Approaches to Achieve Sustainability in Traffic Management

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Abstract

Transport problems in developed and developing countries are calling for a sustainable traffic management with clearly predefined goals and objectives. This article presents potential approaches to achieve sustainability in traffic management based on international experience. Principles, strategies and approaches for sustainable traffic management are formulated with a due consideration to Intelligent Transport Systems, including its functions and applications in various approaches to achieve sustainability.

Keywords: Transport Problems, Sustainability, Traffic Management, Intelligent Transport Systems

1. INTRODUCTION

Transport problems in developing countries

Every country in the developing world is facing transport problems in capacity, safety, environmental compatibility, and economic efficiency. The problems are significant for both passenger and freight transport. Vietnam does have such problems. Traffic congestions, traffic accidents, and environmental pollutions are challenging the sustainable development of the country. In major cities like Hochiminh City and Hanoi, motorcycles are dominating transport and traffic systems (Hung, 2006). Motorcycle ownership has been increasing at more than 10% per year for the last two decades, so the ownership rate is currently 400 motorcycles per 1,000 people, taking the second rank in the world after Taiwan (about 700 motorcycles per 1,000 people) (Tuan, 2015). Road infrastructure is

limited and growing slowly. In Hochiminh City, land area for transport accounts for less than 2% of the total urban area, thus causing traffic congestions. Time loss per year due to congestions was estimated to be 23 trillion VND (or equivalent to 1.2 billion USD) (Hoa, 2014). Furthermore, traffic fatality rate is extremely high; about 13.4 deaths per 100,000 population and motorcycles are involved in 75% of the total accidents (Tuan, 2015). Traffic is one of the main causes to environmental pollutions in the country. Vehicular exhausts, such as SO_2, HC, NO_2, and PM, are seriously causing health problems. According to Healthcare Ministry of Vietnam (Bộ Y tế, 2012), about 4.1% of the population were suffering from lung diseases, 3.8% pharyngitis and tonsillitis, and 3.1% bronchitis and bronchiolitis, the emission from vehicles is one of the major causes for these diseases. These problems constrain economic growth and social development of the country.

Figure 1 presents various transport problems. If we put them together to a whole picture, we cannot see the transport system that we aim for and which is required by a prosperous society that offers a high quality of life to their citizens. Therefore, it is obvious that transport problems need a due attention.

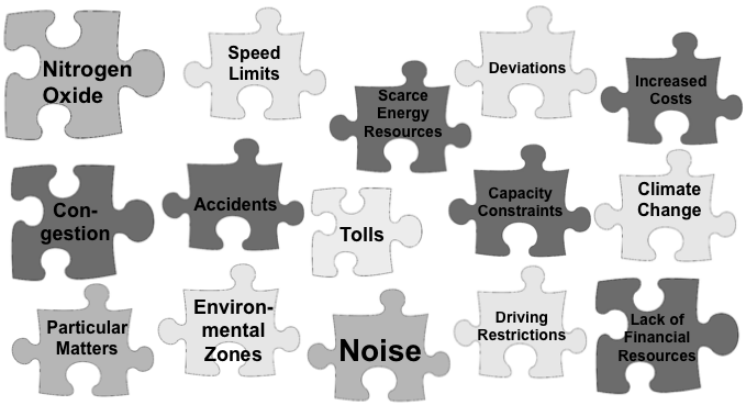

Figure 1: Various transport problems (Boltze, 2013)

The need for Traffic Management and ITS applications

In every country, mobility is a major value to the people because economic activities and social welfare depend on it, and people consider it a major asset of their life, as they can move freely, safely, quickly and at a reasonable expense. So it is commonly acknowledged that mobility should not be restricted. In fact, travel or mobility demand usually continues to increase. But the pace of passenger demand growing depends on socio-demographic developments and

thus we need to carefully specify it for each region and country. Demand for freight transport usually growing at higher rates and dependent on economic growth.

To deal with the transport problems, the first question is always that sufficient infrastructure is important. But providing infrastructure alone cannot solve the problems completely. We must be aware that no country in the world can extend its transport infrastructure to catch up with demand growths. Indeed, for Vietnam and other developing countries the most important question must be for the right infrastructure.

