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Smart Transport System, Its Layers and Safety

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In this article, we present our view on the Transport System of a city as a system, consisting of four layers: aesthetic, functional, safe and smart. We define the layers and describe their relationships. Getting deeper into the system and features needed in every layer are summarized. In the following part, we will introduce some smart and safe transport solutions, applied in the city of Žilina, solutions from Finnish city of Tampere, that is one of the smartest middle-sized cities in Europe, and also few more examples from around the world. In the last part, we take a look at the futuristic plans for the transport systems, represented by autonomous driving from the safety point of view.

Keywords: transport, Smart City, Safe City.

1. INTRODUCTION

The concept of Smart City covers many fields of the city development. One of the most prioritized fields is transportation and it is one of the systems of the Smart City concept. Higher purchase power and demand for transport means rising amount of cars on the roads. That supports higher and higher air pollution and traffic congestion. Due to these and other reasons, smart traffic solutions are an important part of every modern city. Moreover, as traffic system does not mean only roads, cars, busses and their timetables, but also every commuter and his/her mobility habits, it is clear that new – smart ideology of transport will affect us all.

2. SMART TRANSPORT SYSTEM

Transport is probably the most discussed city system in the smart development pursuit and one of the most important systems, when it comes to urban area functioning. It affects all citizens and almost all administrative and business bodies within the city in many ways, such as pollution, street congestion, travel times across the city and so on. Benevolo et al (2016) use the term Smart Mobility and they consider it to be „a complex set of projects and actions, different in goals, contents and technology intensity“ [1].

2.1. IMPACTS AND APPROACHES OF SMART TRANSPORT

Its importance can be seen from the fact, that inadequate transport systems constrain a city´s economy and vitality and can cause a loss of valuable space. Therefore dealing with transport needs to be tied with the housing and land use policy. It also needs to take into account the density of the city. The most dense points are becoming the centres, where it is the most convenient to gather shops and services, so that no one has to walk – or drive great distances to get where they need to. From this point of view, we may say that smart and sustainable city should be dense [2].

It is up to debate if this theory does not collide with other systems of Smart City.

With transport and density comes the problem of so called last mile. Last mile is the term that describes the transport of people and goods from a transportation hub to the final destination - home of any citizen. As the settlements are further from the city centre which are less dense, that „last mile“ is a more problematic part of transport than the rest of the delivery. Smart Transport system is expected to bring solutions also to this problem. A possible solution is often seen in bicycle sharing systems. Problems with establishing such a system

were shown in the case study of Beijing by Liu et al (2012): unreasonable distribution of bicycle stations, lack of safety on cyclist, deteriorated conditions of public bicycle equipment, unattractive fare and inexplicit policy orientation [3]. One of these reasons – namely unreasonable distribution of bicycle stations – caused bicycle sharing system in Bratislava to be shut down in less than a day of service [4].

A different approach than crowding people at one centre is building streets in such a way, that every street will represent homes, shops, restaurant and offices, so that people do not need to spend much time, money and energy on travelling across the city on an everyday basis, thus creating more local, smaller centres [2].

The question is whether cities are successful in this approach, how it affects the income (and sustainability) of urban mass transportation?

2.2. DEFINING SMART TRANSPORT SYSTEM OF A CITY

The system of transport within the city, as well as other systems, consists of more layers, portrayed in figure 1. The first, basic layer is the functional one, that consists of basic features, that serve for transport, without any further intention to specifically address the safety or smartness of its use. Measures taken to ensure safety of transport, are features of the safe layer. And finally, smart layer of transport system covers features, that aim to transform the system accordingly to the philosophy of Smart City concept. As Smart and Safe concepts are partially blended together, some components may belong to more than one layer.

