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Smart interconnections of interurban and urban freight transport towards achieving sustainable city logistics

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Abstract

The booming increase in the need for passenger and freight transport concerning both interurban and urban context during the last two decades has resulted in deep impact in human and natural environment. Towards the alleviation of consequences, the decision makers consider various smart logistics solutions, which do not always results in the desired impacts. The key concept of the methodology presented in this paper is the incorporation of an evaluation framework and the estimation of the assessment indicators for smart logistics solutions, to be used in the decision-making of the involved stakeholders. Such solutions fall into two sub-categories: “administrative and regulatory schemes and incentives” and “cooperative logistics”.
The paper presents:

- an integrated evaluation framework for city logistics which incorporates the complexity of interconnecting interurban and urban freight transport and the life cycle of the smart solutions;
- the impact of these solutions on the city performance and business viability and sustainability, based on a pilot implementation;
- guidance for implementing these solutions through the establishment of communications links and collaborations amongst the involved stakeholders.

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Keywords: freight transport; sustainability; city logistics; supply chain; multi stakeholder multi criteria evaluation

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1. Introduction

The increase of urban population and the growth of goods movements to the cities cause congestion, environmental impacts, excessive energy consumption and accidents. According to the European Commission White Paper "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system", the elimination of these negative impacts and the provision of sustainable transportation systems require the implementation of innovations and interventions related, among other, to coherent cooperation of the relevant stakeholders and development of efficient interfaces between short and long-distance networks. The *enabling of cooperative logistics*, which foresee collaborations among operators, in «win-win» businesses, is the main focus of this paper.

Such schemes are in line with the overarching goal of optimizing urban freight transport and thus make significant contribution to the sustainability and livability of cities, by the alleviation of traffic congestion and the mitigation of emissions and noise impacts. The impact of the proposed solutions on the city performance and business viability and sustainability are tested and validated based on a pilot implementation. Operators share a platform where they can declare their services and, subject to inter-operator agreements, they proceed into transportation sharing solutions for consolidated cargo and finally revenue sharing.

In the paper, results from the freight demand and traffic and environmental impact assessment models are coupled with relevant criteria and indicator weights for each stakeholder category. A before-after analysis reveals the effect of the two sub-concepts through a life cycle analysis (LCA) of the processes, advancing the research in LCA of products.

2. City logistics solutions

When analyzing a freight transport supply chain, two main transportation legs are identified, the interurban and the urban. The two successive legs are interconnected to each other, but the main countable consequences from the elaboration of freight transport activities on human and natural environment are recorded and estimated within the second part as they appear to be more direct. According to the results and findings of the STRAIGHTSOL project (2012), the impact areas are economy, environment, society and transport in the meaning of the performance of a freight transport system concerning efficiency and reliability (quality of service provided to customers). The impacts of city logistics are more intense especially where population densities become higher and higher. Considering congestion, excessive energy use and road safety problems as "side effects" and focusing mainly on the environmental impacts, Taniguchi et al (2003) have set three basic pillars as guiding principles for city logistics: mobility, sustainability and livability.

Hence, the goal of (green) city logistics should be the collection and delivery of goods in an efficient way, integrating the respective urban freight transport (UFT) activities in the urban concept without disrupting the mobile, sustainable, livable and environmental friendly character of the city. Moreover, the green logistics should also ensure upgraded level of provided services through the promotion of competitiveness, congestion alleviation, energy conservation, safety and security (Geroliminis et al, 2005).

Towards this direction, two main categories of measures have been identified affecting city logistics:

i. the administrative/regulatory schemes and incentives and
ii. the collaborative schemes and cooperative logistics.