Furthermore, it is important to highlight the aspects related to discussion on measures to increase the capacity. "Capacity" should not be defined by traffic flow characteristics only; instead it must consider other aspects, such as acceptable levels of noise and air pollutions along the infrastructure. Therefore, we need to influence both transport supply and demand, and to balance them as to maximise the positive impacts (or benefits) and to minimise the negative impacts (or costs). The balancing of supply and demand brings about the concept of traffic management, including its goals and objectives.

The Objectives and Structure of this Article

As mentioned, since infrastructure extension alone cannot handle the traffic problems, Traffic Management seems to be an effective strategy to deal with the problems and contributes to achieve sustainable development. Therefore, the objective of this paper is to set a framework for traffic management and also for ITS applications in Vietnam in order to help address the traffic problems at regions level.

It is noted that many of the thoughts in this paper have been followed by the project REMON - Real Time Monitoring of Urban Transport - Solutions for Traffic Management and Urban Development in Hanoi, in which, the study team has been developing a traffic management strategy and ITS applications for Hanoi.

This article is structured as follows. Chapter 2 explains the principles of traffic management, including the concept, goals, and objectives. Chapter 3 introduces ten potential approaches to achieve sustainability. In the context of the

approaches, the roles are highlighted that ITS can and should play to achieve the sustainability. Chapter 4 summarizes and concludes.

2. PRINCIPLES OF TRAFFIC MANAGEMENT

Traffic management influences the supply of traffic and transport systems as well as the demand for travel and transport through a bundle of measures with an aim to optimize the positive and negative impacts of traffic and transport (Boltze, 2013).

As any planned activity, traffic management should follow a specific goal concept for traffic and transport. Figure 2 presents a hierarchical goal concept, including four basic upper goals: mobility needs, traffic safety, environmental protection, and economic efficiency. Usually, there are different stakeholders involving in the discussion of measures for traffic management, such as municipality, general public, travellers, companies, urban services, and contractors. It is important to note that there is usually no difference the goals and objectives as perceived by different stakeholders, but the weight they give to each of the goals and objectives may be different, depending on their views and perspectives. Therefore, it is important to develop a common understanding of these weights for the goals and objectives in our society.

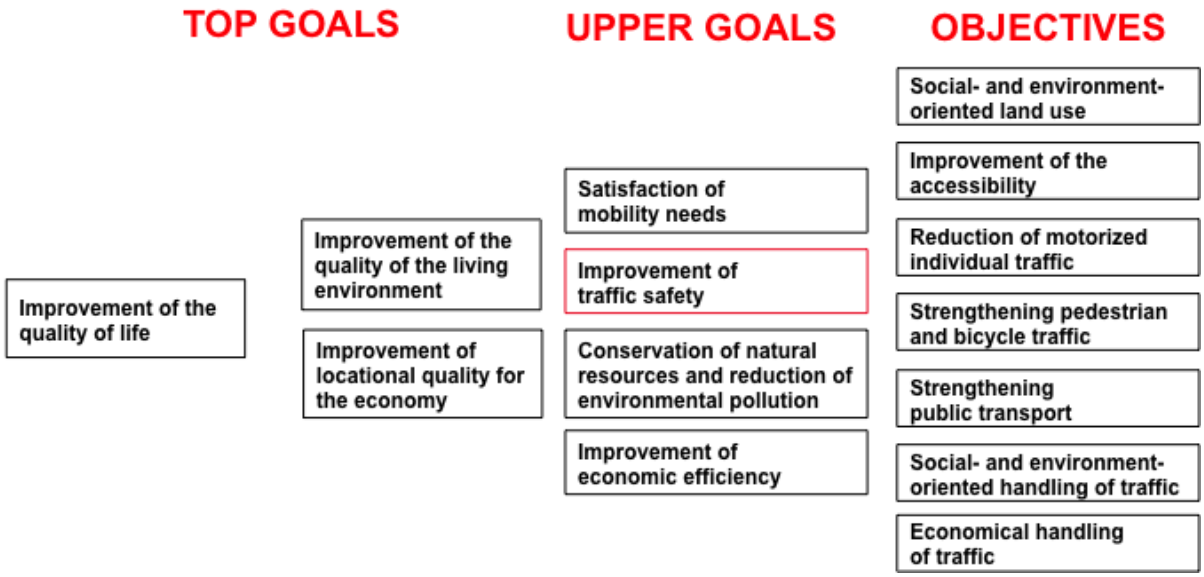

Figure 2: A Goal Concept for Traffic and Transport Systems

(Boltze, Transport Planning and Traffic Engineering, 2012)

