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Evaluation of specific policy measures to promote sustainable urban logistics in small-medium sized cities: the case of Serres, Greece

Maria Morfoulaki[a], Kornilia Kotoula[a,*], Alexander Stathacopoulos[a], Foteini Mikiki[b], Georgia Aifadopoulou[a]

[a]*Hellenic Institute of Transport (HIT)/Centre for Research and Technology Hellas (CERTH), 6th km Charilaou Thermi road, Thessaloniki, 57001, Greece*

[b]*Municipality of Serres, K. Karamanli 1, Serres, 62122, Greece*

Abstract

Urban logistics is an integral part of the proper functioning of a city. It generates employment, serves and supports industrial and commercial activities that are daily taking place in modern urban centres, considered to be important levers of development and prosperity for a region. In recent years, interest in sustainable freight distribution procedures has been increasing among Local Authorities. Sustainable mobility, planning and development of relative management systems involves multiple stakeholders who -through collective effort- need to design, organize and implement actions and measures to support them. This paper presents specific policy measures regarding the enhancement of urban logistics procedures in small-medium sized cities, evaluated through a multi-criteria analysis in the framework of the elaboration of a Sustainable Urban Logistics Plan (SULP) for the city of Serres in Greece.

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Keywords: Multi-Criteria Analysis; Sustainable Urban Logistics Plans (SULP); Logistics Measures Evaluation; Small-medium sized cities

* Kornilia Kotoula. Tel.: +30-2310-498441; fax: +30-2310-498269.
E-mail address: nilia@certh.gr

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1. Introduction

During the last decades, the demand for urban freight transport services has increased, making freight transport a significant contributing factor to the sustainability of the urban environment. Distribution of goods is a complicated procedure, causing a variety of social, environmental and economic impacts including traffic congestion, road safety, air pollution, greenhouse gas emissions and noise disturbance. Dablanc (2007) argued that freight deliveries contribute significantly to high congestion levels, due to lack of space devoted to logistic activities. According to Figliozzi (2010), urban freight vehicles account for 6 to 18% of total urban traffic volume. Schoemaker et al (2006) estimated that freight vehicles account for 19% of energy use, 21% of CO2 emissions and 14% of vehicle-kilometers, while Korver et al. (2012) supported that 40% of air and noise emissions are attributable to freight vans. Furthermore, Allen et al (2007) stated that one of the problems connected to goods distribution is policy related.

Although freight transport is one of the primary components affecting the appropriate function of a city, cities' mobility plans are not used to integrate measures and policies regarding the distribution procedures. Rodrigues (2006) argued that traditionally, most local authorities focus on public transport, while freight transport seems to be not only a more complicated area to engage in but also a less interesting one. Van Duin (2005) argued that even though freight is on the top of the Netherlands' agenda, over one third of Dutch cities lack a political agenda for freight. He justified it by showing that local authorities did not share experiences, but only copied each other's' freight measures without examining the measures' transferability and the link between measures' impact and cities' different profiles.

Although interest in the implementation of sustainable freight distribution procedures has been increasing from Local Authorities, practical evidence is poor as few efforts have been made to act on this. In order to mitigate negative effects derived from freight transport and to improve the distribution procedures in urban areas, certain measures and policies are being examined and implemented in several European cities. They take into account specific guidelines and policy tools that have been elaborated in order to address the different impacts caused by urban freight transport operations. The BESTUFS (Best Urban Freight Solutions) I and II projects describe and communicate best practices, plans and obstacles in order to propose city logistics solutions for adoption. The IEE C-LIEGE (Clean Last mile transport and logistics management) project, defines shared policies and measures for an energy-efficient urban freight transport demand management and planning through a cooperative approach between public and private stakeholders. The STRAIGHTSOL (Strategies and measures for smarter urban freight solutions) project tests last-mile distribution demonstrations. The FREILOT (Urban freight energy efficiency) project examines ways of cooperation between Intelligent Transport Systems (ITS). The SUGAR (Sustainable urban goods logistics achieved by regional and local policies) project came up with a tool –a handbook for Authorities- that aims to address the problem of inefficient and ineffective management of urban freight distribution. To accomplish this goal, the project promotes the exchange, discussion and transfer of policy experience, knowledge and good practices through policy and planning levels in the field of urban freight management. The IEE ENCLOSE project provides guidelines to small-medium sized cities towards the elaboration and implementation of Sustainable Urban Logistics Plans in order to tackle city logistics issues through a concrete sustainable strategy. A SULP is a dedicated to city-logistics management plan in line with EU guidelines for achieving sustainability in urban mobility.

