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SMART PLATFORM FOR SUPPORT ISSUES AT THE FIRST AND LAST MILE IN THE SUPPLY CHAIN - THE CONCEPT OF THE S-MILE PROJECT

Summary. The concept of an innovative support tool for freight transport used in planning, organization and realization is presented in this paper. In addition to the basic functions of a fleet management tool, the educative approach towards environmentally friendly behaviour will be based on promoting ecological solutions, such as unconventionally powered cars, e.g., electric vehicles (EVs). The suggested criteria for a routing algorithm, which will be implemented in the freight transport planner tool, not only allows routing in relation to time and cost criteria, but also the criterion regarding the limitation of emissions of harmful factors. The implementation of innovative the S-mile platform gives rise to environmentally friendly cognition behaviour in the freight transport sector. This is a fundamental aspect to its application, which could help to move the planning, organization and realization of freight transport in the direction of more environmental friendly solutions.

Keywords: sustainable transport; supply chains; transport modes; multimodal; ecological transport.

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1. INTRODUCTION

The basic assumption of freight forwarding and transport companies is focused on transport within the defined area, in which goods are exchanged between two points. Implementation of freight transport is based on the assumption of minimizing time and costs. In the opinion of forwarding and transport companies, the green (ecological) criterion is marginalized; even worse, it is overlooked in the planning of used modes of transport and the routes they take [23].

A change in thinking is necessary to promote electromobility or other new technologies for powering vehicles. The decarbonizing of the transportation sector is one of the main challenges facing the whole world. For instance, EVs are more efficient from an energy viewpoint, more economical in terms of consumption and more environmentally friendly compared to internal combustion engine vehicles [7, 9-10, 15].

Two distinctive issues can be found in the literature. The first relates to the proper location of distribution centres. It is important to minimize the cost of distribution, especially between centre and the customer [3, 6, 17-19, 21]. The other issue is related to supply chains [1, 4, 13, 16, 20]. The most important approach is to look for answer regarding how to optimize connect deliveries (if fleet parameters are known) in supply chains [5]. The state-of-the-art options in fleet management are vast, with many tools already offering routing services for freight transport [8], such as the MyRouteOnline Route Planner or the Freight Journey Planner Map. Unfortunately, none of them includes the particular restrictions imposed by the use of the EVs, nor do they address pro-ecological routing strategies or take into consideration road surface conditions.

Generally, although many tools offer routing services, they overlook the possibility to choose among many types of fleet (especially pro-ecological), as well as lack integration between customers, shippers and freight transport companies. Additionally, any analysis of the macro implications of these tools is avoided.

Nowadays, the issues for logistics and supply chains are as follows [25]:

- difficulties in integrating different transport modes into one supply chain
- issues relating to multiple aspect at the first/last mile:
  - lack of transportation availability for the main modes in a supply chain directly to the customer's address (lack of infrastructure equipment, such as railroads, airstrips and docks) and also the possibility of zones with limited traffic for vehicles
  - the problem of optimal matching of the route from the loading to individual recipients (customers) and the opposite when delivering from many to one
- the lack of transport planners who have implemented criteria other than economic ones for transport companies (in this case, planners who take into account environmental aspects)
- the lack of any analysis of freight transport quality when planning the route, given that the conditions of road surfaces and traffic congestion significantly impact on the quality of transport [14]
- approaching the problem at the micro level of individual transport companies, rather than on a macro level in accordance with urban policy

The proposed solution by the authors of the article, the S-mile smart platform, will be implemented with an innovative routing algorithm at the first and last mile in the supply chain, taking into account the particularities of environmental impact, the possibility of using EVs or other new technologies for freight transport, and the quality of road surfaces along the route. The structure of the platform will allow for integration between customers, shippers and freight transport companies by using mobile devices, which are arguably the most popular tools in the entire world [2].