Satisfaction of **mobility needs** – the first upper goal – means that we need to ensure the mobility for all transport demands in the coverage area. This goal might be divided into four sub goals, including strengthening public transport and non-motorized transport to provide more choices to the travellers, increasing the capacity of transport supply, and enhancing productivity and efficiency of transport supply (Hung, 2006).

Improvement of **traffic safety** – the second upper goal – means that we need to ensure safety for all traffic movements performed by diverse transport facilities and services. This goal can be divided into sub goals, such as reductions in number of traffic accidents and accident severity.

Conversation of **natural resources** and reduction of **environmental pollutions** – the third upper goal – may include the following sub goals, namely reduction in air pollutions and noise from transport, reduction in energy use for transport, reduction in green house gas, climate protection, and reduction in urban land use for building transport infrastructures and facilities.

Improvement of **economic efficiency** of the city and region – the fourth upper goal – can be divided into three sub goals, including reduction in total transport and logistics costs, increase in economic productivity and efficiency, and improvement in economic attractiveness of the city and region.

To pursue the goals and objectives, there are mainly three strategies for managing traffic (see Figure 3),

- **Traffic Avoiding** strategy comprises measures to reduce the total traffic demand in a targeted area. The number of trips per day is one of the main criteria used for evaluating the impact of this strategy.
- **Traffic Shifting** strategy includes measures to switch traffic demand between different modes, time windows, destinations, and routes. Modal split, demand distribution by time, and changes in Origin-Destination transport demand are main criteria used for impact evaluation.
- **Traffic Control** strategy consists of measures that aim to guide and control the movements of vehicles over time and space with an aim to improve traffic safety and efficiency. A ratio between actual traffic volume and designed capacity, average traffic speed, total vehicle delay

time, frequency of traffic accidents, and accident severity are the main criteria to examine the impact of this strategy.

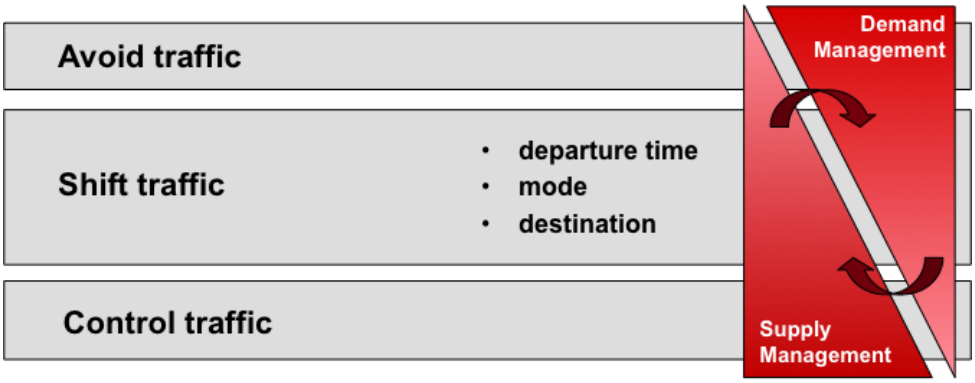

Figure 3 : Traffic management strategies (Boltze, 2013)

3. TEN APPROACHES TOWARDS TRFFIC MANAGEMENT SUSTAINABILITY

Based on the principle of traffic management and international experience in ensuring sustainable transport, we develop ten potential approaches for Vietnam and other countries as summarised below:

Approach 1: Control transport demand

Worldwide experience has shown that the capacity of transport systems cannot be extended to fulfil every demand. Infrastructure extension is not only limited by financial constraints, but also by environmental conditions. One of the keys to avoid at least unnecessary traffic demand is land-use control. Land-use planning should be made in favour of short-distance trips connecting places of human activities, and must reflect the characteristics of different transport modes or systems, including their capacity. Transit-oriented development (TOD) is certainly one of the most effective and long-term strategies in this context. For example, Curitiba, Brazil has successfully integrated transit and land-use planning to achieve its desired settlement patterns. The city has innovated its public transport system so as to create a linear city. The densities of housing and jobs are made higher in transport corridors with exclusive busways in the centre, and urban expressways used by both cars and express buses on either side. The coordination of land-use regulation and transit service has resulted in one of the

highest rates of transit use anywhere. There were about 1.3 million passengers using Curitiba's public transport everyday, and 28% of them shifted from cars (Goodman et al., 2006).