The experience in this field has proven that within the first category, measures are either adopted as single interventions or applied in combination with each other, according to the decisions taken by the municipal authorities (Torrentellé et al., 2012; TURBLOG, 2011; BESTFACT, 2013; Ruesch and Glücker, 2001; TRAILBLAZER, 2013; SUGAR, 2011; Dasburg and Schoemaker, 2006; Geroliminis et al, 2005; STRAIGHTSOL 2012, European Center for Government Transformation, 2015). Some of such measures include: Restriction/Low--emission/Light or low traffic zones; Promotion of green freight transport modes, such as electric vans, bicycles and tricycles for the last mile delivery of goods or promoting alternative modes of goods transport such as rail (e.g. Zurich cargo tram) and inland waterways where applicable (e.g. Amsterdam canal system and Venice Lagoon);

Congestion mitigation, incorporating concepts such as the multi-user lanes; Use of information systems (ITS of ICT) for enforcement.

Pertaining to the second category of interventions which affect city logistics, they include: Multimodality for urban freight, incorporating multimodal integration with transshipment facilities for last mile distribution in urban concept; Establishment of urban consolidation/distribution centers (UCC/UDC) or similar premises in the city suburban or wider, adjacent area, acting as intermodal interchanges for the connection of different transportation modes or networks and the transshipment of cargo from one to another, also connected to UFT activities and last mile deliveries with green and energy efficient transportation modes.

However, such types of measures do not constitute a "one fits all cases" concept. In fact, each measure's sustainability, effectiveness and suitability should be estimated separately according to each case and respective parameters and furthermore each single or combination of interventions should be analyzed as a different scenario when planning and designing at strategic level for the future of a city. A comprehensive evaluation framework will facilitate the ranking of tested scenaria in order to provide support and guidance in reaching the best alternative solution given the available budget. Based on the estimation of certain key performance indicators (KPIs) the impacts, effectiveness and applicability of each measure may be assessed providing a total performance index in order for it to be respectively ranked and also be compared with the other alternatives, facilitating the decision making.

3. State-of-the-art

Stakeholders are considered as main drivers in the realization of a supply chain. Stakeholder categories comprise of shippers, receivers (or consumers), service providers, authorities (governmental, regional and/or municipal) and general public (Lidasan, 2011; STRAIGHTSOL, 2012).

Concerning city logistics policy measures driven by policy-making stakeholders, Visser et al. (1999) separated them according to the type of policy (infrastructure, regulatory and economic measures) the quality of intervention(s) (physical and/or transport/information, regulations/standardization, pricing/subsidies) and their concept (land use, networks, terminals, parking, vehicles and cargoes). Similarly, Munuzuri et al. (2005) classified them into those related to public infrastructure, land use management, access conditions, traffic management, enforcement and promotion.

According to the reporting of OECD, the major categories of city logistics measures are initiated by public authorities, decision and policy makers. Amongst others they include: infrastructure development, distribution and consolidation centers/intermodal terminals, regulatory measures and license provision, traffic management measures, traffic calming measures and land-use zoning. Moreover, private companies are mainly focused on the implementation of innovative business models and collaborative schemes, such as cooperative operations, off-peak deliveries, use of alternative fuel types in the trucks, vehicle scheduling/routing techniques, material handling systems, etc (OECD, 2007).

Russo and Comi (2010) introduced their classification of city logistics measures adopted in urban environment, incorporating: a) measures related to material infrastructure, b) measures related to immaterial infrastructure (telematics) or ITS, c) measures related to equipment and d) measures related to governance of the traffic network. Later on, Van Rooijen and Quak (2014) performed an analysis of the different urban freight logistics measures implemented under the CIVITAS initiative in European cities, also analyzing their impacts. Empirically, and taking all the afore-mentioned measures and their respective categorization, pertaining to the clustering of city logistics measures, the authors of this paper ended up with a set of ten (10) discrete categories or clusters characterized by different objectives and city logistics elements (Papoutsis & Nathanail, 2015):

1. Distribution and logistics models for operators, incorporating mostly measures initiated by the private sector, such as off-peak deliveries, consolidation or collaboration schemes and joint operations.
2. Capacity sharing, in the meaning of infrastructure and equipment sharing amongst multiple operators, stakeholders and different transportation modes, such as the multi-use lanes concept.
3. Infrastructure development, pertaining to the designing, construction and development of consolidation/distribution centers and logistics premises, such as interchanges and transshipment areas or terminals.