In addition, the authors will integrate the innovative algorithm with existing open-source routing platforms to issue first and last mile routes according to both the clients' and freighters' preferences (in the same way as the MyRouteOnline Route Planner or the Freight Journey Planner Map). The obtained platform will offer a significant solution to demonstrate the possibility of using pro-ecological transport modes and creating pro-ecological corridors for transport of goods.

2. INTERNATIONAL COOPERATION ON THE S-MILE PROJECT

The primary idea of the S-mile project is to create an integrated system of tools, which is utilized in following the steps of a supply chain, such that freight transport development is fostered in accordance with general and specific EU guidelines, such as EU White Papers, with the aim of realizing more efficient, safe, pro-ecological and also cost-effective freight transport in cities [10-12].

The proposed platform will support the optimization of supply chains, multimodal transport and the reduction of emissions, stretch, noise and congestion, as well as the improvement of transport quality with the help of highly effective and developed routing optimization algorithms [22]. As the goals of the platform will be related to sustainable logistics in cities, pro-ecological solutions for urban and suburban areas will be offered. These solutions will considering the possibility of shaping transport availability from an urban logistic concept regarding the first and last mile problem into distribution concepts for urban logistics, which will also help to foster pro-ecological modes of transport.

The project required an interdisciplinary research team. Thus, a team has been established under the leadership of SAITEC. The team consists of people representing companies and scientific institutions, such as SAITEC, Factor CO_2 and DeustoTech (both from the Basque Country), the Silesian University of Technology (Poland) and PlusOneMinusOne (Turkey). This international cooperation is designed to deliver a product that, in the future, will foster the ecological transportation of goods and support decision-making processes for freighters, customers and local governments.

The cooperation between the above-mentioned institutions from the three countries (different in terms of culture, geography and forms of traffic organization in transport systems) has one more advantage, namely, that the implementation of the S-mile project enables testing project products in relation to the three specific research areas. It aims to unify project solutions and establish universal tools for developing multimodal transport systems. This will directly translate into the use of project products in the future.

3. CONCEPTION OF THE S-MILE SMART PLATFORM

The general list of all modules expected in the S-mile project are shown in Figure 1. In this paper, the authors only describe a small part of the modules involved in the S-mile platform. The major usability of the S-mile platform will be to optimize the freight transport supply chain for customers, freighters or shippers, as well as the possibility of moving transport system monitoring by local authorities in the direction of both greater efficiency and ecological sustainability. The platform will be a great support to these stakeholders in shaping more appropriate transportation behaviours, especially pro-ecological ones.

