

Mobility in Smart City

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Abstract— The smart cities have become emerging phenomena with rapid urban growth and boost in the field of information technology. The concept of the “smart mobility” has become something of a buzz phrase in the planning and transport fields in the last decade. After a fervent first phase in which information technology and digital data were considered the answer for making mobility more efficient, more attractive and for increasing the quality of travel, some disappointing has grown around this concept: the distance between the visionary potential that smartness is providing is too far from the reality of urban mobility in cities.

Key words: Smart City, Mobility

I. INTRODUCTION

Starting from this, the study critic the smart mobility approach and applications and argues on a “smarter mobility” approach, in which technologies are only one aspects of a more complex system. With a view on the urgency of looking beyond technology and beyond consumer-oriented solutions, the study arguments the need for a cross-disciplinary and a more collaborative approach that could supports transition towards a “smarter mobility” for enhancing the quality of life and the development of vibrant cities. The smart city is designed, constructed, and maintained by using highly advanced integrated technologies, that include sensors, electronics, and networks which are linked with computerized systems comprised of databases, tracking, and decision-making algorithms [1]. Smart City is considered like a winning urban strategy using technology to increase the quality of life in urban space, both improving the environmental quality and delivering better services to the citizens [2]. Several academic papers have been written about smart city, smart strategies and smart initiatives, interesting a very large set of topics: from waste treatment to air quality, from green energy production to buildings energetic efficiency, from open data to e-government in smart city. The smart city hence promises smarter growth. It is said that proper investments in developing the systems of a city through embedded technologies will help in immense growth in economic system as well [3].

There are certain pioneering cities that are considered as the next generation smart cities.

Due to the complexity of the urban mobility scenario, the aim of this paper, which operates a multiple level classification of a large number of Smart Mobility initiatives due to a deep literature review, is trying to provide an overview of this area through the proposal of an action taxonomy considering three aspects:

- 1) Smart Mobility actors: who are the main agents moving the smart initiatives;
- 2) Use and intensity of ICT in Smart Mobility initiatives;
- 3) Goals and benefits of Smart Mobility actions on smart goals.

II. CONCEPTS OF MOBILITY & ARCHITECTURE

A. Mobility Concept

The negative implications of our modern car centric world include environmental problems and the congestion that results when large numbers of people give priority to their own comfort when getting from place to place.

On the other hand, placing too much importance on the environment would impose excessive restrictions on mobility. For example, placing simplistic restrictions on entry by vehicles into a city would likely restrict its growth prospects by being a hindrance to motorists and making it a less convenient and attractive place to live.

To solve this dilemma, Hitachi is not only seeking to optimize specific forms of transportation such as trains and cars, it is also working toward a society based on smart mobility, which optimizes all transportation services by coordinating the different means of transportation within the city.

This will eliminate frustrations related to traffic and smooth the process of getting from place to place while helping create harmony in the form of a sustainable society with a reduced impact on the planet.

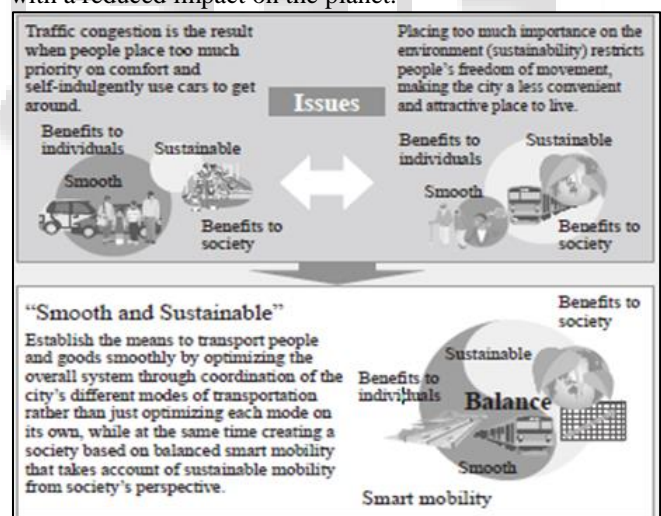


Fig. 1: Overview of mobility concept.

Transportation problems can't be solved by solutions that merely deliver smoothness on its own or sustainability on its own. Rather than optimizing the various different modes of transportation independently, a balanced smooth and sustainable approach is possible by optimizing the overall system.

