Evaluating urban freight transport policies within complex urban environments

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Abstract
Urban Freight Transport (UFT) entails significant advantages for urban economic growth, but can also hamper population quality of life, obstructing vehicular and pedestrian mobility while exacerbating environmental problems. Many initiatives have been taken by many city administrators in order to manage UFT efficiently, evaluating different policies on a global level. From the perspective of the operators, most works analyze a limited set of policies or only focus on the companies' benefits. In this work, a decision-making process is used to evaluate a large set of UFT policies, through different attributes representing the advantages and limitations of each policy for promoter companies and society. To do so, a five step ex-ante procedure is proposed for classifying the policies: (1) attributes definition, (2) attributes weighting, (3) policy-attribute assessment, (4) policy ranking, and (5) feasibility threshold satisfaction. The whole process is supported by consultations with 26 experts regarding shop supply and restocking activities within complex urban environments. The results show a classification of the analyzed policies, according to their suitability for implementation, which could be extended (directly or with small adjustments) to other contexts, given the flexibility of the decision-making procedure developed.
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1. Introduction

Nowadays many cities face a dilemma, between the desire to maintain (or increase) commercial activities in the city center and the need to reduce the negative impacts caused by traffic (Sánchez and Albert, 2015; Rodseth, 2017). Many towns are becoming 24-hour cities, which implies greater difficulty when designing city logistics to achieve reliable and quick access to products and services (Browne et al., 2007; Lindholm and Behrends, 2012). In particular, Urban Freight Transport (UFT) is essential for satisfying citizen's needs, but can also be detrimental in terms of environmental sustainability (Nuzzolo and Comi, 2014; Gil-Saura et al., 2017). Over 80% of the European UFT can be found within the urban and suburban areas, where around 25% of the traffic congestion and an estimated 21% of the CO_2 emissions are caused by UFT activities (BESTUFS, 2007; Dablanc, 2007; ALICE/ERTRAC, 2014).

Freight transport generates conflicts between carriers and other stakeholders involved in urban traffic (Sánchez-Díaz, 2017; Le Pira, 2018). On the one hand, public interests focus on improving the population's quality of life, through good mobility management, respect for the environment and promoting economic development, among others. On the other hand, private interests pursue company objectives such as reducing inventory costs, increasing competitiveness and attracting customers. However, while municipalities expect companies to introduce new logistics services, companies wait for municipalities to provide them. These services could be barely profitable and highly risky (Dablanc, 2007; Lindholm and Behrends, 2012). Although the preferences of both parts may sometimes be opposed, they should be complementary in order to achieve sustainable urban systems from a social, environmental and economic standpoint (Taniguchi, 2014; Guimaraes et al., 2017).

In this context, the restrictions imposed by Public Administrations aiming to protect citizens' interests heighten the challenge of finding appropriate policies for UFT (Stathopoulos et al., 2012). Such constraints, not always sufficiently evaluated (Quak and de Koster, 2009), can have negative impacts on goods distribution costs and may not solve the main problems of urban logistics (Vieira and Fransoo, 2015; Meersman and van de Voorde, 2017). For instance, nighttime UFT activities can entail many benefits, such as a reduction in traffic congestion, but need a deeper assessment in each city or context to avoid environmental impacts, depending on traffic speeds and meteorology (Sathaye et al., 2010). Some policies, seen as sustainability promoters by politicians, have shown severe non-sustainable impacts when implemented (Boussauw and Vanoutrive, 2017). Other policies such as urban tolls or city access restrictions have also shown limitations (Kopp and Prud'homme, 2010; Cantillo and Ortúzar, 2014).