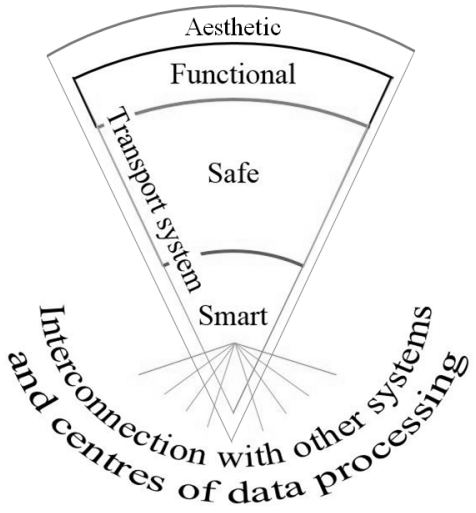

Fig. 1. The City Transport system and its layers (own creation).

From the Smart City point of view, where the Smart Transport system is one of the main systems of the concept, we address mainly the smart layer of the system and we define this layer in a similar way as the Smart City concept itself.

The Smart Transport layer is the part of the Smart Transport system, so by the integration of smart technology, planning and construction increases the effectiveness of transport and movement of citizens and goods in the city and surrounding region, which results in reduction of transport times, noise, costs, unnecessary economic charges and traffics congestion, and which minimizes air pollution and allows simple access to any public area through the city, even for people with special needs.

As well as the other systems of Safe City, the Smart Transport system also partially belongs to the concept of the Safe City with its safe layer.

The safe layer of the Smart Transport system by the use of technology, planning, construction, traffic rules and supervision minimalizes the amount of various traffic accidents in order to increase the safety of all traffic users and means of transportation and safety and integrity of traffic infrastructure.

The layers of the Smart Transport system should include the following features:

- Functional layer:
  - quality roads and other transport lines, bridges and tunnels,
  - means of transportation,
  - road signs,
  - data.
- Safe layer:
  - traffic rules,
  - safe parking systems,
  - data monitoring sources from critical parts of infrastructure,
  - tools for prediction of impacts of various crisis phenomena on traffic and planning of evacuation and backup routes.
- Smart layer:
  - UMT (urban mass transportation) systems: UMT preference traffic, with effective back-to-back connections and possibility to adjust services in order to meet changing commuter needs,
  - preference and support of emission-free vehicles, bicycles and pedestrians,
  - smart parking systems,
  - effective road signs and traffic lights system with real time adjustments,

  - real time informational tools for traffic consumers,
  - intelligent tools for collection and work with data, planning and prediction of results of changes in the traffic,
  - drone management,
  - solutions for shortening everyday travel needs.
- Design and other features.

Due to the fact that cities were designed mostly with cars in mind, it is very difficult to reorient the nature of the city, where automobiles were made the most practical mode of transport. However mixed use and transit oriented development are becoming a must [2].

3. SMART AND SAFE TRANSPORT COMPONENTS

Among components and solutions already implemented in the cities, we can notice many components, improving safety of transport. Traffic rules themselves are one of those. Recent years brought also smart solutions to the system and we will introduce some of those in this chapter. But the merge of safe and smart approach brings new possibilities, rarely implemented yet.

3.1. ŽILINA

The aim of the smart and safe parking system implemented at the University of Žilina is to decentralize the supervision on the parked cars in order to enable the end user the direct supervision over his/her own vehicle and thus reducing the idle time between the crime and the reaction. A patented camera system is able to recognize the movement of specific vehicles and to alert the owner about the unauthorised movement of his/her own vehicle. An owner is also able to log into the system to see his/her vehicle, or to find an empty slot for parking [5].

Another solution is under development in the Laboratory of Simulation and Modelling of Crisis Phenomena in Transport. By the use of simulation we are able to view possible outcomes, support the decision making during the response and reaction to a crisis phenomena (not only in traffic), and strengthen the preparedness of executives for such situations.

3.2. TAMPERE

UMT of Tampere consists of diesel and electric busses. Right now there is a construction going on, that should bring also light tram route with facilities, tram stops and new fibre backbone network, built along the tram line [6].

For holistic and reliable insights on people behaviour, transportation, urban planning and experience, Tampere uses Telia's Crowd analytics. Together with authorities, universities, companies and research centres, Tampere developed Mobility Innovation Test Areas [6].

City light poles are about to get upgraded to smart light poles during the next 5 years [6].