Hitachi uses the concepts of “smooth and sustainable” to represent this idea of aiming for a win-win society that balances benefits to individuals (providing the comfort sought by people) with benefits to society (providing the practicality, safety, and continuity sought by government).

III. MOBILITY ARCHITECTURE FOR REALIZING SMART MOBILITY CONCEPT

Currently, each transportation company provides its own services. The provision of transportation in a way that realizes the smart mobility concept requires building a network for the coordination of transportation companies, which collects and analyses information from the various companies that operate in the city and supplies each company with information they can use to optimize the overall system. Hitachi believes that building such a network will require an architecture that allows three specific types of optimization to be performed and that spans the five layers of transportation functions that make up a city.

A. Five Layers of Transportation Functions

Hitachi's approach is to consider the elements that make up a society based on smart mobility in terms of the five separate layers listed below, which it calls the "five layers of transportation functions" (see Fig. 2).

1) *Transportation user experience layer (domain of transportation service users)*

Layer in which users receive transportation, information, and other services from transportation companies as they travel from place to place.

2) *Transportation services layer (domain of transportation companies)*

Layer in which transportation companies supply services to users

3) *Information collection layer (domain of transportation companies)*

Layer in which usage information is collected, such as on how users use the services supplied by transportation companies

4) *Information management and control layer (domain of transportation companies)*

Layer in which information management and control is performed to ensure that transportation companies supply their services smoothly

5) *Transportation company coordination layer (domain of transportation companies)*

Layer in which information from all the transportation companies is collected and analyzed, and information is provided to guide the operation, control, and other functions of the transportation companies with the aim of optimizing the city's overall transportation system.

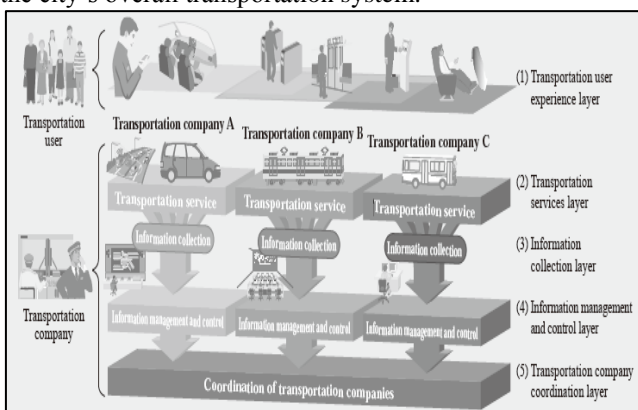


Fig. 2: Five layers of Transportation Functions

B. Six Key themes related to Smart city

Smart Mobility	Smart Economy	Smart Living
<ul style="list-style-type: none"> Improved Accessibility Safe Transportation More efficient and intelligent transportation systems Leveraging networks for efficient movement of vehicles, people, and goods, to reduce gridlock New 'social' attitudes such as car sharing, car pooling, and car-bike combinations 	<ul style="list-style-type: none"> Regional/global competitiveness Entrepreneurship & Innovation Momentum High Levels of Productivity Broadband access for all citizens and businesses for business opportunities Independent of location, helping maintain population in rural areas, Electronic business processes (e.g., e-banking, e-shopping, e-auction) 	<ul style="list-style-type: none"> Better Quality of Life Social Aspects - Education, healthcare, Public Safety, Housing Access to high-quality healthcare services (including e-health or remote healthcare monitoring), electronic health records management Home automation, smart home and smart building services Access to social services of all kinds.
Smart Governance	Smart People	Smart Environment
<ul style="list-style-type: none"> Participatory Decision Making Public & Social Services Transparency Democratic processes and inclusion Interconnecting governmental organizations and administrations Improving community access to services 	<ul style="list-style-type: none"> Social & Human Capital Qualified, Creative and Educated Citizenry Able to utilize the ICT based smart services Delivering a more consistent educational experience in both urban and rural areas e-education solutions (remote learning and collaboration) to have citizens better informed 	<ul style="list-style-type: none"> Pollution Monitoring Use of Sustainable Technologies Environmental/ sustainable /Energy consumption Reducing energy consumption through novel technology innovations while promoting energy conservation and material re-use

Fig. 3: Key themes related to Smart city

IV. SMART CITY INFRASTRUCTURE

Infrastructure of a city comprises of, inter alia, housing, sanitation, water supply and sewage, electric power supply and distribution, transportation, waste management and communication. Smart city infrastructure differentiates itself from the traditional urban infrastructure through its ability to respond intelligently to changes in its environment, including user demands and other infrastructure, to achieve an improved performance¹⁶. Smart City Infrastructure provides foundations to all the six key themes related to a smart city namely, smart mobility, smart economy, smart living, smart governance, smart people and smart environment. But the smart infrastructure components are highly context specific and their nature is determined by the level of development of the cities as well as by the specific developmental challenges.