Many works in the literature compare the policies implemented by city administrators in different urban contexts. For example, Browne et al. (2007) investigate the measures taken in London and Paris over five years, focusing on vehicle units: loading/unloading (from now on l/u) activities, city access times, clean vehicles and modal shifts. Gammelgard (2015) analyze the emergence and evolution of city logistics in Copenhagen. Nuzzolo et al. (2016) compare the measures implemented in Rome, Barcelona and Santander based on retailers and transport operators surveys. dell'Olio et al. (2017) analyze the behavior of receivers in two Spanish cities with regards to off-hours deliveries and urban distribution centers. Vierth et al. (2017) compare freight transportation policies implemented in Sweden and Germany. On their behalf, Russo and Comi (2011a) consider the involved stakeholders and outcomes for different policies implemented in European cities, in order to compare the expected goals and the obtained results. Marcucci et al. (2017) propose a participatory multi-stakeholder framework to integrate the perspective of several decision-makers within the development of city logistics policies. From a wider perspective, Lindholm (2013) performs a review of UFT research over the last 15 years, focusing on the viewpoint of city administrators. Kant et al. (2016) compare and identify the lessons learned from UFT initiatives in many contexts, grouping the analysis into policy, logistics and technology projects. Other investigations compile, analyze and compare many city logistics solutions implemented in different contexts and regions worldwide (Muñuzuri et al., 2005; van Duin and Quak, 2007; Vázquez-Paja et al., 2017). Possibly the best known projects analyzing the impacts of UFT measures implemented in Europe are BESTUFS I and II (BESTUFS, 2005, 2007).

One of the main conclusions highlighted by many reviewed projects is the need for ex-ante assessments to avoid applying policies that lead to undesired or unexpected results (Filippi et al., 2010; Ibeas et al., 2012). In other words, methodologies are necessary to evaluate the impacts of UFT measures in each city or region before their implementation; even more so, assuming that extrapolating results from one area to another is not straightforward (Ambrosini et al., 2013).

In this regard, many models for assessing UFT policies are proposed in the literature (Anand et al., 2012; Gonzalez-Feliu and Routhier, 2012; Gonzalez-Feliu et al., 2014). These approaches conceive city logistics as a global problem involving many stakeholders and study a set of measures that can be applied in specific contexts in order to determine their appropriateness, mainly in terms of environmental sustainability. Among other examples, Filippi et al., (2010) propose a methodology for ex-ante assessment and quantification of the impacts of UFT policies, focusing the study on city access limitations and urban distribution centers. The authors evaluate the environmental externalities of such measures, as well as whether they have achieved the objectives for which they were designed. Also related to urban distribution centers, Musolino et al. (2018) propose an ex-ante methodology for the evaluation of such centers when achieving sustainability goals, both from a public and private perspective. Tamagawa et al. (2010) use a multi-agent model to assess city logistics solutions considering stakeholders' behavior. In particular, they focus the study on truck bans and toll charges to analyze their influence on environmentally damaged areas. Russo and Comi (2011b) develop a model system to show that end-consumers' behavior can be influenced by material infrastructures or governance measures, since both can modify the travel cost between the consumption and the buying zones. However, they demonstrate that the restocking process, when designing paths or the number of stops, can be influenced by material, non-material, equipment and governance infrastructures. Ambrosini et al., (2013) propose a methodology for scenario construction and assessment, defining the elements of a policy-based scenario and developing a procedure to build the inputs of models to simulate the impacts of measures on urban goods transport flows and land-use. In particular, they analyze four scenarios that use peripheral platforms and/or urban distribution centers, studying their influence on the distance travelled per vehicle type. Balm et al., (2014) develop a step-by-step assessment framework that starts from an understanding of the context, the stakeholders' objectives and indicators to define feasible and suitable UFT solutions. Nuzzolo and Comi (2014) present a three-stage method that allows UFT policies to be analyzed while considering the level of transport service, the delivery time periods, the itinerary and the type of vehicle used. Nordtømme et al. (2015) present an ex-ante analysis of seven measures applied in the city of Oslo, based on stakeholder surveys, and a generic ex-post evaluation framework that enables efficient and environmentally-friendly city logistics measures to be designed. On their behalf, Nuzzolo et al., (2013) review models using a different approach: to adapt UFT solutions in diverse contexts through the modification of infrastructures, services or regulations.

In general terms, most works develop interesting models to assess UFT policies before implementation; but the amount of policies studied is generally limited as many works consider large-scale problems, while the local context has been less studied (Filippi et al., 2010). A key issue is to develop methods for ex-ante evaluation of policies to be implemented by city administrators and logistics operators, responding to the needs of companies and society (Ibeas et al., 2012). In this context, this paper presents an ex-ante procedure to evaluate and prioritize the suitability of 38 existing UFT measures, considering the advantages and limitations of policies regarding promoter companies and society. For this purpose, a five-step process is developed: (1) 30 attributes are defined for policy evaluation; (2) the importance of each attribute is determined; (3) each policy-attribute pair is assessed; (4) the policies are ranked according to the previous steps; and (5) some feasibility thresholds are considered to discard non-qualified measures.