Citizens of Tampere, as well as citizens of other Finnish cities will have the chance to participate in project, that aims to increase already high cycling habits up to 30% until the end of 2021. After the final acceptance of the programme, 16.3 million euro should be assigned for that purpose. Through the program, participants who will fill in the online form, will be given a donation to buy an electric bicycle [7, 8].

3.3. THE WORLD

In order to lower emissions and to dissuade drivers to enter certain parts of cities, various measures were taken [2]:

- congestion pricing - Stockholm, Singapore, London,
- vehicle quotas through auctions or lottery systems – Beijing,
- license plate restrictions - Mexico City,
- low-emission zones parking restrictions – Singapore,
- car sharing.

Naturally, people are often not pleased by any kind of restrictions or services getting more expensive. It is needed to ensure that the people know the big picture. And also, the people need to feel, that their money is getting back to them in a form of real changes and new smart, but mainly useful possibilities.

For the support of pedestrianism and cycling, various cities perform the following activities [2]:

- promoting density,
- aiming for deceleration of vehicles,
- pedestrianizing core areas of the cities,
- building bicycle sharing points,
- building supporting infrastructure.

When building such solutions, executives need to hear out the commentary from the society to meet their needs and expectations as much as possible, to avoid the above mentioned situation, when the bicycle sharing points were, according to society, distributed inappropriately [4]. If a society will be integrated in the development, the results will be much more likely to suit the needs of citizens and they will be more likely to actively use given possibilities, instead of using private cars.

4. TRANSPORT OF THE FUTURE

Probably the most monitored and controversial attempt in the field of futuristic transport is autonomous driving. Cars without the need of human driver are said to significantly reduce traffic accidents, as the most common cause of traffic accident is human failure. However, there are still many issues that need to be addressed before the autonomous cars are able to become equal or superior mode of transportation.

One of these is the current state of existing infrastructure. It would require great investments into infrastructure, if we wanted to eliminate imperfections on the roads and there is no way to ensure that all the roads will stay in such renewed condition at all times. The dependence on the perfect road condition would be a great safety issue. To make autonomous vehicles function reliably on roads with imperfections and missing or unclear lane markings is a big challenge for researches and companies. Possible way of keeping the lane is „positioning with respect to other vehicles, guard rails, and barriers, with input from several sensors and 3D maps“ [9].

The road and highway infrastructure as we know it was designed for human drivers. Nowadays solutions might need changes in order to be more suitable for computer driven vehicles. Among the changes, lane width is discussed by Karim (2015): „Lanes dedicated to self-driving vehicles will not require additional width to accommodate for human error. Lane width could be closer to actual vehicle width, and be reduced by as much as 20 percent... For mixed traffic situations, reductions even to ten feet could also benefit conventional cars, pedestrians, and bicyclists, because they discourage risky driving behaviour and lower vehicle speeds, thus increasing safety“ [10].

5. SUMMARY

And such might be the first steps of humanity, slowly starting to conform to machines, and they do not have to be even fully intelligent. Sure, autonomous vehicles have many advantages that make this technology worth some changes, but do we want to force human drivers out of the roads in the future? Do we want to make roads more safe (lowering vehicle speeds) by decreasing safety, when the vehicle is driven by a human (reduction of lane width)? And after we will succesfully present autonomous vehicles, should we disable the chance of living passenger to turn off the autopilot and to take over the control of the car? Another safety oriented question is, how are we going to deal with the cases of traffic accident, caused by autonomous driving car?

For the last question, the community will have to find the answer soon, as before the finishing of this article this very situation unfortunately occurred, and not only once. An autonomous car of a popular taxi service Uber was being tested on the streets of Tempe, a city in Arizona, when it hit the pedestrian, who later died in the hospital [11]. Sadly, it is not the first victim in the pursuit of autonomous vehicle development. Back in 2016, semi-autonomous Model S of famous Tesla Motors Company crashed into the truck while autopilot was active and the man inside died. However, no legal actions against Tesla were taken. The autopilot warned the driver 7 times, that he should hold onto the wheel, but the man ignored the warnings [12].