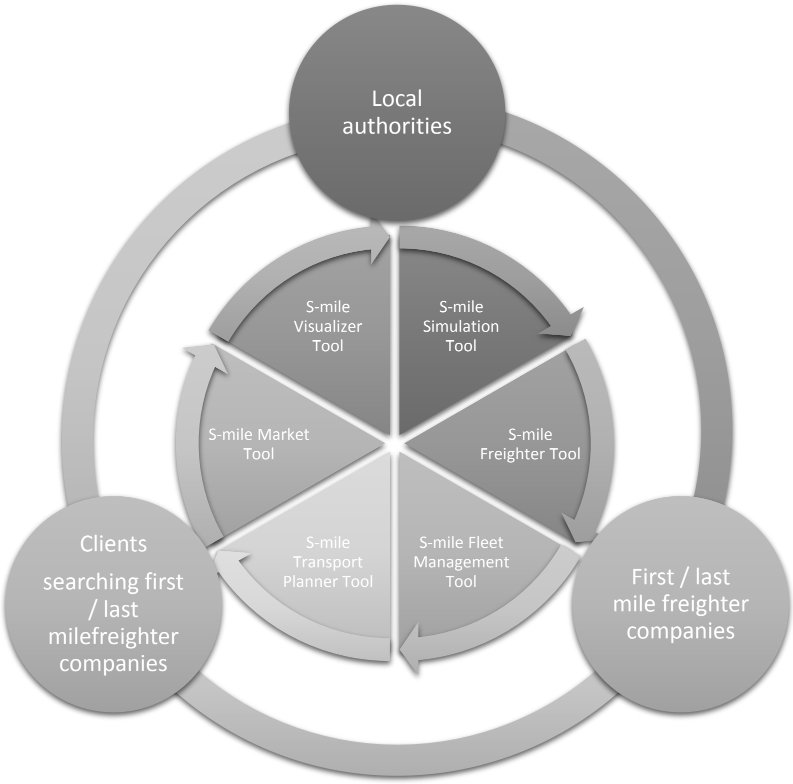

Fig. 1. Proposed modules of the S-mile platform involving three kinds of users

The implemented S-mile smart platform will use data servers and many types of mobile devices, such as smartphones and tablets. In the devices will be installed applications (modules/tools), which are universal for ICT infrastructures and will be responsible for collecting data about the transport system and changes in road and traffic conditions. Tips will be shown on the display screen of the mobile devices in order to foster more efficient, pro-ecological and cost-effective freight transport in the areas at the first and last mile.

One of the possible functionalities of the platform is shown in Figure 2, namely, the concept of a system operation for two freight transport route options. The red route shows that there will be a negative impact on the environment because it will involve travel through the city. As the green route will travel along the highway in order to bypass the city, this will be indicated as a pro-ecological option.

On the S-mile smart platform, the freight transport planner tool is a key module of the proposed system and will support the option of multiple shipments in one direction, as well as facilitate route optimization according to whichever is quicker, shorter and greener.

Additionally, road conditions and traffic data will be taken into account in the routing algorithm. The main goal of planning freight transport is to distribute goods with intermediate points for defined criteria:

1. Minimize the distance along the route:
   - with the option of changing the order of points
   - without the option of changing the order of points
2. Minimize the time of transportation:
   - with the option of changing the order of points
   - without the option of changing the order of points

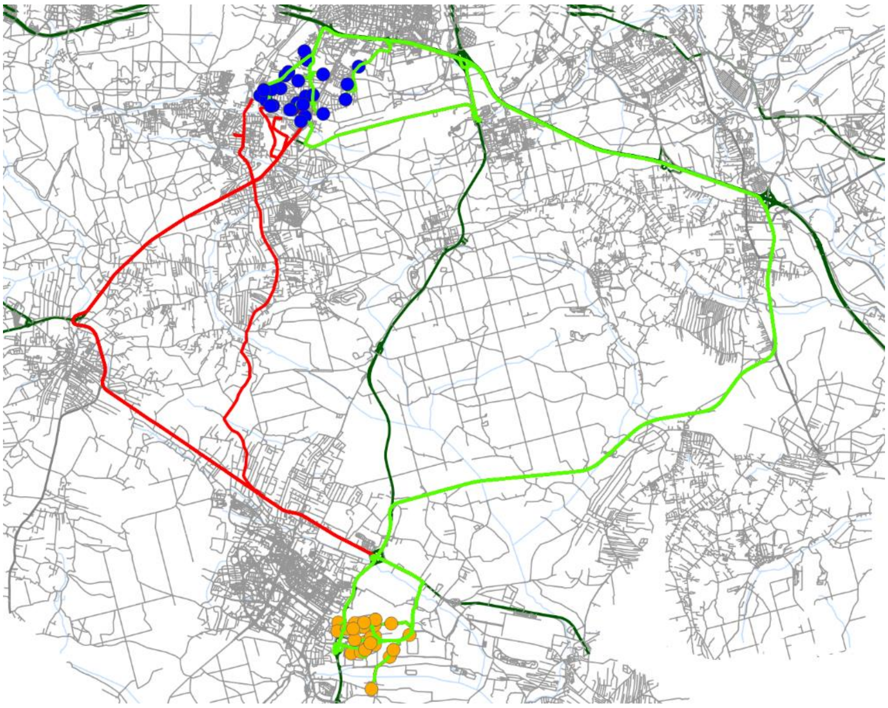

Fig. 2. Concept of two different freight transport routes [25]

Although the system will display many solutions as a part of the response list of routes, it will ultimately propose the one with the lowest level of emissions, namely, the pro-ecological route. The route including intermediate points will be described by parameters of time, distance and emissions. Any users of the platform will have the option of adding fixed start and end points, as well as intermediate points, which are the order points in the supply chain.