The decisions taken at each step are supported by surveys and interviews with 26 experts in the field of UFT, as an appropriate analysis of stakeholders' perspective is a key to ensuring policy success (Domínguez et al., 2012). In particular, the experts are consulted regarding shop supply and restocking activities within complex urban environments, such as most European cities. Consequently, a ranking of the 38 analyzed UFT policies is obtained, from the most to the least suitable; this in turn could be extended (directly or with small adjustments) to less complex contexts, given the flexibility and adaptability of the research and the decision-making process developed.

The rest of the paper is organized as follows. In Section 2, the methodological approach used in this work is clarified and justified. In Section 3, the five-step evaluation procedure for the 38 UFT policies is described. In Section 4, the process is applied to classify the identified measures, based on expert opinions. Finally, in Section 5, the main conclusions are summarized.

2. Methodological approach

As detailed in the introduction, UFT is a challenge faced by many companies when organizing the supply or restocking of a chain of shops located in complex urban environments, characterized by traffic congestion, high population density and narrow streets. In this context, Sanz et al. (2013) performed a literature review to compile 38 policies aiming to facilitate UFT activities (Table 1). Some solutions can be directly applied by companies (for example: implementing information systems, updating equipment or redesigning the supply chain), while others require the involvement of city administrators (for example: preparing physical spaces or adapting city conditions). In the first case, companies are expected to directly engage the policies; while in the second case, companies are expected to adapt their activity according to the administration's constraints or to seek cooperation to achieve global solutions.

Table 1. List of policies

M1	Urban tolls	**M20**	Shuttle areas
M2	City access time restrictions	**M21**	Use of public and private parking
M3	City access restricted to max. weight	**M22**	Last mile with electric vehicles
M4	City access restricted to vehicles age	**M23**	Urban railway for freight
M5	City access restricted to the cargo	**M24**	Special vehicle positioning systems
M6	Close city center to private vehicles	**M25**	Logistics containers easily management
M7	Time restriction in l/u zones	**M26**	Suitable equipment for l/u zones
M8	Use of reserved places	**M27**	Communication equip. in vehicles
M9	Use of controlled parking zones	**M28**	Advanced transport management systems
M10	Combined use of l/u zones	**M29**	Intelligent transport systems
M11	Multi-use lane	**M30**	Night delivery
M12	L/u exclusive zones to UFT vehicles	**M31**	Sharing vehicles with other loaders
M13	Reservation of l/u zones	**M32**	Urban logistics services
M14	Vigilance of l/u zones	**M33**	Self-storage space for cargo unload
M15	Temporary closure of streets	**M34**	Providers central. in dist. centers
M16	Logistic platform out-of-town	**M35**	Efficient integration of reverse logistics
M17	City terminals	**M36**	Home delivery logistics
M18	External delivery zones	**M37**	Time scheduling in the l/u zones
M19	Underground logistics platform	**M38**	Agreements for sharing l/u zones

Nevertheless, when the logistics manager of a specific shop has to take a decision about the UFT measure (or set of measures) to implement, there is a lack of methods to aid in the decision-making and unintended negative effects may arise (Filippi et al., 2010; Holguín-Veras et al., 2017). In fact, many authors focus on an assessment of policies to be implemented by city administrators, evaluating the impacts globally. Other works look at logistics operators, but focusing on a short set of solutions and evaluating the advantages and limitations for the company itself, but not the urban environment.

Therefore, this paper focuses on an assessment of the large set of UFT policies, detailed in Table 1, to be embraced by logistics managers in order to improve the efficiency of the chain's supply or restocking activities, while minimizing the negative impacts on the citizens. The analysis is performed from an ex-ante approach, aiming to analyze the policies before their implementation in order to avoid any unintended results (Filippi et al., 2010; Ibeas et al., 2012).

In addition, a classical multi-attribute decision-making perspective is sought, particularly as used in the transportation field (Tsamboulas et al., 2007; López and Monzón, 2010; Macharis and Bernardini, 2015). In this work, starting from the list of 38 UFT policies compiled in Sanz et al. (2013), the first task is to define a set of attributes. Each attribute is defined in order to evaluate a specific aspect of the policies, which can be beneficial or detrimental for the target company or society. Second, the attributes are weighted; i.e. a value is assigned to each one representing its importance regarding the others. Third, each policy is assessed in order to determine the level of accomplishment regarding each attribute. Fourth, from the weights and assessments, an overall score is calculated for each policy, representing its suitability for the studied context, with policies being ranked accordingly. Finally, some feasibility thresholds are defined, which allow policies that do not satisfy certain quality standards in some attributes to be discarded.