4. Use of advanced information technologies, intelligent transport systems of information and communication technology.
5. Promotion of greener – environmental friendly ways of transport, taking advantage of respective innovations in vehicle, engine and motors technology (e.g. electric and LPG or natural gas freight vehicles) and of alternative freight transport modes, reclaiming and upgrading the role of railways and inland waterways (where existing and applicable) also exploiting their huge capacity.
6. Access control (permanent) in combination with the use of advanced monitoring systems interconnected with police enforcement and in combination with charging (tariff policy), incorporating policies and measures that imply access restrictions to certain areas based on concrete constraints (environmental, vehicle weight, etc.), traffic calming measures in low traffic zones (e.g. historic city centers) etc.
7. Regulations on enabling activities (periodically depending on dynamic traffic conditions), including regulatory measures that determine logistics processes for certain types of vehicles at certain times per day, such as loading/unloading, time windows, parking regulations and other soft measures that do not apply to none of the aforementioned categories belong to this category.
8. Enforcement, integrating all police enforcement actions
9. Routing optimization, concerning infrastructure and road marking or signing for route optimization.
10. Training, including activities such as the tutoring and promotion of safe and eco driving.

Pertaining to the most common methodologies used to assess the performance of city logistics solutions, the researcher should take into consideration their impacts, given that the reflecting impact areas are economy, environment, society and transport as mentioned before in the text. According to Nathanail et al (2014), pertaining to the impacts, the application of city logistics solutions increases the transport resources utilization efficiency, promotes the simplification of transport and supply chains management and contributes to the diminishing of transportation costs and time delays increasing reliability concerning cargo delivery. It also helps towards the reduction of greenhouse gas emissions, supporting competitiveness strategy for logistics companies and carries a core role in the management of organizations. In addition, it may provide for improved turnover and enlargement of the clientele owing to improved level of provided services leading to customer satisfaction. In the end, we may assume that the application of smart city logistics solutions may result in more effective integration across supply--chain, with error-free and 'greener' operations.

Based on the above, there are several methods to assess, select and implement the appropriate measures in logistics supply chain and especially focusing on a city. When the need is to depict the costs versus the benefits of an initiative, the Cost-Benefit Analysis (CBA) and the Social Cost-Benefit Analysis (SCBA) constitute the most suitable method. Costs and benefits incurred for each measure or intervention are estimated taking into account any peculiarities and special features of each particular city case.

As opposing to the CBA, the Cost-Effectiveness Analysis (CEA) does not require monetization. It mainly regards the amount of money spent in order to generate one or more target-benefits of the project. This method enables viewing the individual impacts separately. Extending CEA, the Multi-Criteria Analysis (MCA) and the multi stakeholder multi criteria analysis is often applied in strategic planning, as it has the significant advantage concerning the capacity of ranking a range of alternatives reflecting a common objective. Each objective is associated to a range of criteria and respective weights and alternative situations (actions, activities and scenaria) are assessed, evaluated and ranked or compared as per their performance (Nathanail et al, 2014).

Most of the above methods require the estimation of Key Performance Indicators (KPIs) which are addressed to one or more stakeholder groups involved in each case. In addition, the Life Cycle Analysis (LCA) is conducted in order to assess the system operation and reaction (e.g. possible consequences or modification in the values of certain KPIs) after the implementation of an innovative city logistics solution taking into account all phases from creation to development, operation maintenance and disposal (reverse logistics).

Within the following sections the proposed evaluation framework is briefly depicted and tested on a specific case addressing interurban-urban demonstration implemented in the context of the European Commission FP7 co-funded research project STRAIGHTSOL – Strategies and measures for smarter urban freight solutions (2011-2014).