Measures and good practices suggested, developed and adopted by many European cities relate to: traffic calming measures, operational regulations (e.g. weight and size restrictions of commercial vehicles, loading and unloading time-slots), green technology use (non-conventionally fuelled vehicles), small or large scale infrastructure solutions (special road lanes reserved for commercial vehicles, loading spaces within the city centre or large consolidation centres located outside urban areas to serve last mile delivery with smaller and greener vehicles), economic measures like urban tolls, use of Information Communication Technologies and traffic management measures.

This paper examines whether specific policy measures, successfully implemented in mid-sized European cities can be adopted by the city of Serres, in Northern Greece, in the framework of a broader policy tool, a Sustainable Urban Logistics Plan. A multi-criteria analysis is conducted in order to identify already tested measures that can actually be included in the SULP of this city, aiming at its optimal service, the immediate effectiveness of the measures, their economic viability etc.

2. Introducing new solutions in the historical city centre of Serres

2.1. Current situation

Since the seventies, the city of Serres has faced intense urbanization, especially in the city centre. Open spaces have been replaced by apartment buildings and a sharp increase in the ratio of private car ownership has been observed. Today, due to the number of activities served in the area of the historical city centre (administrative, commercial and leisure activities), congestion problems are faced in the largest part of the city road network and the city's inner ring road cannot effectively serve the traffic generated. Although some sustainable mobility solutions have been implemented, like pedestrianization of city centre streets, cycling paths construction and urban reform works, mobility conditions seem to get worse as efforts were not so far part of a concrete mobility management plan, parking enforcement became poor after the abolishment of municipal police, while the increase of travel demand and the lack of parking spaces derives public space from other network users, such as pedestrians and cyclists.

In this context, city logistics have been in the dark for long and urban freight transport operations have been being carried out with significant obstacles, due to lack of coordination. The non-regulation of urban deliveries together with the increasing traffic of private vehicles penalize urban environment and place an important burden on city life in terms of energy consumption, air quality degradation, visual and noise pollution increase. Furthermore, urban freight transport is also accused of public space occupation, and of having a share in accidents in urban areas. The lack of coordination of urban freight transport seems to intensify these negative impacts. All the above highlight the need to tackle city logistics issues and organize them optimally through the implementation of best practices, in accordance with the European vision for sustainable development.

2.2. Policy measures to include in sustainable urban logistics plans

Urban freight policies fall within the jurisdiction of local authorities in the sense that it is within their scope to engage in a transport policy-making and an actual measures implementation which meets the sustainability standards for urban environment, according to the local vision. According to Hickman & Banister (2007) the only way to ensure environmentally friendly solutions for a more effective transportation system is through an integrated package of technological and behavioural policy measures. Developing a framework for best freight solutions adoption includes relevant actions and activities which have an impact on freight transport operations.