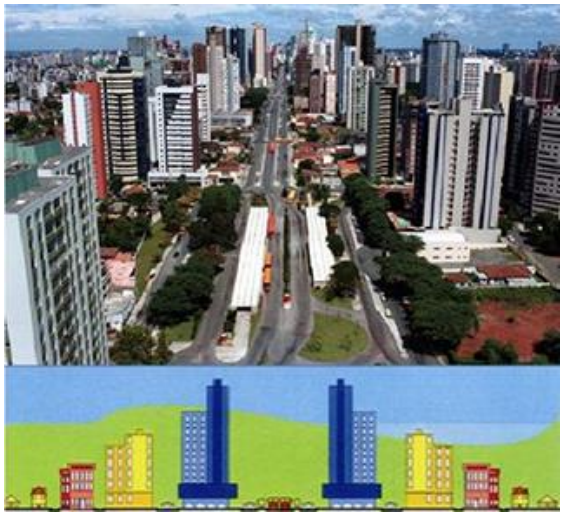

Figure 4: Curitiba successfully focusing urban developments along mass transit corridors (World Bank, 2014: http://blogs.worldbank.org/transport/comment/reply/655)

In daily operation, traffic management should control the demand with specific aims. It should try to influence the departure time to avoid overloads in peak hours. Most recently, Hanoi has applied a flexible time scheme to change the departure time and thus could help reduce traffic volume in peak hours. Furthermore, we should influence mode choice by trying to make people use public transport, bike, and walking instead of riding motorcycles and private cars. We can also influence route choice, and even the choice of trip destination to allow for more efficient and environmentally compatible traffic. Information systems will contribute significantly to optimizing the distribution of travel demand by time and location. Finally, influencing demand must target not only passenger transport but also freight transport as they are interrelated and using the same road infrastructures in many cases.

Approach 2: Control modal choice

Modal choice is important in many aspects; for instance, traffic safety and efficiency can be improved by shifting travellers from dangerous and low-

capacity modes (e.g., car and motorcycle) to safer and high-capacity modes (e.g., train and bus). To do so, we need to apply Push-and-Pull measures with a principle "*Making the modes with lower preference less attractive and the preferred modes more attractive*". The implementation of Push and Pull measures must be coordinated to synergise impacts.

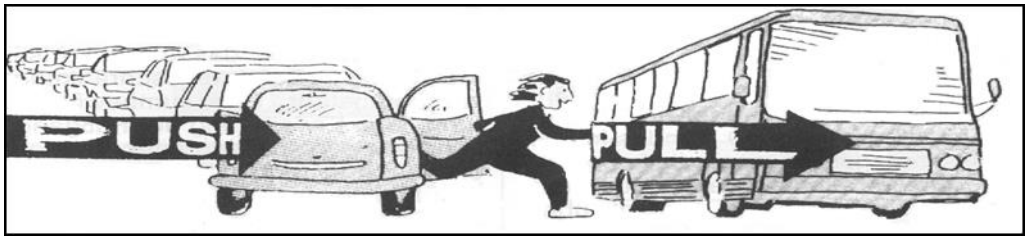

Figure 5 : An Illustration of Push and Pull Measures

(Topp and Pharoah,1994)

While thinking about Push measures and restrictions, we always need to ensure attractive alternatives for the users. Full measures may include, for example, pedestrian zones, safe bicycle routes, and signal priority for buses, separated bus lanes, Bus Rapid Transit (BRT) and Metro System. To attract a large number of passengers, public transport must provide the passengers with shorter travel times, reliable timetables and/or significantly lower costs as compared to private motorised transport modes. For example, in Denmark the government provided financial grants to integrate train and regional bus services allowing passengers across regions to use a single ticket to transfer between modes and giving free passes to children (under 12 years old). This pull policy has contributed to a significant increase in the number of public transport passengers in the country.