4. Evaluation framework

The proposed evaluation framework constitutes a tool supporting the process of decision making. It is based on the multi stakeholder multi criteria concept, meaning that it integrates the approaches of all stakeholder groups involved in a city case or demonstration, determining criteria and indicators set by them addressing exclusively to each one of them in order to capture individual needs, expectations and behavioral trends (Nathanail, 2007). The framework may be utilized for the evaluation, comparison and ranking of the performance and effectiveness of smart city logistics solutions based on impact assessment. In addition it may pave the way for discussions around a table facilitating the presentation of similar, different or contradictory points of view and approaches with the potential to lead to partnerships and collaborative schemes.

The framework incorporates a multiple weighting scheme as well as elimination and ranking techniques and models, to enable "shared" decision-making, i.e. taking into account the participation, point of view, approach and contribution from all involved stakeholders to the configuration of the final decision on policies and measures taken. In addition, it establishes a commensurate scale for the valuation of the KPIs through normalization or utility function. The steps to be followed and therefore the functions of the tool are those used in multi-stakeholder multi--criteria assessment methods and allow to take into account multiple stakeholders in the assessment as may be depicted the respective functions presented within Figure 1.

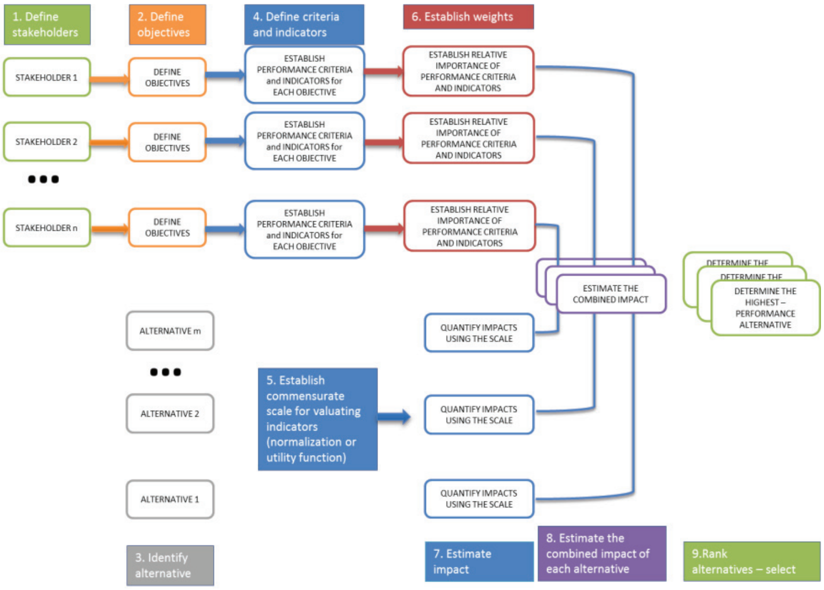

Fig. 1. Evaluation framework – structure and functions of the evaluation tool.

Although it consists of different modules and functions and even though many activities are discrete and autonomous or occur simultaneously or in parallel, there is concrete sequence when the whole evaluation process is elaborated. According to Figure 1, the first step is to identify the stakeholders involved in the case (Function 1). Next step is the definition of objectives, goals and expectations as expressed from the part of each stakeholder category, and investigate their compatibility or contradiction, with view to take all parameters and coefficients of the problem into consideration towards the provision of an optimum solution (Function 2).

Then, in order to describe the situation(s) to be analyzed, evaluated, compared and ranked, after the collection of data (e.g. concerning demand, supply, socioeconomic trends for the projection of flows etc) the respective scenaria modeling each situation are built (Function 3). The current scenario reflects the situation as is (business as usual) and each one of the future scenaria address to alternatives of possible future situations that will appear after the implementation of the respective smart urban logistics solutions. The calibration of the various impact models being used in the evaluation on the current situation scenario helps in the reliability of the future ones based on it.

Each scenario is tested against a set of representative performance criteria and respective key performance indicators (KPIs) are established in association with each one of the objectives set by the stakeholders (Function 4). The relative importance of those criteria and indicators within the multi stakeholder multi criteria evaluation process are based on the involved stakeholders' and points of view. The importance (weight) is estimated based on the Analytic Hierarchy Process (AHP), after the pairwise comparison of criteria and indicators, as such analysis is considered as better depicting the size of preference for each element as compared to all other (Function 6).