For a city in a developing country, the immediate need is to provide adequate urban infrastructure to meet the increasing pace of urbanization. Therefore, in the process of meeting these infrastructure demands, smart infrastructure applications provide an avenue for these cities to leapfrog, as shown by a recent study on Africa and smart cities. [4]

Further, these smart infrastructure applications have the potential to provide foundations for new innovations that will promote efficiency and better management of resources. For example, the data generated by new smart mobility infrastructure could provide useful information for redesigning transport networks as well as to build new smart mobility apps.

In developed countries, the challenge is to maintain the legacy infrastructure systems, which cannot be abandoned due to cost, space and other considerations. Here smart infrastructure applications would focus more on facilitating optimal use of these existing legacy infrastructure resources and monitoring of operations of these resources. For example, in Paris, the existing metro network represents a huge legacy infrastructure system[5]. As part of its modernization, automated trains were introduced in Line 1 Paris Metro network, along with new audio-visual systems and information control systems. This led to an additional capacity of 70,000 passengers per day

and major reductions in passenger delays¹⁸. However, in both developing and developed country contexts, the primary motive behind smart infrastructure applications is that they respond to the sustainable development needs of the society.



Fig. 4: Smart City Infrastructure

A. Three types of Optimization

The three types of optimization are “optimization of coordination between transportation companies,” “intra-company optimization,” and “service optimization.” Fig. 3 shows the relationships among these.

To realize the smart mobility concept, “optimization of coordination between transportation companies” and “intra-company optimization” (which means optimizing the respective transportation companies’ services) are performed by using the urban management infrastructure described in the section “Solutions” to collect and analyze actual operational data and provide guidance on what is best for the overall system.

In this way, “service optimization” (which means optimizing the services supplied to users) is achieved along with seamless interoperation between the services supplied by the transportation companies.

This allows transportation users to move about in a smooth and sustainable way without being conscious of the boundaries between transportation companies.

1) Relationship between “service optimization” and five transportation function layers

“Service optimization” consists of the following processes. First, “intra-company optimization” is performed for the services within the domain of a particular company’s business via the transportation company coordination layer and through the information management and control layer. Furthermore, “optimization of coordination between transportation companies” provides smooth and sustainable trips in which the continuity of all travel through the transportation system is guaranteed up until the users reach their destination, without their having to pay undue attention to junctions in the transportation system, such as locations where users can transfer from one company’s service to another (through the transportation services layer to the transportation user experience layer).

In practice, “service optimization” for users involves the three types of control: (1) “Control of demand,” meaning the control of the total volume of the flow of people and goods from point of departure to destination, (2) “Control of supply,” meaning control of transportation capacity provided by transportation companies from point of

departure to destination, and (3) “Control of actions,” meaning guiding people’s actions by supplying information at the point of departure and up until the destination.

In this way, the smart mobility concept means approaching “service optimization” in terms of a mobility architecture consisting of five layers of transportation functions and seeking to create a smooth and sustainable society achieved through three different types of control.

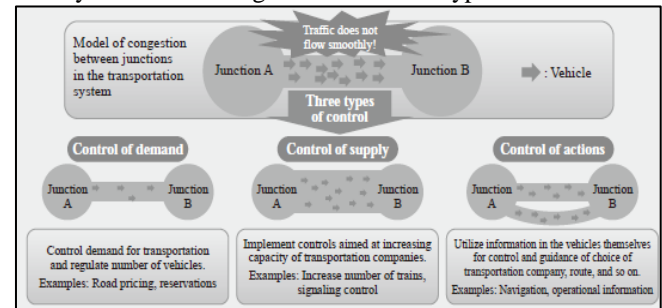


Fig. 5: Three types of optimization

V. SMART MOBILITY ACTIONS AND SMART GOALS

The different groups and the actions composing them, highlighted in the first column, are related to two other macro-variables evidenced in the second and third columns: the intensity of ICT for each action and the goals pursued by 24 C. Benevolo et al.