We need to prioritise the preferred modes by location and situation because the best modes depend a lot on the location. While individual transport is well compatible and efficient in less densely populated areas, it is impossible to handle the traffic if all the cars go to the city centre. Therefore, we must support the concept of intermodal travel through provision of Park+Ride, Bike+Ride, bike transport in buses and trains, and so forth.

In addition, there are important restrictive (push) measures to control modal choice. For instances, many historic cities in Italy have implemented access

control schemes since the early 1990s; parking management is a powerful tool to influence travel demand; and road pricing is also an important instrument.

Approach 3: Use mobility pricing instruments to control demand

Let's ask a question: In the current situation of Vietnam, what could motivate you not to go in the peak hours with your motorcycle or car, and even what could make you shift to another mode? We guess that it might be congestion. But congestion is really the worst instrument to control demand as it has so many negative impacts on our life and environment. Therefore, we have to find alternatives. Clearly, we can understand that mobility pricing is not only an instrument for financing but also a most efficient tool to control demand.

There are many examples of pricing instruments: vehicle and fuel taxes, city tolls, parking fees, public transport tariffs, public transport commuter pass for students and employees, and so on. Also, demand-actuated or variable prices should be used in public transport, parking, and road pricing. Several transport modes are practicing variable prices to a large extent; In fact, prices of air tickets are higher in peak demand periods with an aim to shift passengers to off-peak demand periods. Unfortunately, so far, most countries have been not thinking about such options for road pricing. Road pricing can influence not only mode choice and spatial distribution of traffic but also the distribution of departure times. In some developing cities, there are intentions to apply simple pricing systems, such as paying a flat rate per day or even per year. Frankly speaking, such a simple pricing scheme cannot help much in controlling the demand.

Singapore has shown greatly success in implementing road pricing. Singapore introduced the area licence scheme in 1975 already with the purpose of reducing traffic during peak periods in the CBD area, and the system was proved highly successful. In 1998, Singapore introduced an electronic road pricing system covering the CBD and a number of urban expressways; there was a huge reduction in the number of vehicles entering the tolled areas at certain times of the day, thereby reducing congestion and improving travel speeds on the whole network (CECD, 2002).

Figure 6 : Electric toll pricing in Singapore

Approach 4: Operate transport infrastructure dynamically and situation-responsive

Traffic demand changes over time and location, but capacity of traffic and transport systems is usually the same. This fact has led to situations in which the demand exceeds the supply, thus causing congestions and environmental degradation. Therefore, it is important to operate transport infrastructure and traffic systems more dynamically in response to changes in traffic demand and other conditions. Available resources in public transport and private transport should be used in a flexible way, depending on time and situation, and on the current mode priorities.

Good examples are tidal-flow systems: traffic-actuated signal control, dynamic speed limits, dynamic route signs, on-demand public transport services, and many others. Obviously, the detection of traffic situations and devising effective control methods are only feasible by employing advanced technologies.

Congestions can be avoided or lessen if counter-measures are taken quickly. Therefore, dynamic traffic management strategies must be planned in advance, evaluated and agreed upon by all stakeholders.

Figure 7 : Motorway lane management to reduce congestion

Approach 5: Promote new concepts of mobility

Individual value system and mobility behaviour are changing, specifically in young generations. Recently, in developed countries we can observe that the affiliated interest in private car ownership and use is decreasing significantly. In the mean time, new technologies are emerging quickly and enable changes in individual value, lifestyle and travel behaviour. The Internet, smart phones, satellite navigation, and new applications (so-called Apps) are playing a major role in the changes. These new technologies allow an easy and spontaneous access to individualised information and services, not only in public transport but also in other transport modes. Examples are traffic information services, multimodal routing services, car rental, car sharing, bike rental, ride sharing, taxi sharing, pedestrian navigation, and so on.