One of the main conclusions from works such as Stathopoulos et al. (2012), Lindholm (2013) and Macharis and Bernardini (2015) is the importance of stakeholder integration in the decision-making process of transport problems. In this regard, the whole decision-making process is supported by 26 surveys and 12 detailed interviews conducted with UFT experts, including:

- Freight transport: 5 logistics directors and 4 executives from Spanish food distribution companies, and 3 executives from other companies.
- Transport operators: 2 managers from Spanish logistics operators: executives from transportation, storage and distribution companies.
- Freight forwarder: 4 logistics executives from the Spanish food manufacturers and 1 manager of a business association.
- Research institute: 5 researchers in Spanish universities and logistics-specialized centers.
- City administrator: 1 political decision-maker and 1 city mobility officer.

The aim of the expert selection is to have a wide representation of the UFT, as has been done in the literature (Lindholm and Behrends, 2012). As observed, most experts are linked to the food sector, which is expected to lead the changes in supply and restocking policies. Indeed, the food industry concentrates the largest and most complex movement of goods, managing perishable products at three temperatures (ambient, fresh and frozen), reverse logistics and recycling (Aung and Chang, 2014). Managers and executives related to city logistics were included in order to provide a wider perspective of UFT. Politicians and researchers were also included in order to take into account the perspective of city administrators, in charge of defining the regulatory framework for city logistics, as well as the point of view of citizens, who coexist with the impacts of UFT activities.

It should be noted that the experts surveyed and interviewed had experience in complex areas for UFT activities, such as Spanish cities between 50,000 and 2 million inhabitants. The morphology of such cities is particularly complicated, having historical centers where the commercial activity is concentrated and vehicle mobility is restricted (Muñuzurri et al., 2012). Therefore, the results of this research are suitable for complex urban environments characterized by historical centers with traffic congestion, narrow streets and high population density, such as many cities in European countries. In addition, given the flexibility of the decision-making process developed, the results could be easily extended (directly or with small adjustments) to establish the supply or restocking chain of a target shop in less complex contexts; for example, cities with large avenues, dispersed population, space for intermediate warehouses, commercial activity concentrated in shopping centres, etc. In fact, company managers do not look for a general assessment of UFT solutions, as usually appears in the literature, but for assistance in decision-making when having to find the solutions to be implemented in their particular shop.

3. Procedure to evaluate UFT policies

In this Section, the proposed procedure for evaluating UFT measures is described. The process is made up of five steps. First, a set of attributes for policy evaluation is defined. Second, the attribute weights are determined. Third, the policies are assessed regarding the attributes. Fourth, an overall score is calculated for each policy, ranking them accordingly. Finally, fifth, some minimum feasibility thresholds allow policies not satisfying the quality standards to be discarded. The whole decision-making process is supported by expert surveys, the literature review, and the authors' knowledge and experience.

Step 1: Attributes' definition

As observed in Table 2, thirty attributes were defined to assess the impacts (whether beneficial or detrimental) of the policies analyzed in this paper. This list emerged from the literature review, the professional and research experience of the authors and the discussions with the UFT experts surveyed and interviewed throughout this work.

Table 2. List of attributes

A1	Decrease of road occupation	**A16**	Increases the control of operations
A2	Reduces the ambient noise	**A17**	Reduces operating costs of vehicles
A3	Reduces congestion in the area	**A18**	Smooth work load in dist. centers
A4	Respects the urban landscape	**A19**	Investment costs for Public Admin.
A5	Increases roads safety	**A20**	Maintenance costs for Public Admin
A6	Reduces CO_2 emissions	**A21**	Hard application for Public Admin.
A7	Reduces damage to urban pavement	**A22**	Delayed goods deliveries to shops
A8	Appropriate unloading systems	**A23**	Second deliveries
A9	Qualified personnel for unloading	**A24**	Increases handling costs
A10	Fast unloading in the shop	**A25**	Investment costs for companies
A11	Synergies with other loads	**A26**	Operating costs for companies
A12	Reduces the travel time	**A27**	Difficult reverse logistics
A13	Reduces occupational risks	**A28**	Difficult operational management
A14	Reduces energy consumption	**A29**	Difficult supply management
A15	Increases flexibility in management	**A30**	Difficult to implement by companies

Step 2: Attributes' importance

The aim of this work is to classify the reported policies according to some attributes that evaluate the benefits and disadvantages to society. For this purpose, an overall score is calculated (Step 4) as the weighted average of the scores for the corresponding attributes. Therefore, the attributes must first be weighted to determine the importance of each one in the evaluation process (Step 2) and then they must be rated for each measure (Step 3).

