as a support system in decision-making (DSS) to assist the decision maker in applications such as routing and use resources, making use of spatial information. As we observe from this synthetic overview of DSS, most of them are public authorities and policy-making oriented without real interaction with private stakeholders.

3 The case study

Bogotá is the capital of Colombia, it has 9.8 million of citizens and it receives 200.000 ton of goods per year, the city is divided in 115 urban entities, which develops different economic activities. According to IDB (Inter-America Development Bank), the city currently develops logistics operations within the city 24 hours per day, 7 days per week; those represent about 2000 daily tours associated with freight transportation. The city has eight principal access ways, by those enter to the city different products.

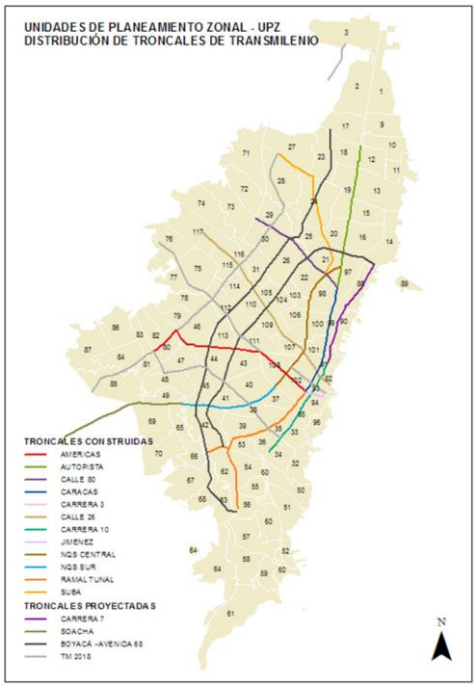

Figure 1: Bogotá's division for urban entities (Source: SEPRO, Universidad Nacional de Colombia)

The particular city design, Bogota does not have ways to transit big trucks, for this reason the transporters or deliverers have to change the vehicles to ones that have less dimensions. These increase the numbers of vehicles that transit in the city and generate more impacts in the mobility and environmental factors.

In addition of the number of vehicles that transit in the city, there is a deficit in infrastructure and the poor coordination among the actors involved in loading and unloading goods operations, this create many failures in the logistic system and generate negative effects on the mobility and citizen's behavior.

The logistic operations conditions within the city have varied circumstances according to the geographical area where it grows, the availability in infrastructure and human resource, land use and other preponderant elements for the development of urban logistics operations. It is necessary take into account that the operations efficiency are subject to factors that are handled under uncertainty due to the lack of tools, misunderstand information, mistake in the data collected, among others. In Bogotá city according to its development, expansion and industrialization processes, it have generated different dynamics within the city and particularly in some geographic areas. Similarly, the control entities influence the development of operations in exercising its control mechanisms over the areas that concern it. Nowadays however, even when the control entities should work cooperatively, there are substantial differences among their objectives, they do not address issues that they have in common and they do not take the decisions in a collaborative form.

It is therefore imperative the development of articulation and cohesion capacity looking to promote conditions conducive to the logistic operations control within the city, allowing the evaluation of measuring accurate indicators under conditions which the operation develops. Similarly, control entities must involve the private sector that is proactive in the selection and care of factors to improve.

The adoption of alternatives that allow the analyze of date requirements for decision making depends on the active participation of control entities and private sector in the process of data requirement that each entity collects in order to allows the analyze in a concise way the situations that arise in the logistics operation of the city.

To this aim is proposed to identify the restrictions and the impact of each actor in order to do not to overlap and create duality in some of the decisions that can throw the DSS. Moreover, looking to establish the dynamic among actors associated with a common interest. These participate in the development of operations of loading and unloading of goods. According to the cross requirements founded it is proposed to develop a sequence of interest modules covering as many stakeholders in it.

Based on the identification of data requirement, needs and stakeholders interests it proposes to give way to future developments in order to meet a latent need in the operations taking place in city logistics

operations. These joint interests for defining the scope of each of the factors that the DSS must take in its design phase as final requirements of the actors involved in the system of urban freight distribution.

It is important to define the main public agents involved in the strategy who are described in the Table 1.