The measures aiming to reduce urban freight transport's negative effects to the urban environment are related to:

- Pedestrianization of streets (individually or in a network) with commercial activity, where commercial vehicles' access is restricted
- Traffic Calming measures
- Operational regulations, like restrictions on the weight and size of the fleet, their load weight standards
- Use of non-conventionally fuelled vehicles and green technology solutions
- Introduction of a tolling system for those who use the urban road network
- Improvement of parking and facilitation of loading and unloading procedures (this may include more loading and unloading places, improvement of horizontal and vertical signage of roads, more effective enforcement etc.)
- Introduction of temporal and spatial restrictions (time restrictions for loading and unloading activities and road lanes reserved for commercial vehicles
- Construction of road infrastructure (dedicated loading areas and accesses in buildings)
- Heavy vehicles parking stations
- Large infrastructure and other installations to support overall supply chain with consolidation centres located just outside urban areas and last mile distribution schemes with smaller and greener fleet
- Information maps regarding loadings spots or even paths, time-slots
- Information Communication Technologies like e-platforms enabling the cooperation with stakeholders and the cooperation of deliveries through loading spots booking system etc.

3. Multi criteria analysis

Multi Criteria Analysis (MCA), is “a decision-making tool developed for complex problems” (CIFOR, 2015). It is a tool which utilises Criteria and Indicators to compare measures and give them values, although these may not be explicitly financial ones (Department for Communities and Local Government, 2009). For MCA a criterion is a principle or standard that is judged by which information provided by the indicators (or attributes) are assessed. Indicators or attributes are the variables, measures in this case, which are to be evaluated. Another important element of MCA are the verifiers, which provide guidance on the condition of an indicator (Mendoza et al, 1999).

The MCA used for the evaluation of potential measures for the city of Serres in Greece used a bottom up approach. Such an approach is used when information from the field must not be lost (Prabhu et al., 1996). This approach allows the local involvement in the analysis in order to ensure a lasting impact and a long term management of measures to be selected. The city of Serres was involved therefore along with key stakeholders in an expert group which provided its knowledge and experience as regards to the understanding of criteria and indicators and to the allocation of their hierarchy. The expert group was comprised of a variety of stakeholders with different advocacies on the issues in order to bring about diverse perspectives to the process.

4. Presentation of suggested measures and policies that could be adopted by the city of Serres

Policy measures already successfully implemented in small-middle sized European cities are presented below, in order to assess whether they can be included in the Sustainable Urban Logistics Plan for the city of Serres. According to the BESTUFS project (2014), these measures are related to:

4.1. Users’ awareness raising and information on sustainable urban freight transport

The effect of city logistics on the way a city operates is not particularly known to citizens. For this reason various awareness and information raising activities are being organized including:

- Distribution of dissemination material informing citizens about environmentally friendly transportation in the city, leading to roads de-congestion, upgrade of environmental conditions and citizens’ quality of life.
- Distribution of dissemination material to shops and citizens informing them about loading and unloading places, official hours of activity and any other restrictions (such as maximum load allowed etc.)
- Training seminars on sustainable urban freight transport focused on citizens, transport companies and shopkeepers
- Incentives to transporters and shopkeepers who suggest and implement practices that support sustainable urban freight transport
- Organization of workshops addressed to all stakeholders for exchange of views, problem solving and proposals that may lead to more efficient city logistics

4.2. Information maps

The information is provided to carriers either in the traditional way (printed on paper) or using technological systems that operate using real time data, with the use of Geographical Information Systems (Best Urban Freight Solutions, 2014).

The maps provide information on routes that transport companies are allowed to take in urban areas, on special heavy vehicles parking areas, on the existence of truck lanes, on restricted areas, on key locations and buildings such as industries etc.

4.3. Truck routes

Local authorities can determine appropriate truck routes in urban areas, either as an assistive service to transport companies or as a compulsory measure. Suggested routes do not require policing, whereas compulsory ones require strict enforcement and for this reason it is complex and expensive to enforce them. Different types of truck routes include:

- Strategic routes; passing through main roads for long distances between main locations or within large urban areas
- Delivery routes zoning; roads that connect major strategic routes with specific locations or areas
- Local routes that provide convenient access to specific locations

This measure requires proper planning of routes (avoiding slopes or sharp turns, sufficient cross sections to accommodate heavy vehicles, avoiding residential areas with many pedestrian crossings etc.), as well as the synergy of all involved authorities.