The surveys of the 26 experts were taken into account when determining the weights of the attributes. However, assessing the importance of 30 attributes all together would have been too complex and confusing, so a lower number, 22, was presented to them. The least representative attributes were discarded: (A1) decrease in road occupation, (A4) respect for the urban landscape, (A7) reduced damage to urban pavement, (A8) appropriate unloading systems, (A9) qualified personnel for unloading, (A15) increased flexibility in management, (A23) second deliveries and (A29) difficult supply management. Thus, each expert was asked to evaluate the importance of each of the 22 attributes.

Finally, the global importance of each attribute was calculated. If only the arithmetic mean was considered, a good global importance could be obtained for an attribute having high values assigned by most experts but also very low values assigned by the rest. Therefore, to avoid tradeoffs, a calculation algorithm was developed (Figure 1) based on three indices: the arithmetic mean, the median (numerical value separating the higher half of the set of answers from the lower half) and the mode (most repeated value in the answers). The three indices allow the global importance assigned by all the experts to be considered, as well as the dispersion between the answers. If the median and the mode take the same value, the most repeated value separates the higher half of the answers from the lower half. Thereafter, if the mean takes the same value, this is considered as the importance of the attribute (objective value). In contrast, if the mean is different, the average between the median and the mean is considered. In any other case, an average of the three indices is considered. Note that the expression *round.multiple 0.5 (a)* is used to round the value *a* to the nearest half; i.e. obtaining only whole or half numbers.

```
Let be me = mean, md = median, mo = mode, ov = objective value

if md = mo then
    if md = mo = me then     vo = me
    else     vo = round.multiple –0.5 (average(md,me))
    end if
else     vo = round.multiple –0.5 (average(md,mo,me))
end if

where round.multiple –0.5 (a) means rounding to the nearest half of a
```

Figure 1. Algorithm used to calculate attributes' importance

The algorithm described in Figure 1 was used for the 22 attributes presented to the experts. In exchange, the importance of the remaining 8 attributes (discarded for the sake of clarity) was determined from the authors' professional experience. Nevertheless, such values were validated along with the detailed interviews with 12 of the experts.

Step 3: Attribute-policy rating

In order to decide whether the attributes complied with the policies assessed, the experts were surveyed and interviewed. In particular, a reduced list of 12 policies was selected from Table 1 (M1, M2, M11, M13, M16, M22, M25, M28, M30, M31, M32 and M34), to reduce the length of the consultations (less than 25 minutes for surveys and 60 minutes for interviews), thus ensuring accuracy in the answers. Hence, the list of policies was presented and, for each one, the experts were asked to evaluate the importance of their attributes from 0 to 4. This scale represents whether the attribute is not (0), occasionally (1), usually (2), often (3) or always (4) accomplished by the policy. For instance, the urban tolls policy (M1) was evaluated regarding the reduction of congestion in the area (A3), and the experts assessed the 0–4 value according to their experience.

Then an algorithm was developed (Figure 2), to calculate the global rates of each attribute for each policy, as in Step 2, to be based on three indices that considered the experts' dispersion in the answers: the arithmetic mean, the median and the mode. As shown in the algorithm, if the three indices coincide, this is the considered rate. However, if only the median and the mode coincide, the considered rate is the integer immediately greater or lower than the median, depending on whether the mean is greater or lower than the median, respectively. On the other hand, if the median and the mode are not the same, the considered rate depends on the absolute difference of the three indices.

```
Let be me = mean, md = median, mo = mode, ov = objective value

if md = mo then
    if md = mo = me then     vo = me
    else
        if md > me then
            if integer(me) < md – 1 then     vo = md – 1
            else     vo = md
            end if
        else
            if integer(me) ≥ md + 1 then     vo = md + 1
            else     vo = md
            end if
        end if
    end if
else
    if |md – mo| > 1 then     vo = round.greater (average(md,mo))
    else
        if |md – me| ≥ |mo – me| then     vo = mo
        else     vo = md
        end if
    end if
end if
```