In Vietnam, Uber and Grabtaxi are new taxi calling services using the up-to-date telecommunication technologies. Users can order a taxi by sending a message or by checking a map on his or her smartphone. Once the request has been sent, close vehicles are notified and the closest driver may contact the user. Although the operation of such services is still discussed in term of legal basis, however these services can be considered as new method for individual mobility and may support urban traffic management as well.

Such new developments are also overcoming basic hindrances to intermodal transport. The flexible and situation-responsive mobility services may help reduce traffic problems and thus should be promoted.

Approach 6: Promote the Application of Intelligent Transport Systems

As mentioned, new technologies allow changes in mobility behaviour and support safe, efficient and environmentally compatible operations of traffic and transport systems. Intelligent Transport Systems (ITS) and its applications play an important role in transport as it can help improve traffic flow, road safety, security and crime reduction, public transport, freight efficiency, and environmental impacts.

In developing countries, including Vietnam, high-quality and high-capacity public transport system is an effective and long-term solution to solve the transport problems. ITS applications are playing a dispensable role in improving service quality and integrating different public transport systems and services. Receiving the right information at the right time and in the right place is critical for successful urban public transport, especially in a multimodal transport system. It is hard to imagine the existence of flexible and high-quality urban public transport without the deployment of ITS. Applications of ITS in urban public transport include: (1) pre-trip and in-trip information services via Internet and smart phone; (2) electronic displays on the remaining time that a vehicle will arrive at stop/station; (3) ticket vending machines; (4) electronic tickets; (5) security cameras; (6) electronic information signs; and (7) other passenger information services, such as displaying vehicle location, walking distances between stops, and parking information.

Many ITS systems are already implemented by different stakeholders and for different purposes. However, we usually cannot exploit all advantages of the systems because information and data cannot be exchanged seamlessly between the different systems. Therefore, sustainability in this context needs to address the integration of systems and ensure their compatibility. Furthermore, the emergence of “Big Data” technologies (e.g., Floating Phone Data from mobile networks) can improve traffic data and thus significantly reduce the costs of data collection. A multimodal ITS vision and framework architecture must be provided to allow for an effective development of multimodal traveller services.

We are convinced that the field of ITS needs further attention in every country. ITS applications are well used in developed countries (e.g., Japan, Singapore,

the United States, and European countries like Germany and France). In developing countries, ITS applications are still limited but steadily developing.

In Vietnam, we are implementing a project named REMON (Real Time Monitoring of Urban Transport - Solutions for Traffic Management and Urban Development in Hanoi) as a first step towards the ITS deployment for traffic management in the country. The idea of this project is to detect urban transport conditions in real time. Systems developed under the project include provision of traffic monitoring information to road users, traffic condition, traffic management, and long-term measures to solving traffic - related problems (REMON, 2013). Figure 8 shows an example of traffic assignment in Hanoi; the width of the line indicates traffic volume of the respective road.

Figure 8 : Map of traffic link volumes (REMON, 2013)

The REMON project is also developing an application for mobile devices to generate traffic data and provide real-time information on the current level of service (LOS). It is called REMON Traffic Viewer App for smart phones and it can also run on either iOS or Android operating system. A first version has been tested in the field (see Figure 9). The App is equipped with the standard functionalities to draw a map on a small monitor. Like the standard Traffic Viewer, this App can also show additional information like bus stops, gas stations or automatic teller. Apart from the displaying function, this App is also

designed to collect traffic data especially from motorcycle drivers. While installing the App on mobile phone, the user will be requested to agree on providing information like real-time positions.