4.4. Spatial and Temporal restrictions

Measures of spatial and temporal restrictions include restrictions related to time constraints (e.g. freight transport permitted hours, specific routes, night routes etc.) or specific loading and unloading locations, regions or areas. These restrictions are being adopted by the authorities mainly for safety and environmental protection reasons and apply to sensitive areas (mainly in the city centres).

4.5. Infrastructure for access restriction application

In order to control truck access, access control systems are used (i.e. cameras, barriers). In an automatic vehicle access control system, access management is enabled with access bars, a video surveillance system (CCTV) and smart cards or wireless communications. If bars are visually disturbing automatic control systems, such as number plate recognition, are used.

4.6. Low emission zones

In low emission zones only vehicles that meet specific emissions standards are allowed to enter. This measure is intended to improve air quality and reduce noise levels. Low Emission Zones have been applied for several years now in many Swedish cities, such as Stockholm, Göthenburg and Malmö (Best Urban Freight Solutions, 2014).

4.7. Truck lanes

Truck lanes refer to road sections that are exclusively used by heavy vehicles (trucks). The implementation of such a measure aims at reducing delays and improving travel time reliability. There are four categories of truck lanes:

- Truck lanes only for vehicles that transfer goods
- Lanes for trucks and buses (no private vehicles)
- High Occupancy Vehicle lanes (lanes for cars, trucks, etc. with certain number of passengers)
- Lanes where loading and unloading is allowed at specific locations (Best Urban Freight Solutions, 2014).

4.8. Urban Logistics Centre

Urban Logistics Centres (ULC) are defined as: “Facilities with geographic proximity to an area (city centre, municipality or a specific location such as a shopping centre), in which logistics companies send goods that need to get delivered in that area and all deliveries get grouped, providing additionally a range of other added value logistics and retail service” (Best Urban Freight Solutions, 2014). ULCs enable logistics companies to distribute goods to an urban area without entering the congested parts of the city. The existence of an Urban Logistics Centre has the potential to improve service reliability and the use of a fleet of environmentally friendly vehicles, where the use of trucks may not be allowed.

4.9. Use of non-conventionally fuelled vehicles

The use of non-conventionally fuelled vehicles for urban logistics mainly refers to the last part of the transport of goods and the use of small in size and power consumption vehicles. These vehicles may be tricycles, electric vehicles with various capacity, length and speed according to their load (e.g. Trondheim) or alternative fuel vehicles.

4.10. Lockers

These groups of boxes are placed in residential areas, commercial areas, parking stations, etc., and can be used by one or more distribution companies. Customers do not have permanent access to the lockers and electronic locks allow the use of different customers on different days (Best Urban Freight Solutions, 2014).

4.11. Logistics management systems

There are many supporting ITS technologies such as vehicle telematics (units in vehicles), GPS, smart cards and variable message signs connected with traffic management systems and / or transportation management systems. The demand for such systems has increased in recent years. Urban authorities are responsible for most of these systems as part of traffic management systems that serve to improve traffic in the areas (e.g. traffic regulations or access control). Private transportation management systems are implemented to optimize logistics and distribution processes contributing to reducing supply chain costs.

4.12. Routes optimization

These freight management systems are used to improve services and trip planning as well as to improve the provided to the customers services (e.g. accurate estimated time of arrival). Such systems provide:

- Automatic route calculation with optimal vehicle loads.
- Navigation with accurate guidance and information about vehicle location, traffic and changes in customer requirements.
- Communication between the driver and company
- Internet booking systems for the coordination and planning of arrivals of trucks in central areas with large flows (Best Urban Freight Solutions, 2014).