Table 1: Description of the main public agents involved in the strategy

Entity	Function
Mobility office	It is a public entity that aims to raise formulate policies and lead mobility sector to generate mobility conditions consistent with the needs of the Bogotá population and its area of influence [11].
Environmental office	It is a public entity that leads, develops and implements policies focused pubic habitat, improve housing, urban planning and access to homes for Bogota [12].
Economic Development office	It is an organization created with the aim of strengthening the competitiveness and productivity of enterprises, employment generation and food security through economic development policies [13].
Ministry of Transport	It is one of the main entities of the national civil service which aims to formulate policies, plans and programs, projects and economic regulation of traffic, transport and road, sea, river, rail and air infrastructure in the country to ensure its development and continuous improvement [14].
Local mayors	Local municipalities are public entities who dependent on the District Department of Government which aim to support the implementation of district policies in the localities. Support promotion policies and land management in the development of roads, providing subsidies, support to schools and recreation for children and seniors; promoting the community organization, public participation of citizens, promoting coexistence and conflict resolution in order to promote peaceful coexistence [15][16].
National Police	It is a public entity that serves as an armed entity, instituted to protect people and ensure compliance with the social obligations of the state and individuals to maintain the necessary for the exercise of the rights and freedoms set conditions to ensure that the Colombians inhabitants living in peace. The rights protected by the police are grounded in the Constitution, treaties or international human rights treaties ratified by the Colombian government [17][18].
Transit police	It is a unit of the national police and transport ministry, responsible for the regulation and control of traffic at major intersections, to ensure and facilitate mobility conditions, safety on the roads of different cities and on the road under normal conditions, accidents, events or activities occurring throughout the country. Its control method is the use of traffic violations, which are designated by the Ministry of Transport, for safety, pollution and citizen welfare [19].

The nature and implication of each stakeholder is different, which makes difficult to find a unique solution and needs then to produce a consensual choice [20] in terms of specifications of the DSS that will be agreed by all stakeholders. It has been important to formulate new strategies and models that lead to overcome the new challenges that bring the restructuring of the cities we know, in cities or large and more complex metropolis. This is why it is necessary to understand in a different way to conventional dynamics under which freight logistics takes place in cities, understanding the emerging needs of the actors involved and the approach of innovative models to respond to these changes and also rethink the paradigm of urban logistics. To do this, it is important to define the main needs and available information of those stakeholders, that will be shared, in an informational sharing logic [21]. To do this, we propose to collect information via a qualitative data collection and analysis.

Currently in Bogotá city, there are stakeholders who are promoting different initiatives in order to improve the logistics operation development. One of this is the creation of the public-private coordination unit for Bogotá's logistics improvements (Unidad de Coordinación Público Privada para el Mejoramiento de la Logística de Bogotá), which is an entity who promotes foster care issues in the logistics sector of the city, by integrating public control authorities and active participation in the real sector.

Its objective is the definition and evaluation of performance measures that give a clear picture of how the logistics operation are performed in the city and propose alternatives to take decisions that should be taken into account to improve the operating conditions. This entity propose the definition of indicators in which all control entities could participate and provide data requirements and information according to their particular areas of interest, regarding the loading and unloading operations in the city.

To collect this data, a combination of a documentary analysis and a feedback-based data collection has been deployed. To collect the feedback information, three public stakeholders have been selected, mainly because of their availability and disposal to contribute to the development of a DSS, as well as for their general knowledge on the context and the aims of the project where this research is included: the Economic Development office, the Mobility office and the Colombian Ministry of Transport. A set of

interviews to key profiles in each organization as well as several visits and phone exchanges have been carried out, on the basis on a feedback guide to collect information on how the following elements are important or still considered by the different stakeholders :

Table 2: Meaning of the initial considered as the main criteria's axes

Initial	Meaning
TM	Traffic measures
INF	Infrastructure
CM	Coordination Media
COO	Coordination
LOS	Logistics Services
SR	Special regulations
PEA	Planning of economic activity
TEC	Technology
EXT	Externalities (security, cost, pollution, etc ...)
LSC	Logistics and Social Costs

4 Results – Matrix of incidence

In this section we present the synthesis of the qualitative analysis. We report in table 1 the criteria selected by each stakeholder as being important. The relationship among this criteria is then identified.

Table 2: Criteria relationship

Stakeholders Entities / incidence strategies in the common interests of the project	Traffic measures (TM)	Infrastructure (INF)	Coordination Media (CM)	Coordination (COO)	Logistics Services (LOS)	Special regulations (SR)	Planning of economic activity (PEA)	Technology (TEC)	Externalities (security, cost, pollution, etc ...) (EXT)	Logistics and Social Costs (LSC)
Secretary of Mobility	x	x	x	x			x	x		
Secretary of Habitat		x							x	x
Secretary of Economic Development			x	x	x		x		x	x
Ministry of Transport	x	x	x			x	x	x	x	x
Local mayors		x				x			x	x
National Police				x		x			x	
Transit Police	x	x		x				x		

We can precise those criteria as follows:

For the mobility office:

- TM: Mobility office as being of leadership in traffic rules at district level, defines and affects the legislative traffic and transportation.
- INF: The state of road infrastructure affects the conditions that allow the citizens a quick and safe transit within the city.
- CM: Mobility office regulates the means that can be performed within the city or in specific regions thereof.
- COO: The coordination needed in logistics transportation into town, generates a greater flow of traffic that affects the general mobility needs of the inhabitants of the district
- PEA: When fixing the location of industrial zones and trade in the same sector, a concentration of freight traffic common in specific points of the city is set.
- TEC: Implementing technologies or research affecting or likely to give users better mobility van with the objectives of the Mobility office.

