Intelligent Transport Systems and Services - chances and risks

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The following paper is based on a literature study and internet research, which was done on behalf of the Austrian ministry of traffic, innovation and technology (bmvit). The study had three main aims:

- ✓ To give an overview of telematic systems for different transport modes, which are on the market or close to market implementation
- ✓ To get a general idea of the psychological and socio-scientific aspects of telematic
- ✓ To give an overview of socio-scientific methods in order to evaluate new systems and equipments.

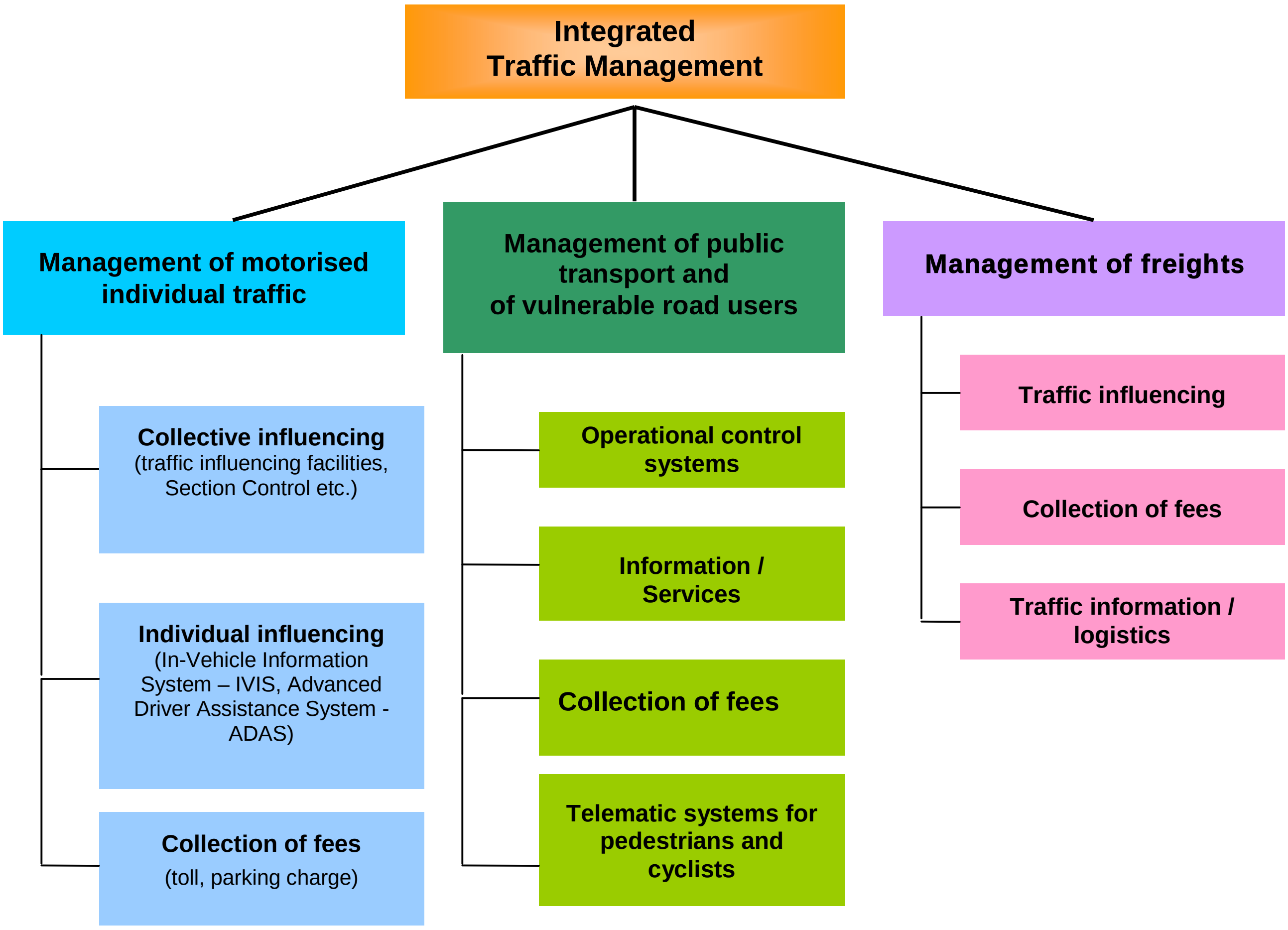
In the following I will concentrate on the psychological and socio-scientific aspects of telematic systems, especially with respect to car traffic. Before that I want to give a short overview of fields of application.

Traffic telematic and fields of application

Using transport telematics means to collect, transmit, process and make use of data relevant for traffic in order to organise and manage the traffic system in the most efficient way. Intermodality has a key function in this context. Transport telematics do not replace an existing traffic system, they only should support the implementation of sustainable traffic strategies.