4.13. Night delivery

Deliveries in stores are usually made in the afternoon, early in the morning or during the night. Many people in Dutch cities reside near or over stores, and as a result they are exposed to noise due to delivery activities. According to the law about noise pollution, the noise produced by freight transport must comply with strict standards. A study showed that many loading and unloading activities exceed the limits of 60 and 65 dB (A) that have been proposed for the afternoon and night.

5. Assessment of the suggested measures and policies through a multicriteria analysis

The best practices and measures that have been presented in the previous section are initially those that fit the profile and needs of the city of Serres and have been discussed for possible implementation. The selection is made by means of a multi-criteria analysis identifying the most suitable measures based on service optimization impact, effectiveness and economic viability of the measures.

The steps of the measures' evaluation are:

A. Identification of the proposed measures
B. Identification of evaluation criteria and weights
C. Criteria rating of all alternative measures proposed
D. Results - Ranking of the proposed measures

5.1. Stage A: Identification of the proposed for implementation measures for the city of Serres

The thirteen measures and practices that were presented in the previous section and are proposed to be included in the Sustainable Urban Logistics Plan of the city of Serres are:

Measure 1: Users' awareness raising and information on sustainable urban freight transport
Measure 2: Information maps
Measure 3: Truck routes
Measure 4: Spatial and Temporal restrictions
Measure 5: Infrastructure for access restriction application
Measure 6: Low emission zones
Measure 7: Truck lanes
Measure 8: Urban Logistics Centre
Measure 9: Use of non-conventionally fuelled vehicles
Measure 10: Lockers
Measure 11: Logistics management systems
Measure 12: Routes optimization
Measure 13: Night delivery

5.2. Stage B: Identification of evaluation criteria and weights

The evaluation criteria (j) deemed as critical for each of the proposed measures are presented below. A large number of criteria to be used for the analysis and evaluation of the indicators were gathered by an expert group and following the selection process, as shown in Fig. 1, the criteria mentioned in table 1 below were selected for use in the MCA. The expert group consisted of 12 persons in total, more specifically, four representatives of the Municipality of Serres, two representatives of transport companies operating in the city, two from the Hellenic Institute of Transport (HIT), which focuses on supply chain and logistics research, one from the Chamber of Commerce, one from the Association of Merchants, one from the Association of Hotel Owners and one from the Traffic Police Department. The expert group participated in two closed meetings held in the premises of the Municipality in order to identify and agree on the evaluation criteria and the weighting of each one (Morfoulaki M. and Kotoula K. 2014).

The expert group was selected by the Municipality along with its consultants from HIT taking into consideration all the possible stakeholders' representatives in order to cover all disciplines concerned. This includes academics, consultants, government officials and industrial and commercial chambers and associations. This wide range of expertise and views will bring diverse perspectives to the process. The expert group selection ensures that risks associated with bias are limited due to the abovementioned diversity. The only identifiable absence is from representatives of the citizens/users of the network. However, their opinion is to an extent covered by the extensive representation of the city of Serres representatives.

Following the selection of the criteria, the expert group provided a ranking for the various criteria in order to be able to rate each measure proposed for the city of Serres. Each evaluation criteria has a specific weight factor which depends on objective criteria, but also on the specific social or economic characteristics of the region.