Figure 2. Algorithm used to calculate attributes' rate for each policy

Additionally, the authors rated each attribute–policy couple based on their professional experience and prior to the experts' surveys and interviews, in order to avoid being influenced by their opinions. After analyzing the authors' and experts' results, the obtained values were similar for most of the 22 attributes and 12 policies evaluated by the experts. Therefore, the authors' opinion was considered valid for the remaining attribute–policy couples. However, for an appropriate validation, the rates proposed by the authors were presented in detail to the 12 experts interviewed, who confirmed the reliability of the authors' choices. Thus, a global rate was finally obtained for the 30 attributes and the 38 policies.

Step 4: Policies' overall score

As explained before, once the importance of the attributes (Step 2) and the rates of each attribute for each policy (Step 3) have been calculated, the overall score for each measure is calculated as the weighted average of the scores for the corresponding attributes. The average is used but not the sum, since the attributes defining each measure do not necessarily coincide in all cases. The overall score allows the existing UFT measures to be classified.

Step 5: Minimum feasibility thresholds

The previous steps described a procedure for obtaining an overall score that allows the set of existing UFT measures studied in this paper to be classified. However, basing decisions only on the overall score of each policy could be counterproductive. In some cases, a low attribute rate described as 'very bad' could be compensated by high positive rates obtained in other attributes. In such cases, the measure would be completely inapplicable (e.g. high investment requirements or outright opposition from neighbors and Public Administrations) but, instead, it might have obtained a good overall score. To avoid this possibility, some minimum feasibility or viability thresholds are defined for the attributes. This means that a policy is considered feasible if the rates of all the corresponding attributes are within such preset margins. Otherwise, it is recommended to discard it. The thresholds proposed in this research were established according to the values of the following attributes: (A21) Hard application for Public Administration and (A30) Difficult to implement by companies. More specifically, if a policy achieved the top score in either of these two attributes, it was considered infeasible and was consequently discarded.

4. Results and discussion

In this Section, the results obtained by applying the procedure described in Section 3 are presented and discussed.

4.1. Attributes' importance

To evaluate the attributes' importance, the experts were asked to assign a weight from 0 to 4 to the 22 attributes presented to them (as explained in Section 3). This scale was used assuming a qualitative assessment: 0 for an unimportant attribute, 1 for a not very important attribute, 2 for an important attribute, 3 for a very important attribute and 4 for an essential attribute.

Little consensus was found among experts regarding the weights assigned to each attribute. Thus, a cluster analysis was carried out to identify whether some experts had similar response patterns with significant statistical differences regarding the others. The analysis was performed using SPSS 16.0 and confirmed the existence of 2 clusters according to the experts' profile. The first group was identified as the companies cluster and included 19 experts with the following profiles: managers from food distribution companies, logistics operators, executives from the food industry and a business association. The second group was identified as the social cluster and included 7 experts with the following profiles: a city mobility officer, researchers and a political decision-maker on urban logistics. A different opinion was observed for each group, depending on whether the attribute to be evaluated was related to benefits for UFT businesses or citizens. Thus, for the companies cluster, the attributes entailing inconveniences for businesses operating in UFT were more important than for the social cluster. In exchange, the attributes representing an inconvenience for citizens and their daily lives were more important for the social cluster than for the companies cluster.

Although initially the scale to evaluate the attributes' importance was defined from 0 to 4 (to represent a qualitative assessment), the range was extended to a scale from 0 to 10, multiplying by 2.5. This change was made so that results were easier to analyze from a mathematical point of view. Table 3 shows the importance obtained by using the algorithm from Figure 1 for the 22 attributes surveyed by experts and the 8 attributes evaluated by the authors (marked with *).