In parallel, a commensurate scale for the valuation of the KPIs is established through normalization or utility function (Function 5) and in combination with the values of KPIs defined for each scenario and given the weights determined the combined impact addressing all the objectives per stakeholder group may be estimated (Function 7), while also giving the option of estimating the combined impact of each alternative solution (Function 8) overall, in total performance index. Through this way, the responsible body for the decision or policy making will be facilitated in selecting the best alternative (system optimum), also being in position to justify the decision taken and the measures applied based on both quantitative and quantifiable results and figures.

The integration of the evaluation framework with the life-cycle analysis of processes considers urban freight and service trips activities, policies and measures, key influential factors and logistics scenarios from creation, through operation and maintenance to closure. When properly set, it constitutes an integrated, multi-dimensional tool to facilitate planning and designing at strategic level while also supporting decision and policy making at tactical and operational scale.

5. Case study

In the demonstration studied within STRAIGHTSOL project, the involved stakeholders were Kuehne+Nagel (K+N) as logistics service provider (LSP), TRAINOSE as rail operator and infrastructure and equipment provider, the shippers, the receivers and the society (general public). According to the concept, the supply chain consists of two discrete but successive and interconnected legs: one interurban performed by rail and one urban implemented by road. The rail operations include the transfer of goods from Central European countries, through the Balkan area to Greece. Goods are transported by rail from Sopron, Hungary to K+N's terminal in the industrial area of Thessaloniki, to be transshipped via cross dock to trucks for the last mile distribution. Under the "business as usual – BAU" scenario, each wagon is allocated to one customer, and a designated truck is assigned to pick-up and deliver the cargo to its final last-mile destination.

For the needs of the current research, the concept of transportation sharing was adopted both in the urban and interurban legs. The "after" scenario assumes the full capacity of wagons and trucks is shared and available for all customers' cargo. So, instead of door-to-door FTL (full truck load) for both wagons and trucks, the LTL (less than truck load) concept has been tested, mainly aiming at reducing transportation throughput (wagon and/or truck kilometers), environmental impacts and operating costs. As it was expected, such scenario increased delivery time and probably customer inconvenience.

Freight demand is estimated to 2400 m^3 transported by rail every day. Each train consists of a set of 26 4-axle and 2-axle wagons (different combinations per trip according to the type of transported cargo). Within the "BAU" scenario a total of 31 trains are used per month. This corresponds for one train arrival each one of the 20 working days. During 11 of those 20 days, there are two train arrivals per day (another 11 trains). The average wagon load factor is 70% and the total number of wagons used is 806 wagons per month. Then the cargo is transshipped to 992 trucks with 60% load factor at the average (FTL) for the implementation of last mile distribution. Within the "sharing" scenario, the same volume of cargo is transported but the load factors for wagons and trucks reaches the 100%.

Pertaining to the costs, the total crew hiring cost reaches the 180€/day for servicing one train. For the servicing of each second train per day the personnel recruited for loading/unloading and transshipment of extra cargo is doubled. Also, the costs for wagon and truck rental are 30€ and 150€ per day of use. Within the "BAU", each truck takes about 45 minutes to cover the total 100 Km of the round-trip twice a day. The figures in the "sharing" scenario are modified to 130 minutes and 250 Km twice a day. The trucks average fuel consumption reaches the 45 lt/100 Km. For the rail leg, the total distance covered in each trip is 1700 Km and the average fuel consumption is 570 lt/100 Km. Finally, the fuel price (for petroleum/oil) ranges around 1.1 €/lt.

Given the data mentioned above, pertaining to the operational costs, the travel delays and environmental issues per stakeholder, in Table 1 there are several indicative figures for both scenaria.

Table 1. Costs, delays and environmental issues per scenario per month.