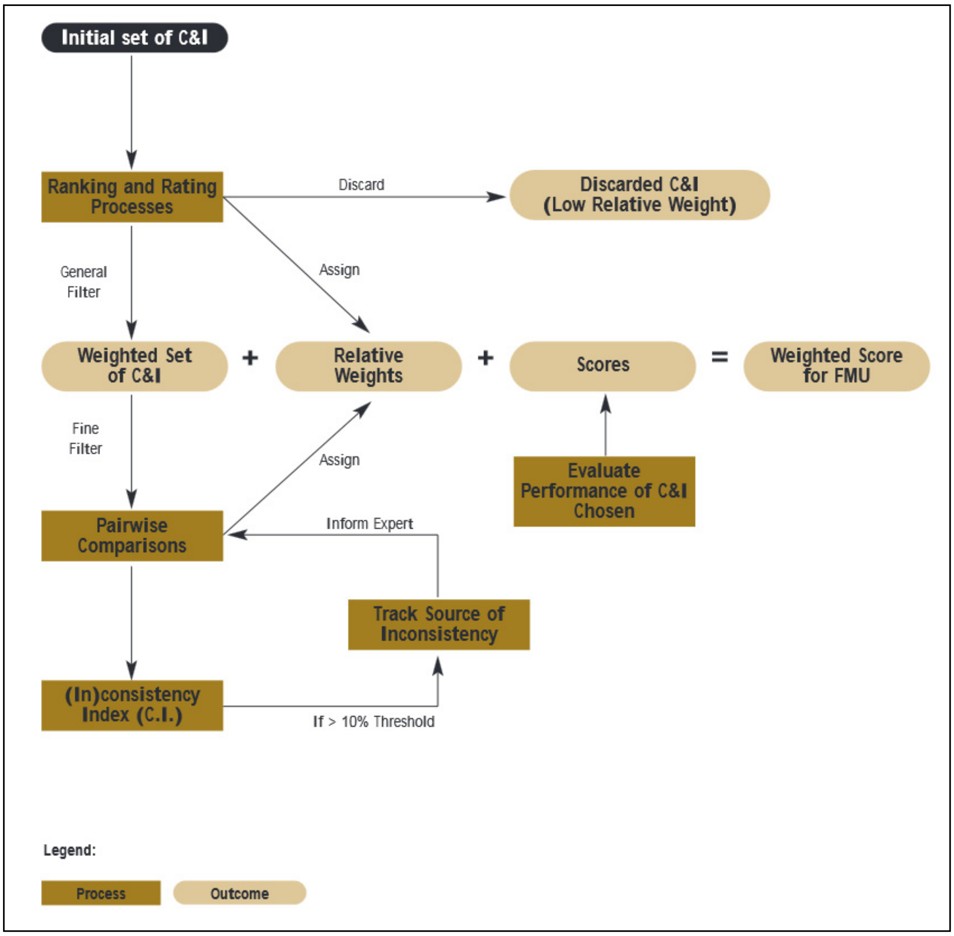

Fig. 1. Application of MCA techniques to the selection and scoring of criteria and indicators (source: CIFOR, 1999)

The evaluation criteria and their weighting factors are presented in Table 1.

Table 1. Evaluation criteria and percentage of significance

EVALUATION CRITERIA (j)	Weight wj (Percentage of significance)
Cost	20% (0.2)
Implementation time	5% (0.05)
Maintenance cost	10% (0.1)
Specialized technical requirements (ITS Technology Support)	5% (0.05)
Social Reaction	10% (0.1)
Requirement for synergy between all stakeholders	5% (0.05)
Exploitation of existing infrastructure, policies and actions	5% (0.05)
Effectiveness for the city of Serres	40% (0.4)
TOTAL	100%

5.3. Stage C: Criteria rating of all alternative measures proposed

Rating is based on a 1-10 scale. 1 corresponds to the lowest score and 10 to the highest. Table 2 shows the proposed measures (i), the evaluation criteria (j) and the corresponding weight (wj), as well as a score for each of them (scale 1-10).

To raise public awareness through information campaigns (Measure 1), implementation costs, time and maintenance costs are highly rated since limited time and cost is required for their design and implementation. Furthermore, the measure is not expected to cause social reactions but to inform and raise awareness among all actors involved in urban logistics of the city. Synergy between stakeholders receives a low score as it can raise issues because the multiple operators' views may vary significantly. Finally, this measure is estimated to be highly effective for the city of Serres, since it suggests to inform citizens and stakeholders on issues related to sustainable urban transport and on the benefits that can be derived from active participation.