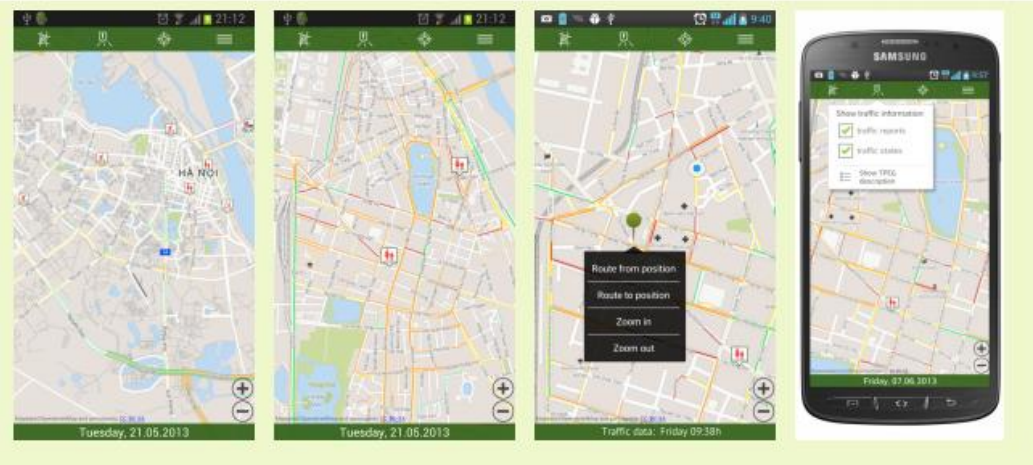

Figure 9 : REMON's App for Android/iOS smart phones (REMON, 2013)

Approach 7: Pay a due attention to traffic safety and environmental impacts

Traffic accidents and fatalities are a serious problem in developing countries, particularly Vietnam. Countries have spent efforts to improve traffic safety and gain some success. But they still need to continue the efforts and further upgrade the efforts to a higher level. Beside this, we must aware that the number of fatalities caused by traffic-related air pollution may far exceed the number of traffic accident fatalities. In the UK, air pollution related fatalities were triple of the traffic accident fatalities (Steve Yim and Steven Barrett, 2012), and the ratio in Germany as well was about approximately 3 times (Boltze, 2013). Though there has been no study on this topic, it is quite sure that the situation in Vietnam and other developing countries is much more severe.

Influencing modal choice, route choice, and driving behaviour has become very important to increase traffic safety and to protect citizens from noise and air pollution. Measures, such as heavy vehicle bans, environmental zones, and speed limits, have been implemented in European cities. In Germany, for example over 70 cities have set up low emission zones (LEZ) (see Figure 10). Drivers, who infringe the regulations, risk a 40 Euro fine and one penalty point on their license recorded at the driver-licensing database.

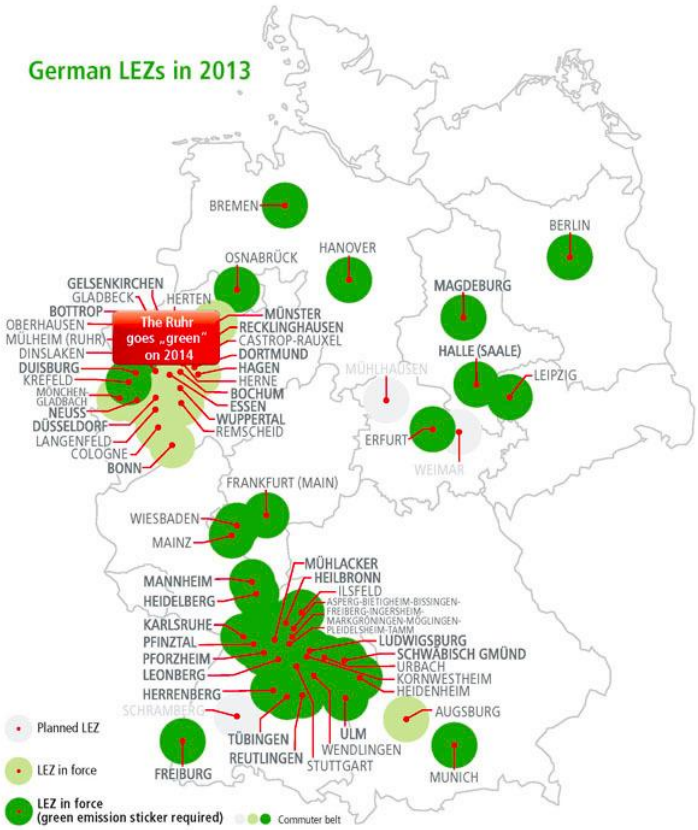

Figure 10 : Low emission zones in Germany (Source: www.berlin-airport.de)

Enforcement is so important for improving traffic safety. Monitoring of speed violations, red light running, and overloaded heavy vehicles show a high potential to improve traffic safety, and clearly it is one of the most applicable areas for ITS. Further, to cope with changing traffic situations, traffic management needs to be dynamic and environmentally responsive. This requires not only traffic control systems but also a comprehensive monitoring of traffic situations and environmental conditions.