The attributes are presented in 4 groups, depending on whether they are beneficial or detrimental for the citizens and the companies operating in UFT. In general terms, citizens look for a friendly coexistence with the derivative impacts of UFT activities. That means the attributes that are beneficial for citizens are related to a pollution free environment, the avoidance of unnecessary noise, low traffic congestion, safe streets, etc. However, attributes that entail difficult implementation (for example due to high investment or maintenance costs) for Public Administrations, in charge of ensuring a user-friendly city environment, are considered detrimental for citizens. On the other hand, companies aim to reduce costs wherever they appear throughout the supply chain. Therefore, the attributes related to faster, cheaper and more efficient UFT activities are beneficial for them while the attributes in the opposite direction are detrimental.

Table 3. Importance of the attributes

Attributes		Relevance
1. Attributes that benefit citizens		
A3	Reduces the congestion in the area	8,5
A2	Reduces the ambient noise	7,5
A6	Reduces CO_2 emissions	7,5
A1	Decrease of road occupation*	7,0
A5	Increases roads safety	6,5
A7	Reduces damage to urban pavement*	5,5
A4	Respects the urban landscape*	5,0
2. Attributes that benefit UFT companies		
A12	Reduces the travel time	8,5
A10	Fast unloading in the shop	8,5
A17	Reduces operating costs of vehicles	8,5
A18	Smooth work load in distribution centers	7,5
A16	Increases the control of operations	7,5
A11	Synergies with other loads	7,0
A14	Reduces energy consumption	7,0
A15	Increases flexibility in management*	6,0
A13	Reduces occupational risks	5,5
A8	Appropriate unloading systems*	4,0
A9	Qualified personnel for unloading*	4,0
3. Attributes prejudicial for citizens		
A21	Hard application for Public Administration	7,5
A19	Investment costs for Public Administration	7,0
A20	Maintenance costs for Public Administration	6,5
4. Attributes prejudicial for UFT companies		
A22	Delayed goods deliveries to shops	8,5
A25	Investment costs for companies	8,5
A26	Operating costs for companies	8,0
A24	Increases handling costs	7,5
A30	Difficult to implement by companies	7,5
A28	Difficult operational management	7,0
A23	Second deliveries*	5,5
A27	Difficult reverse logistics	5,5
A29	Difficult supply management*	4,0

4.2. Policies overall score

This Section presents the overall score of each policy, which was obtained by combining the elements described previously: the ratings of the attributes for each measure (Step 3), the importance of each attribute (Section 4.1) and the minimum feasibility thresholds (Step 5).

The overall assessment of the policies was finally obtained by averaging the advantages and disadvantages for the two clusters of experts. In other words, to calculate the overall score of each policy, the average of advantages minus the average of disadvantages was calculated for both clusters; then the average of these two values was assumed. Depending on the intended use of the evaluation, another method of averaging could have been used to assign, for example, a greater significance to the advantages over the disadvantages or to the companies cluster over the social cluster. In that case, a different score would have been obtained for each policy, mainly representing companies' interests. However, an equally weighted method was chosen to calculate the overall score, since it represents a global assessment where the benefits and impacts on the companies and society are considered equally in order to avoid any preference when evaluating UFT policies. Therefore, the evaluation is expected to be more impartial, considering all the stakeholders involved in the problem.

Table 4 shows, for each policy, the following information: the ratings in terms of advantages and disadvantages (both for the social and the companies clusters); the overall scores, calculated as the average evaluation of the advantages minus the average evaluation of the disadvantages; and, last but not least, the classification, from best to worst overall score. In order to validate these results this ranking was shown to the experts interviewed, who confirmed the results' coherence and consistency. Note that the policies considered infeasible (with attributes not reaching the minimum feasibility thresholds) are marked with a symbol **.