Regarding information maps (Measure 2), most of the criteria are rated high, as the design and production of maps requires limited expenses and time, does not cause social reaction, can be integrated into the Sustainable Urban Mobility Plan of the city and does not require the synergy of all stakeholders that may cause delays. As a result this measure is applicable and highly effective, since it provides important information to shopkeepers and carriers, so they can better organize deliveries.

As for truck routes (Measure 3), cost of implementation and maintenance is high as it requires strict control, and frequent maintenance of the road section due to increased heavy loads. The implementation of this measure is estimated to cause several reactions, mainly from the city's residents and users of the road network, as some major roads will be loaded and resulting in visual and noise pollution.

The road network to be used is the existing network, so application may be direct (high scoring criterion). This measure is not considered efficient for Serres that is a small-sized city, as it is a measure affecting the main arteries of the city.

The spatial and temporal constraints (Measure 4), is a measure directly applicable and with low cost (e.g. purchase and installation of horizontal and vertical signs), that does not require the use of high technology systems and can be applied to existing road segments of the city. It is expected to cause strong reactions from shopkeepers and transport operators, since there may be arrangements that do not serve the policies and operation mode of both. However, its application is deemed effective as its implementation in other European cities is considered successful, since in a short period of time traffic congestion, greenhouse gas emissions and visual and noise pollution have been reduced.

The equipment to apply access restriction rules (Measure 5) requires large implementation and maintenance costs, as no infrastructure and technology systems exist currently that support it. The implementation of such a measure that prohibits the entrance of vehicles is expected to cause reactions. It is considered to be effective for the city of Serres since it will restrict circulation of certain types of vehicles in the city centre.

Regarding low emission zones (Measure 6), it is not considered to be particularly effective for the city of Serres, as it is implemented mainly in large urban centres, where air pollution problems are intense.

Truck lanes (Measure 7) require large maintenance costs as the exclusive use of the lanes by heavy vehicles will affect the pavement condition. Moreover, the exclusive use of a lane by trucks and the exclusion of other vehicles is expected to cause strong reactions.

The development of Urban logistics centres (Measure 8) is a measure too costly and time consuming (low score). However, the Municipality of Serres owns a parking lot that could be used as a transhipment hub. Use of this could achieve security, improve aesthetics and reduce pollutants in the city centre by the reducing the number of large vehicles circulating in the city. The measure is expected to be easily accepted by the citizens as it will contribute significantly to improving the quality of the city and by carriers who will not have to circulate in the city centre where traffic is heavy.

The use of new technologies vehicles (Measure 9) is costly in order to replace old vehicle fleet and it would cause negative reactions mainly by transport companies. The effectiveness of the measure is marked negative (low score), as it is estimated that the results of the use of new technology vehicles are more prominent in major urban centres where there exist heavily congested roads and high levels of air pollution.

Placing lockers (measure 10) in specific locations of the city requires cost and maintenance but it is a measure directly applicable and it is not expected to cause reactions. ITS technologies are required, which can at an early stage cause difficulties for users to get familiarised with the system. It also receives a low score in synergy of all actors, which will take time.

The use of an urban logistics management system (Measure 11) is a measure which could be particularly effective for the city of Serres, as the EASYTRIP project (in which the Municipality of Serres was actively involved) electronic platform could be used (www.easy-trip.eu). The EASYTRIP platform is an online platform that provides mobility services (i.e routing, traffic information, points of interest). The cost is low, since the platform has already been developed and the technology requirements have been fully covered.

Routes optimization (Measure 12) requires cost and time as the necessary algorithms need to be developed, while the system should be supported by specialized technical requirements as well. It is though a measure commonly accepted as it reduces time and cost of freight transport.

Night deliveries (Measure 13) are directly applicable, without cost, but require the synergy of all stakeholders and may cause reactions mainly by residents of the city centre due to noise that will be created during night hours.

The assessment of all the above measures is presented in the following multi-criteria analysis table (Table 2).