Finally, e-mobility can contribute to the lessening of environmental pollutions. In motorcycle-dominated nations like Vietnam, e-bike and e-scooter shall be considered because it bears a good prospective for environmental compatibility. For a significant market penetration of such e-mobility vehicles, appropriate technological improvements, sales incentives, and stringent traffic emission standards need to be in place (Luke et al., 2014).

Approach 8: Make the quality of traffic transparent and improve it continuously

How is the traffic in Vietnam? How is it in Hanoi as compared to other cities in Vietnam and in other countries like Frankfurt (Germany)? Besides your individual impressions, can you give some objective figures on the achieved quality, such as average delay and travel speed? How good is the traffic management? What performance indicators are you using for assessing the public transport system? It is often that the real quality of traffic, especially urban traffic, is not known and hence the interrelations between used resources (the inputs) and traffic quality (the outputs) are not transparent.

Developed countries such as the US and Japan have already established a comprehensive set of traffic performance measurements for the purposes of monitoring, evaluating, and improving the performance of transport and traffic systems.

In principle, independent parties should do such measurements; the execution and supervision should be separated. Frequent quality reports may be used not only within the transport-related institutions but also as a tool for politicians to prove the achieved quality in the overall transport system and to support decisions to allocate resources. In short, like other fields of production and service provision, the principles of quality management should be applied to all traffic and transport systems, including policy-making.

Approach 9: Provide sufficient and sustainable financing of transport

To continuously improve mobility and traffic safety, requires a stronger investment and new approaches to funding for the growing list of transport projects in developing countries. Reducing congestion in cities and delivering productivity and economic growth all rely heavily on an efficient, integrated and safe transport network. Achieving these outcomes will inevitably require a substantial reform to the status quo.

Funding the priority list of transport projects will require increased government revenues, a wider application of user pays, smarter thinking about value capture and innovative private funding, in addition to options such as reinvesting the proceeds from the sale of public assets, to create immediate capacity for urgent priority transport projects. But over the medium-term, fundamental reform will

also be needed, because the current charging/pricing and investment system seems to be inequitable to road users and unsustainable for tax payers.

In many countries, we can observe more and more attempts to introduce road pricing as an instrument for revenue and fund raising. However, road users only accept additional payments if such new revenues are definitely utilized to improve the transport system and not being cut for other expenses. Therefore, the impacts of pricing instruments must be carefully assessed and balanced in each case. Furthermore, we can seek for financing sources from other beneficiaries, such as commercial housing and real estate developers in the neighbourhood.

Approach 10: Create the right institutional framework for intermodal transport

For the convenience of the users, traffic and transport must be a holistic system. The supplies of different systems must be closely coordinated and integrated to allow for a seamless mobility and transport in every situation. It is worth mentioning that London is a good example: an authority called “Transport for London” manages all road traffic and public transport. During the introduction of congestion pricing in London, they were able to optimise the whole urban transport system. The establishment of Transport for London also allowed cross financing, revenues from road pricing could be used to finance the public transport improvements. In some countries, the association of public transport authorities provide a good starting point for further development, but there still lacks of intermodal traffic management authorities. Ultimately, every city needs an integrated traffic management authority that brings together the competences in public transport and road network operations on a regional level.

4. SUMMARY

Since developing countries, including Vietnam, are certainly far from being complete in collecting potential approaches to achieve sustainability in traffic management, the ten mentioned approaches may be a useful reference, including:

1. Control transport demand

2. Control modal choice
3. Use mobility pricing instruments to control demand
4. Operate transport infrastructure dynamically and situation-responsive
5. Promote the Application of Intelligent Transport Systems
6. Promote the applications of mobility
7. Pay a due attention to traffic safety and environmental impacts
8. Make the quality of traffic transparent and improve it continuously
9. Provide sufficient and sustainable financing of transport
10. Create the right institutional framework for intermodal transport

It should be highlighted again that ITS plays an important role in realising many of these approaches towards traffic sustainability. Given the local conditions, specific measures need to be devised under each approach.

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