For the environmental office:

- INF: Infrastructure affects and should serve as support for the development of urban planning, improving the conditions of mobility of citizens to carry out their activities.
- EXT: The living areas are considered better, they are those with the fewest negative externalities such as safety and pollution.
- LSC: expected costs, labor hours lost or delayed orders go against the quality of the residential sectors, affecting the inhabitants of these areas.

For the Secretary of Economic Development

- CM: The transport of goods for companies in a sector of the city, are affected by the feasibility of the income of certain types of freight vehicles.
- COO: The lack of coordination in freight generates a cost overrun compared to companies that perform the same sector coordination by the number of orders placed.
- LOS: The services have logistics companies and warehousing, consolidation or deconsolidation of cargo or transport operations are acquired by other companies that need these spaces for inventory management, incoming or outgoing goods.
- PEA: The agglomeration of economic specifics of the city activities, generates the raw materials necessary for the operation and products produced, are common or similar with respect to suppliers, customers, product management among others.
- EXT: Externalities such as theft producers, costs for lost production capacity or economically affect businesses in terms of sales.
- LSC: Operating costs for logistics and product maturity, falls on the customer's production company.

For the Ministry of Transport

- TM: The ministry is in charge of leading, raise and issue measures and rules on road use, which must be met on local measures.
- INF: The Transport Ministry is responsible for carrying out works road, sea, river, rail and air throughout the country infrastructure, including local works.
- CM: Ministry by the state of the roads, in a way defines the use of the means of mobility for freight.
- SR: The ministry is responsible for issuing traffic rules, conditional under certain circumstances allow greater mobility for citizens.
- PEA: As glider national territory, we have the interest to know the best way to consolidate the load locally.
- TEC: Using Technology allows the ministry to share information that would allow him to improve him or actors involved inside and outside use mobility infrastructure or regulations.
- EXT: The decisions of this entity are reflected in national security issues, pollution, among others.
- LSC: Logistics costs that are reflected in all entities of the cities of the country are part of the planning we have of the country's road infrastructure it is in charge of this entity.

For Local mayors

- INF: Part of the functions and budget for local municipalities is to ensure a good state of roads in their localities and define the needs of their territories.
- SR: The specific town or district regulations affecting the town should be taken ensuring citizen participation and the benefit of the local territory.
- EXT: Local municipalities as entities seeking the proper use of public force and conciliation must ensure the safety of the sector.
- LSC: Local municipalities should ensure that the social costs that are designated for non-senior citizens in terms of mobility, transport, opportunities, etc ...

For the National Police

- COO: The national police has the ability and duty to ensure public order through coordination methods capable of promoting good use of public space.
- SR: The national police should enforce special rules made throughout the Capital District.

- EXT: The national police should ensure the proper use and compliance with pollution standards and safety throughout Bogota

For the Transit police:

- TM: As an entity regulated and dependent on the norms issued by the transport ministry, traffic police should ensure compliance with these in city traffic.
- INF: transit infrastructure is part of the information that must be reported and compliance by the traffic police.
- COO: Coordination can be guaranteed by the traffic police as an event or activities that occur regularly in the country.
- TEC: The implementation of information technology to share road condition, traffic, faster response to accidents among others, it goes with the objectives of the traffic police.

By defining some cross values between the entities, it is necessary to identify nodes of interest that are representative for different control entities in order to stablish the data requirements that address the identified problems. Therefore, the city promotes the identification of real problems by collection accurate data for the decision making process. Nowadays the vehicle flows can be estimated (via origin / destination matrices) and heat maps can be defined to identify the priority actions to address areas, as well there are a primary characterization of input and output data flows about these areas, such as historical speed of access corridors and availability of infrastructure. This data requirement is part of the information that will integrate a DSS to provide accurate information on the conditions for operations. This is way, it is necessary the integration of the data requirements and available date from the recipient, conveyor and freight companies as well as the entities control.

5 Conclusions and practical implications

Nowadays, there are many aspects to be developed over the management of loading and unloading logistics operations in cities to deal with the main needs of the different stakeholders. A DSS structured by alternative management of logistics operations can be a good alternative to this purpose. Since the condition of implementation is not covered under any course in the contents of this proposal, it is necessary to make clear that follow-up action can become a bit subjective according to the perception of design development support system making (DSS). In that vein three performance areas will be established to evaluate the design and the previous phases to it for the purpose of establishing a continuous improvement process by which barely have identified a flaw in the design, can enter and intervene fix the same. Own design characteristics may be assessed by stakeholders to participate in the articulation of this tool, rather than a system of monitoring and support decision -making, you want to become an integrating tool among the actors , and thus it allows discourse among the conflicting aspects among actors and government agencies regarding governing loading and unloading in the city.

Moreover, without neglecting the need to look at potential impacts or externalities that involve the development of such proposals, especially the five cornerstones on which the central project develops. The assessment of such impacts depends more on the perception of the community, since the ultimate goal is to design a Decision Support System (DSS).

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