Table 2. Multicriteria analysis table

Evaluation criteria (j) / Measure (i)	Cost 20%	Implementation time 5%	Maintenance cost 10%	Specialized technical requirements (ITS Support) 5%	Social Reaction 10%	Requirement for synergy between all stakeholders 5%	Exploitation of existing infrastructure policies and actions 5%	Effectiveness for the city of Serres 40%
1. Users' awareness raising and information on sustainable urban freight transport	9	9	9	7	8	4	9	9
2.Information maps	9	9	9	6	9	6	8	9
3. Truck routes	5	8	6	6	2	4	9	1
4. Spatial and temporal restrictions	9	9	9	6	2	4	9	9
5. Infrastructure for access restriction application	2	6	2	4	2	4	3	9
6.Low emissions zones	9	9	9	7	2	4	3	3
7.Truck lanes	9	9	2	7	2	4	5	5
8.Urban Logistics Centres	1	1	1	6	7	4	5	2
9. Use of non-conventionally fuelled vehicles	1	8	1	6	2	4	2	2
10.Lockers	1	8	1	4	7	4	3	7
11. Logistics management systems	5	5	5	4	9	4	8	9
12. Routes optimization	3	3	3	2	9	4	5	9
13.Night delivery	9	9	9	6	4	4	9	7

5.4. Stage D: Results - Ranking of the proposed measures

The final evaluation of the measures corresponds to a total score for each measure (Swij) calculated as the sum of the multiplication of each criterion j with the corresponding weight (wj).

Table 3. Final rating of proposed measures

Measure i	Weight w_j				Total rating Σw_{ij}				
	0.2	0.05	0.1	0.05	0.1	0.05	0.05	0.4	Sum
	Rating								
1: Users' awareness raising and information on sustainable urban freight transport	9	9	9	7	8	4	9	9	8.55
2: Information maps	9	9	9	6	9	6	8	9	8.65
3: Trucks routes	5	8	6	6	2	4	9	1	3.55
4: Spatial and temporal restrictions	9	9	9	6	2	4	9	9	7.9
5: Infrastructure for access restriction application	2	6	2	4	2	4	3	9	5.25
6: Low emissions zones	9	9	9	7	2	4	3	3	5.25
7: Truck lanes	9	9	2	7	2	4	5	5	5.45
8: Urban Logistics Centres	1	1	1	6	7	4	5	2	2.6
9: Use of non-conventionally fuelled vehicles	1	8	1	6	2	4	2	2	2.3
10: Lockers	1	8	1	4	7	4	3	7	4.75
11: Logistics management systems	5	5	5	4	9	4	8	9	7.05
12: Routes optimization	3	3	3	2	9	4	5	9	6.1
13: Night delivery	9	9	9	6	4	4	9	7	7.3

The above results show that measures 1, 2 and 4 are found to be the three most suitable ones for inclusion to the Sustainable Urban Logistics Plan of the city of Serres.

6. Conclusion

The multi-criteria analysis used for the evaluation of the measures considered for the Sustainable Urban Logistics Plan (SULP) of the city of Serres identified the most suitable measures. The top three measures are "user awareness raising and information on sustainable urban freight transport", "information maps" and "spatial and temporal restrictions", which score higher mainly on both categories with the highest weight factor, cost and effectiveness. The final selection for the measures to be added to the SULP of Serres was made by the city, which examined all the results and the city's capabilities and selected additional measures for implementation. These measures based on the ease of application will be implemented immediately or in the near future.

The implementation requirements of each measure requires that although many measures were selected, some could be applied immediately and others at a later stage when conditions are more suitable. The highest scoring measures are also those which can be applied immediately with effective, but harder to apply measures being added with implementation forecast for a later date.

The criteria selection and weighting method thus provides the city under study with a means of evaluating any measure that can be considered for addition to its SULP and implementation. The weighting factor which is used provides the prioritization of a small-medium city criteria which can lead to effective measures (as proven in other cities) being rejected as not suitable due to low scores.

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