In order to determine the optimal route for freight transport, all potential freighter companies using the S-mile platform will have to define the parameters characterized by:

- payload (in certain units, e.g., a palette) and its maximum load
- the time taken to load or unload at various points
- dimensions (width and height) of a vehicle and the vehicle weight
- type of fuel (gasoline, oil, LPG, CNG, electric etc.)
- average fuel consumption (for determining emissions)
- year of manufacture of the vehicle (for estimating emissions)

Online data about options along the planned route will provide crucial information for drivers of transport companies. The drivers using the S-mile platform can update the route online in relation to the state of the roads, thereby ensuring fast and reliable journeys, improving connectivity, facilitating seamless connected travel, supporting the option of multiple shipments in one direction and the optimization of the route, by taking into account road surfaces and traffic conditions. As such, this freight transport planner tool ought to analyse the following parameters, which are determined in relation to a section of road:

- maximum width of the vehicle
- maximum vehicle height
- maximum weight of the vehicle
- speed limit

3. CONCLUSION

The proposed S-mile smart platform represents a useful concept to support the planning, organization and realization of freight transport, as well as shaping people's behaviours connected with the transportation of goods. The platform's stakeholders, such as customers, drivers, freight companies, logistics centres and local authorities, will be educated in the spirit of the sustainable development of the transport system. Promotion of environmentally friendly behaviours will be the main element of the platform scope. The planning and organization of freight transport, as a result of the platform's operation, will reduce the negative impact on the environment, while ensuring that there is no increase in costs.

One of the objectives of the S-mile project is that the routing algorithm, one of the main platform tools, must optimize the routes, not only in terms of time and cost criteria, but also the criterion about limiting the emission of harmful factors. By presenting the results regarding the means or routes in freight transport, including pro-ecological solutions, should be helpful to every stakeholder seeking to choose the option that will best protect the environment.

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The National Centre for Research and Development

S mile

References

1. Bowersox Donald, David Closs, M. Bixby Cooper. 2002. *Supply Chain Logistics Management: Second Edition*. New York: McGraw-Hill.
2. Celiński Ireneusz, Grzegorz Sierpiński. 2013. "GSM network telemetric capabilities supporting the construction of modal split focused traffic models". *Journal of Intelligent Transport Urban Planning* 1(1): 29-40.
3. Chen-Tung Chen. 2001. "A fuzzy approach to select the location of the distribution center". *Fuzzy Sets and Systems* 118(1): 65-73. DOI:10.1016/S0165-0114(98)00459-X.
4. Chopra Sunil, Peter Meindl. 2007. *Supply Chain Management: Strategy, Planning and Operation*. Gabler. ISBN 978-3-8349-0519-2. DOI: 978-3-8349-0519-2.
5. United Nations. 1987. *Report of the World Commission on Environment and Development: Our Common Future*. Available at: http://www.un-documents.net/wced-ocf.htm.
6. Dong Kaifan, Haomiao Li. 2012. "Study on distribution center location model based on economics and timeliness". *Advances in Mechanical Engineering and its Applications* 3(1): 263-267. ISSN 2167-6380.
7. European Platform on Mobility Management. "Homepage". Available at: http://www.epomm.eu/index.php.
8. Esztergár-Kiss Domokos, Csaba Csiszár. 2015. "Evaluation of multimodal journey planners and definition of service levels". *International Journal of Intelligent Transportation Systems Research* 13(3): 154-165. ISSN: 1868-8659. DOI: 10.1007/s13177-014-0093-0.
9. European Commission. 2012. *Action Plan on Urban Mobility*. Available at: http://ec.europa.eu/transport/themes/urban/urban_mobility/action_plan_en.htm.
10. European Commission. 2013. *Clean Power for Transport: A European Alternative Fuels Strategy*. Available at: http://ec.europa.eu/transport/themes/urban/cpt/index_en.htm.
11. European Commission. 2001. *White Paper: European Transport Policy for 2010: Time to Decide*. Available at: http://ec.europa.eu/transport/themes/strategies/doc/2001_white_paper/lb_com_2001_0370_en.pdf.
12. European Commission. 2011. *White Paper: Roadmap to a Single European Transport Area - Towards a Competitive and Resource Efficient Transport System*. Available at: http://ec.europa.eu/transport/themes/strategies/doc/2011_white_paper/white_paper_com(2011)_144_en.pdf.
13. Stadtler Hartmut. 2002. *Supply Chain Management—an overview*. Berlin Heidelberg: Springer. ISBN 978-3-662-10144-5. DOI: 10.1007/978-3-662-10142-1_2.
14. Mallinckrodt Jack. 2010. "VCI: a regional volume/capacity index model of urban congestion". *Journal of Transportation Engineering* 136(2): 110-119. ISSN 1943-5436.
15. Jacyna Marianna, Jolanta Żak. 2013. "Selected aspects of the model of proecological transport system". *Journal of KONES Powertrain and Transport* 20(3): 193-202.
16. Lee Hau L. 2004. "The triple: a supply chain". *Harvard Business Review* 82(10): 102-12.