Such actions[4]. As already pointed out previously, the first macro-column, titled “Intensity of ICT adopted”, has three sub-columns, indicating a low, medium and high level of intensity of ICT. From the intersection between these columns and the rows corresponding to different actions you can then observe the level of intensity of ICT.

It is a systematization of a large number of initiatives discussed in the literature, with an emphasis on ICT[5]. As can be seen from this classification, it can be state that the wide range of initiatives analysed is often but not strictly and necessarily tied to high intensity of ICT. Although the new frontier of innovation is certainly linked to the adoption of mobility solutions for ITS, we can say it is possible to adopt solutions and changes in the system of mobility without the need for large investments or sophisticated technologies. We can therefore argue that ICT is a pivotal, but not necessary technology to start the implementation of Smart Mobility initiatives; its importance however increases when the complexity and the maturity of Smart Mobility projects become higher. In ITS or other integrated Smart Mobility policies, ICT plays a crucial and fundamental role.

The second column Benefits is composed by six sub-columns, regarding the six smart goals The goals highlighted are those pursued through the examined actions. As evidenced in the table, not all cells are complete because not all actions can be associated with a target, while some of them contribute to the achievement of more objectives. Several findings derive from the analysis of the benefits associated to the Smart Mobility actions[6]. First of all, an interesting evidence is the fact that certain actions contribute to the achievement of these objectives more pervasively than others. Looking, for example, at some integrated systems based on ICT such as ramp metering or urban traffic control systems, it is possible to observe a positive effect that affects almost all the objectives underlined. In

this case it is possible to say that the ICT, if properly directed, would seem to have a greater positive benefit than other initiatives. Finally, observing the listed objectives it is also possible to note that these are closely related to those of a smart city as well as to the concept of well-being expressed by the OECD.

In its “Better Life Index”, in fact, the OECD underlines the most important areas that a society has to improve in order to enhance its quality of life. The concept of well-being is wide but it is possible to individuate some common targets to look at: the safeguard of the environment is strictly related to the reduction of PM10 concentrations in the air and greenhouse gas emission and is one of the most important. Also personal safety and a good balance between work and life time are shared goals between well-being and Smart Mobility. It is possible therefore to argue that Smart Mobility directly impacts on the quality of life of people living in cities and to design a link between Smart Mobility actions and well-being indicators. [6]This could be very useful to better support Smart Mobility implementation, especially choosing the most effective actions and prioritizing the ones better impacting on citizens’ well-being.

VI. CONCLUSION

The study gives some insights on the debate on the smart mobility. It provides through a set of selected applications in Belgium the evolution of the concept of smart mobility through a more techno-centre towards a consumer centred one. Solutions to the mobility problem are seen in technological fixes and high tech solutions, such as alternative fuels, intelligent transport systems, integration of information and communication technologies and means of transportation etc. In the face of the outlined challenges of current mobility regimes, mobility scholars tend to see potential solutions in new technologies and their combination, e.g. smart mobilities systems. This study argues that these solutions are not complete and that smart mobility is beyond technology or consumers[5]. Our final thoughts are then stressing that a new concept of smart mobility is necessary that would address the positive, integrated, and sustainable future, as the one described in Figure (British Standard Institution, 2014).

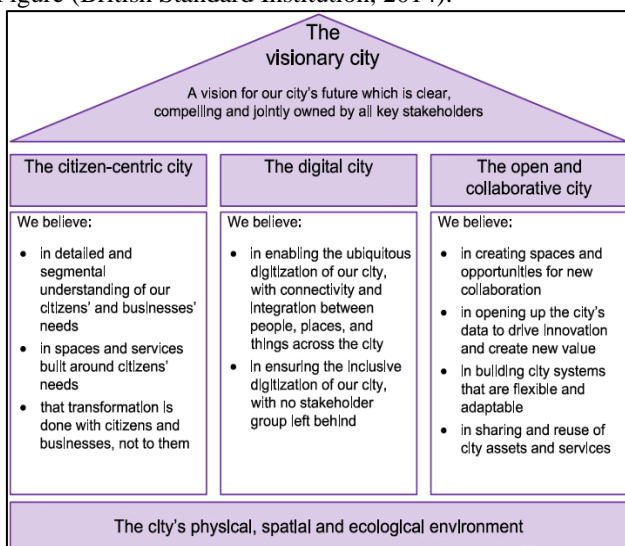


Fig. 6: The city physics spatial and ecological Environment

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