Smart Transport system can improve the life in cities greatly, but as well as in any other system, we need to carefully think about the safety point of view and consider pros and cons of those solutions. Transport is a part of development that can be done by administrative and business bodies but the best results will be brought, if citizens are informed about the vision and idea behind the changes. Active participation of citizens in the smart development is a very important factor in every system of the smart city concept.

REFERENCES

[1] Benevolo C., Dameri R. P., D´Auria B., *Smart Mobility in Smart City*. 2016. In Empowering Organizations (Enabling Platforms and Artefacts), p. 13-28. Springer International Publishing, ISBN: 978-3-319-23783-1

[2] Can a city be sustainable? (State of the world). 2016, The worldwatch institute, Island press,

Washington, DC, ISBN 13: 978-1-61091-755-1, ISBN 10: 1-61091-755-3, 448 pages,

[3] Liu Z., Jiab X., Cheng W., *Solving the Last Mile Problem: Ensure the Success of Public Bicycle System in Beijing.* 2012 [online: cit 14-3-2018]. Available at: https://www.sciencedirect.com/science/article/pii/S1877042812009603

[4] Ambrozová M., *Bratislavský bikesharing pod vlnou kritiky. Prvá stanica pre bicykle nevydržala ani* deň. 2018 [online: cit 14-3-2018]. Available at: https://www.startitup.sk/local-bratislavsky-bikesharing-pod-vlnou-kritiky-prva-stanica-pre-bicykle-nevydrzala-ani-den/

[5] Holečko P., Janota A., Pirník R., Hruboš M., Vívodík M., *Inteligentné technológie z pohľadu UNIZA (Inteligent technologies from the University of Žilina point of view).* 2017. [online: cit 11-7-2018]. Available at: https://www.archinfo.sk/diela/teoreticka-praca/inteligentne-technologie-z-pohladu-uniza.html

[6] Blomqvist T., Smart Tampere. 2018. Presentation, Studio Libeskind, Tampere, 15p.

[7] Vitkovský R., *Fínsko chce obmedziť počet automobilov. Vláda „daruje" ľudom peniaze na bicykle*. 2018 [online: cit 9-4-2018]. Available at: https://www.startitup.sk/finsko-chce-obmedzit-pocet-automobilov-vlada-daruje-ludom-peniaze-na-bicykle/

[8] Välimaa M., *Jokaiselle sähköpyörän ostajalle tulossa 400 euroa valtiolta – jopa kymmeniä prosentteja pyörän hinnasta*. 2018 [online: cit 9-4-2018]. Available at: https://www.helsinginuutiset.fi/artikkeli/620316-jokaiselle-sahkopyoran-ostajalle-tulossa-400-euroa-valtiolta-jopa-kymmenia

[9] *Planning for Connected and Automated Vehicles.* 2017. Public Sector Consultants and Center for Automotive Research. [online: cit 12-7-2018]. Available at: http://www.cargroup.org/wp-content/uploads/2017/03/Planning-for-Connected-and-Automated-Vehicles-Report.pdf

[10] Karim, Dewan Masud. June 2015. "Narrower Lanes, Safer Streets." Presentation, CITE Conference Regina In *Planning for Connected and Automated Vehicles.* 2017. Public Sector Consultants and Center for Automotive Research. [online: cit 12-7-2018]. Available at: http://www.cargroup.org/wp-content/uploads/2017/03/Planning-for-Connected-and-Automated-Vehicles-Report.pdf

[11] *Self-driving Uber kills Arizona woman in first fatal crash involving pedestrian*. 2018. The Guardian news. [online: cit 12-7-2018]. Available at: https://www.theguardian.com/technology/2018/mar/19/uber-self-driving-car-kills-woman-arizona-tempe

[12] *Man killed in Tesla 'Autopilot' crash got numerous warnings: Report.* 2017. CNBS online news. [online: cit 12-7-2018]. Available at: https://www.cnbc.com/2017/06/20/man-killed-in-tesla-autopilot-crash-got-numerous-warnings-report.html

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