Data	BAU scenario	Sharing scenario
Number of trains	31	22
Train fuel cost (€)	330429	234498
Number of wagons	806	564
Wagon renting cost (€)	24180	16926
Number of trucks	992	595
Truck renting cost (€)	148800	89280
Truck km	496000	297600
Truck fuel cost (€)	245520	147312
Personnel cost (€)	5580	3960
Total operational costs (€)	*754509*	*491976*
Total delays	*Up to 2 h*	*Up to 4 h*
Total CO_2 emissions (tons)	*229.5*	*137.7*

The criteria and indicators addressed to each stakeholder group, together with their significance (weight) are depicted in Table 2. The weights are based on survey data, collected in 2014 and the use of the Analytical Hierarchy Process (AHP) (Saaty, 1980). A commensurate scale (1-10) was used for the estimation of the indicator values.

Table 2. Criteria, indicators and their weights per stakeholder group.

Stakeholder group	Criterion	Indicators	Weight	Value BAU	Value Sharing
Logistics service providers	Costs	Operational costs (wagon and truck fuel and renting, plus personnel and extra personnel)	0.505	3.9	6.1
	Company image	Time punctuality	0.063	6	4
		Deliveries in right quantity	0.060	8	8
		Deliveries in right form	0.060	8	8
		Loading/unloading time	0.063	7	7
	Safety and security	Infrastructure/equipment accidents	0.024	8	8
		Personnel accidents	0.073	8	8
	Environmental burdening	CO_2 emissions	0.110	3.75	6.25
	Supply chain visibility	Trips with real time information	0.042	10	10
Shippers	Costs	Energy/Fuel consumption	0.346	3.75	6.25
		Delivery cost			
		Opportunity costs/ Lost profits			
		Total driving time (including delays and stops)			
	Environmental burdening	CO_2 emissions	0.041	3.75	6.25
	Level of service	Time punctuality	0.041	6	4
		Deliveries in right quantity	0.040	8	8
		Deliveries in right form	0.040	8	8
		Loading/unloading time	0.111	7	7
	Company image	Customer satisfaction	0.127	8	6
	Safety and security	Infrastructure/equipment accidents	0.085	8	8
		Personnel accidents	0.169	8	8

Stakeholder group	Criterion	Indicators	Weight	Value BAU	Value Sharing
Receivers	Costs	Delivery cost	0.659	3.9	6.1
		Average delay cost			
		Opportunity costs/lost profits			
	Level of service	Time punctuality	0.156	6	4
		Deliveries in right quantity			
		Deliveries in right form			
	Supply chain visibility	Updated and reliable data	0.185	8	8
		Data transmission frequency			
		Type of information			
Society	Environmental burdening	Optical disturbance	0.048	6	10
		Accessibility	0.168	8	8
		CO_2 emissions	0.250	3.75	6.25
		Noise nuisance	0.127	7	5
	Safety	Road safety level	0.407	8	8
Infrastructure and equipment providers	Costs	Wagon renting cost	0.553	4.1	5.9
		Additional costs due to information alerting delay or unavailbility			
	Level of service	Time punctuality (delays)	0.447	6	4
		Deliveries in right quantity			
		Deliveries in right form			
		Updated and reliable data			

Applying the above weights and indicators, the partial and total performance indices per scenario is estimated in Table 3.

Table 3. Partial and total performance indices per scenario.

	Partial and total performance index per scenario	
Stakeholder group	**BAU**	**Sharing**
Logistics service providers	7.827	8.239
Shippers	7.156	7.958
Receivers	6.682	8.382
Society	7.527	6.965
Infrastructure and equipment providers	7.447	6.424
Total performance index per scenario	**5.63383**	**6.37257**

Even though the differences after the evaluation are quite small, the “Sharing” scenario indicates better overall performance than the “BAU” scenario for all stakeholders except of society and infrastructure and equipment providers, for whom the “BAU” scenario prevails over the “Sharing” scenario.