17. Lixing Yang, Ji Xiaoyu, Gao Ziyou, Li Keping. 2007. "Logistics distribution centers location problem and algorithm under fuzzy environment". *Journal of Computational and Applied Mathematics* 208(2): 303-315. DOI: 10.1016/j.cam.2006.09.015.
18. Maciejewski Marek, Waldemar Walerjanczyk. 2006. "Dynamic optimization system of distribution process for SMEs based on GIS, GPS and metaheuristic algorithms". In *Polish-German Networking Day (Transportation and Mobility)*, Szczecin, Poland, 2006.
19. Mirchandani Pitu B., Richard L. Francis. 1990. *Discrete Location Theory*. New York: John Wiley & Sons. ISBN: 978-0-471-89233-5.
20. Nagurney Anna. 2010. "Optimal supply chain network design and redesign at minimal total cost and with demand satisfaction". *International Journal of Production Economics* 128(1): 200-208. DOI: 10.1016/j.ijpe.2010.07.020.
21. Narbuntowicz Eugenia, Waldemar Walerjańczyk. 2003. "Simulation method of public logistics center localization in Poznan city". In *First International Industrial Simulation Conference, The European Simulation Society*: 276-280. Valencia, Spain, 2003.
22. Sierpiński Grzegorz, Ireneusz Celiński, Marcin Staniek. 2014. "Using trip planners in developing proper transportation behavior". In *International Conference on Traffic and Transportation Engineering International Science Index* 8(11): 482-490. 13-14 November 2014, Venice, Italy. eISSN: 1307-6892.
23. Sierpiński Grzegorz. 2011. Integration of activities as a method to the sustainable mobility. In *Contemporary Transportation Systems: Selected Theoretical and Practical Problems - New Culture of Mobility*, edited by Janecki Ryszard, Grzegorz Sierpiński, Gliwice: Publishing House of the Silesian University of Technology. Monograph no. 324.
24. Sridhar Tayur, Ram Ganeshan, Michael Magazine. 2012. *Quantitative Models for Supply Chain Management.* New York: Springer Science and Business Media. ISBN 978-1-4615-4949-9.
25. Staniek Marcin, Grzegorz Sierpiński, Ireneusz Celiński. 2015. "Shaping environmental friendly behaviour in transport of goods: new tool and education". In *Eighth International Conference of Education, Research and Innovation*:118-123. 16-18 November 2015. Seville, Spain. ISBN: 978-84-608-2657-6.

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