Table 4. Overall score of policies

Policies		Provides benefits		Provides inconveniences		Overall score	Position
		Soc.	Com.	Soc.	Com.		
M28	Advanced transport management systems	2.16	1.81	0.00	1.14	1.42	1
M35	Efficient integration of reverse logistics	1.88	1.12	0.00	0.30	1.35	2
M30	Night delivery	3.13	1.99	1.38	1.27	1.23	3
M37	Time scheduling in the l/u zones	1.62	1.13	0.00	0.48	1.14	4
M33	Self-storage space for cargo unload	1.78	2.09	0.36	1.27	1.12	5
M26	Suitable equipment for l/u zones	1.34	1.50	0.00	0.66	1.09	6
M38	Agreements for sharing l/u zones	1.62	1.13	0.00	0.60	1.08	7
M27	Communication equip. in vehicles	1.00	1.64	0.00	0.52	1.06	8
M6	Close city center to private vehicles**	3.28	1.82	3.05	0.00	1.03	9
M11	Multi use lane	1.34	1.33	0.67	0.00	1.00	10
M34	Providers centralized in distribution centers	2.03	1.22	0.00	1.25	0.99	11
M12	L/u exclusive zones to UFT vehicles	1.48	1.16	1.02	0.00	0.81	12
M31	Sharing vehicles with other loaders	2.18	0.95	0.00	1.58	0.78	13
M4	City access restricted to vehicles age	1.46	0.68	0.00	0.78	0.68	14
M36	Home delivery logistics	2.14	0.00	0.00	0.90	0.62	15
M22	Last mile with electric vehicles	1.74	0.51	0.00	1.04	0.61	16
M9	Use of controlled parking zones	1.00	0.93	0.67	0.13	0.57	17
M24	Special vehicle positioning systems**	1.48	0.93	0.00	1.29	0.56	18
M8	Use of reserved places	1.18	1.25	1.38	0.00	0.52	19
M10	Combined use of l/u zones	1.00	1.05	1.02	0.00	0.51	20
M5	City access restricted to the cargo	3.00	0.52	1.69	1.04	0.40	21
M14	Vigilance of l/u zones	1.04	0.71	1.02	0.00	0.36	22
M15	Temporary closure of streets	1.47	0.15	0.71	0.25	0.33	23
M1	Urban tolls	1.59	1.02	1.71	0.65	0.13	24
M2	City access time restrictions	2.21	0.56	1.02	1.61	0.07	25
M29	Intelligent transport systems**	2.75	1.78	3.69	0.77	0.04	26
M25	Logistics containers easily management	1.05	0.82	0.00	1.93	-0.03	27
M7	Time restriction in l/u zones	1.18	0.94	1.33	0.90	-0.06	28
M13	Reservation of l/u zones	1.00	1.17	1.69	0.79	-0.16	29
M16	Logistic platform out-of-town	2.06	1.73	2.69	2.20	-0.55	30
M3	City access restricted to max. weight	1.61	0.70	1.02	2.41	-0.56	31
M23	Urban railway for freight**	2.86	1.96	3.69	2.37	-0.62	32
M17	City terminals	1.73	1.64	2.69	2.02	-0.68	33
M32	Urban logistics service	2.64	1.01	2.38	2.90	-0.81	34
M19	Underground logistics platforms	1.73	1.64	3.02	2.02	-0.84	35
M20	Shuttle areas**	2.47	0.76	2.36	2.65	-0.89	36
M21	Use of public and private parking**	1.59	0.89	2.41	2.32	-1.12	37
M18	External delivery zones**	1.18	1.34	3.00	3.08	-1.78	38

5. Conclusions

This paper evaluates a set of policies found in the literature applicable to UFT activities. The assessment is carried out following a proposed procedure organized in 5 steps. First, a list of attributes is defined to evaluate the impacts of each policy (Step 1). Then, the attributes are weighted to determine their relative significance (Step 2). Next, each policy is evaluated according to each attribute (Step 3). Finally, an overall score is calculated for each policy using the results from the two previous steps (Step 4). Additionally, some minimum standard thresholds that represent unacceptable values in the policy-attribute evaluation are considered (Step 5). This whole process was carried out together with a group of experts in the field of UFT, who were surveyed and interviewed to assess the attributes' weights and the attribute–policy evaluation, giving a very practical approach to the research. To conclude, the proposed procedure provided a final ranking of policies according to their appropriateness and priority for implementation in an urban context.

This research hopes to bring theoretical investigations and the reality of UFT closer. Most of the works found in the literature study the impacts of a specific policy (or set of policies) or develop ex-ante assessments to evaluate measures, but understanding cities as a uniform whole. In contrast, the proposed procedure aims to study a large amount of policies directly affecting the supply chain of urban shops, including the opinion of companies and social experts, which is a key issue for the success of the measures to be implemented. The proposal can be easily applied to new contexts or new measures that may arise, obtaining an indicator (an overall score) of their appropriateness and suitability regarding other policies.

As future research, a comprehensive methodology to assist logistics managers in the design or improvement of the supply or restocking chain of a target shop could be developed. Such methodology would start from the policy ranking obtained here and be a guide in the decision-making process, taking into account the shop features and surroundings, as well as the perspective of all the stakeholders involved.

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