6. Guidance for effective city logistics

Setting up cooperative schemes among stakeholders, operators and authorities, should be strongly promoted. The role of training and testing on business plans is considered to be fundamental and vital towards the establishment of operative, profitable and successful business models. A good business plan fits the business needs and is realistic, meaning that it can be implemented. It is characterized by its specificity of tasks, deadlines, dates, forecasts, budgets and metrics with special reference to assumptions, while ensuring the clarity of responsibilities assigned to the involved stakeholders. In addition, its success is expended on condition that it is communicated to the stakeholders who have to run it or bear its impact, getting people committed to tasks and responsibilities and keeping alive its concept and approach through following ups according to the updated planning process. So, concerning a new business or collaborative scheme (e.g. partners consortium), such as the establishment of an integrated interurban--urban cargo-supply chain, the respective business model is depicted in figure 2, following the Osterwalder, Pigneur & al. canvas (2010).

Key Partners	**Key Activities**	**Value Proposition**	**Customer Relationships**	**Customer Segments**
1. LSP including independent truck companies 2. Shippers 3. Receivers 4. Infrastructure and equipment providers (e.g. railway operators throughout Europe such as TRAINOSE Greece) 5. Society	1. Planning of railway operations 2. Accurate planning of delivery to customers via GPS location information 3. Automated identification of location of cut-off wagons 4. Expected CO_2 reduction from city distribution due to capacity sharing 5. Expected reduction in energy/fuel consumption due to capacity sharing	1. Different operators for the two different legs (interurban – urban) 2. Different operators for the urban leg. 3. Multiple customers sharing the capacity of a wagon/truck transporting their cargo to multiple destinations reducing delivery cost (LTL) 4. Cargo consolidated and allocated to trucks according to routing of vehicles during the last mile distribution (longer round-trip with many stops to multiple final destinations) 5. Truck movements facilitated by the city authorities' policy making and regulatory framework (reduced travel time and congestion impacts)	1. Customer contracts for long-term service provisions 2. "One-off" contract relationships 3. Each customer has contract with multiple rail and truck operators for the transportation of cargo in each different section of the supply chain	1. Senders and receivers of cargo 2. Special cargo according to each customer's needs 3. Multiple types of cargo sharing the capacity of the same wagon or truck
	Key Resources 1. Trucks and railways 2. Warehousing space	**Externalities** 1. Environmental (CO_2 emissions) 2. Safety and security (rail and road accidents for personnel and equipment)	**Channels** 1. Online booking 2. Telephone contracts with truck and railway operators 3. Tracking information to customers through the K+N portal	

Cost Structure	**Revenue Streams**
1. Railway and truck operators 2. Management and maintenance of vehicles equipment and infrastructure 3. Personnel	Price per shipment

Fig. 2. Osterwalder BM canvas for "Sharing" scenario.

Moreover, experience has proven that the continuous updating of the model based on evaluation and testing results and findings constitutes a key element for success, meeting the emerging needs per case. In the end, the transferability and sustainability of a situation or/and scenario elaborated through the proposed integrated evaluation framework will help the decision makers take action, justifying their selection of policies and measures, also having the approval from the part of the involved stakeholders together with public acceptance, leading to the adoption of advanced smart solutions or the reviewing and supporting of the current ones with complementary measures towards system optimum.

7. Conclusions

In this paper, a framework for the evaluation of smart logistics solutions is introduced. It is based on the multi stakeholder multi criteria approach, providing some space to the involved stakeholders, both private (e.g. operators) and public (e.g. authorities), take part in the decision making process. It provides a system clarity when applying smart logistics solutions, policies and measures in favor of all involved stakeholders' benefit, also preserving natural, socio-economical and human environment When integrating all criteria and stakeholders, the tested solutions have the advantage of being commonly reviewed by all involved stakeholders, and although not completely complying with everyone's goals and objectives, it sets the scene for an open discussion and negotiation panel, avoiding trade-offs and monopolies or individual profit.

The applicability of the evaluation framework is tested on a specific case study. Further research involves a more elaborated implementation of LCA, incorporation of sensitivity analysis and validation of the results with observed data.

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References

BESTFACT, 2013. Deliverable 2.2 – Best Practice Handbook 1.

Dasburg, N., Schoemaker, J., 2006. Best Urban Freight Solutions II (BESTUFS II), Deliverable D5.2 – Quantification of Urban Freight Transport Effects II.

European Center for Government Transformation, 2015. Boosting innovation in cities to deliver better public services – A view from tomorrow's leaders. College of Europe student case studies, Final report.

Geroliminis N., Daganzo C. F., 2005. A review of green logistics schemes used in cities around the world. UC Berkeley Center for future urban transport, VOLVO center of excellence.

Lidasan H. S., 2011). City Logistics: Policy measures aimed at improving urban environment through organization and efficiency in urban logistics systems in Asia. Transport and Communications Bulletin for Asia and the Pacific.

Muñuzuri, J., Larrañeta, J., Onieva, L., Cortés, P., 2005. Solutions applicable by local administrations for urban logistics improvement. Cities, 22, pp. 15-28.

Nathanail E., 2007, "Developing an integrated logistics terminal network in the CADSES area", Transition Studies Review, May 2007, Volume 14, Issue 1, pp 125-146.

Nathanail E., Gogas M., Papoutsis K., 2014. Investigation of stakeholders' view towards the introduction of ICT in supply chain using Analytic Hierarchy Process. Journal of Traffic and Logistics Engineering, Vol. 2, No. 2, pp. 113-119.

OECD – Organisation for Economic Co-operation and Development, 2007. Efficient and Sustainable Intermodal Logistics Network in the Asia--Pacific Region. OECD/ECMT Outreach Activity of the Asian Logistics Project, Tokyo.

Osterwalder A., 2004. The Business Model Ontology – A Proposition In A Design Science Approach. PhD thesis, University of Lausanne.

Osterwalder A., 2012. Tools for Business Model Generation. A 53-minute video discussing the Business Model Canvas in detail, Stanford Entrepreneurship Corner.

Osterwalder A., Pigneur Y., Smith A. and 470 practitioners from 45 countries, 2010. Business Model Generation. Wiley published.

Papoutsis K,. Nathanail, E. (2015). Facilitating the selection of city logistics measures through a concrete measures package: A generic approach. 9th International Conference on City Logistics, Tenerife, Canary Islands (Spain), 17-19 June 2015.

Rooijen V. T., Quak H., 2014. City Logistics in the European CIVITAS Initiative. Procedia – Social and Behavioral Sciences, 125, pp. 312-325.

Ruesch, M., Glücker, C., 2001. Best Urban Freight Solutions (BESTUFS), Deliverable D2.1 – Best Practice Handbook Year 1.

Russo F., Comi A., 2010. A classification of city logistics measures and connected impacts. Procedia Social and Behavioral Sciences 2, pp. 6355–6365.

Saaty, T. L., 1980. The Analytic Hierarchy Process. McGraw-Hill, New York, USA.

STRAIGHTSOL project, 2012. Deliverable D3.1 – Description and set up of demonstrations.

STRAIGHTSOL project 2012. Deliverable D3.3 – Description of indicators, KPIs and measurement methods.

STRAIGHTSOL project 2014. Deliverable D5.1 – Demonstration assessments.

SUGAR project, 2011. City Logistics Best Practices: a Handbook for Authorities

Taniguchi E., Thompson R., Yamada T., 2003. Visions for City Logistics. Proceedings of the 3rd International Conference on City Logistics, Madeira, Portugal, June 2003, pp. 1-16.

Torrentellé, M., Tsamboulas, D., Moraiti P., 2012. Deliverable D2.1 – Elicitation of the good practices on UFT. C-LIEGE project: Clean Last mile transport and logistics management for smart and efficient local Governments in Europe.

TRAILBLAZER project, 2013. Deliverable D2.3 – Report on the State of the Art.

TURBLOG – Transferability of urban logistics concepts and practices from a worldwide perspective, 2011. Deliverable 3: Urban Logistics Practices – Synthesis of Selected Case Studies.

Visser J., Binsbergen A., Nemoto T., 1999. Urban freight transport policy and planning. In: "E. Taniguchi and RG. Thompson (eds.)", City Logistics I, 39-70.