There is a huge range of telematic systems for nearly all transport modes. The telematic systems can be divided into the following fields of application:

Graphic 1: Fields of application for traffic telematic



Aims of telematic systems

The main aims of the use of telematics are:

- ✓ Increase of traffic safety
- ✓ Increase of efficiency
- ✓ Increase of comfort
- ✓ Contribution to a more environmental friendly/sustainable traffic system
- ✓ Cross linking of different transport modes

With regard to the various transport modes the main focus differs. In public transport area the implementation of new high-tech technology (e.g. prioritising surface public transports at traffic lights, electronic ticketing, information displays etc.) mainly aims at the simplification and acceleration of processes in order to make public transports more attractive and more comfortable for the users.

In commercial transport telematic facilities support above all the more efficient, more economical and environment-friendly use of existing infrastructure (freight-management) and offer customer-friendly ways to e.g. trace goods on their route.

Reducing the number of accidents is one main objective, in motorised individual transport. New technology, however, holds chances **and** risks. The effects of new equipment are still not completely foreseen and can only be predicted in a rather general way.

In general high expectations, that are linked to the use of telematics in traffic are likely not to be fulfilled completely. Traffic is a complex dynamic system. It consists of a large number of single actions. People's actions are the core of the traffic system and they are responsible for the character of the traffic. The efficiency of telematic systems will mainly depend on the sum of the activities of all single road users, viz. how they make use of the system.

Psychological and socio-scientific aspects of transport telematics

Telematic equipment in cars will definitely change the driving conditions and in the long run even the general driving behaviour (see, e.g., OECD 1990). If one wants to implement new telematic systems three main questions have to be clarified from a psychological and socio-scientific point of view:

- ✓ Are potential users willing to use a new system? → **acceptance**
- ✓ Can you expect that a new system will be used in an appropriate way without any negative side effects? → **behaviour adaptation**
- ✓ Does a new system promote equal opportunities for all road users? → **equality of opportunities**

Acceptance

Acceptance is the precondition for the use of an innovative system. Acceptance can be defined as a phenomenon that reflects, to what extent potential users are willing to use a certain system. Whether a system will be accepted or not will depend on the way how user needs are integrated in the development of a system. The personal importance for the users has to be higher valued than the degree of innovation (Franken & Lenz 2004).

With respect to the individual Franken & Lenz (2004) differentiate between *attitudinal acceptance* and *behavioural acceptance.* Attitudinal acceptance means that the innovation is accepted in a cognitive way (e.g. "ISA is a good way to reduce traffic speeds, but I do not need it"). Behavioural acceptance is expressed by actual behaviour (e.g. to buy an ISA-equipped car.)

With regard to the implementation of a new system intensive behaviour and attitude analyses are necessary in order to guarantee that the majority of the road users will actually make use of a system.

Behaviour adaptation

The phenomenon of behaviour adaptation (= possible unintended changes in behaviour, caused by a change in the traffic system; OECD 1990) is most relevant for car traffic. People do not always behave according to rules and instructions. For that reason it is very hard to predict, if telematic systems will actually be used in the wished for-way. The following aspects should be considered and thoroughly evaluated before a new system is implemented:

Risk-compensation

There is a dialectic relationship between risk as it actually exists ("objective risk") and the risk experienced by people, in different situations ("subjective risk"). Many safety problems result from a discrepancy between these two aspects. An increase in objective safety can lead to a disproportionate increase in a person`s feeling of safety, leading to overcompensation and, thus, to a reduction of safety (Wilde 1989).

Delegation of responsibility

If, e.g., an intelligent equipment "takes the responsibility" in difficult driving situations, people tend to delegate responsibility to the system. Thus, it could happen that one relies fully on, e.g., an automatic warning function. A "higher instance" will solve difficult situations and the driver might not any longer feel responsible for his/her behaviour. In emergency cases, e.g. when persons suddenly have to decide themselves, considerable risk due to reduced vigilance could result. Delegation of responsibility in car traffic could lead to high speeds, lack of anticipation for other road users` and actions, short headways, small lateral distances, etc. (Petica & Risser 1998)

Situation awareness

Endsley (1988) defines situation awareness as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their meaning and their status in the near future." New technical equipment, above all IVIS-systems will probably have a negative impact on the situation awareness, as the driver is either physically, cognitively or visually distracted from the real traffic situation.

Imitation

In the frame of the socialisation imitation is one of the main learning mechanism ("learning from a model"). With regard to new systems it may happen that drivers without an equipped car imitate drivers with an equipped vehicle. This can have positive effects (e.g. all people drive slower), but it might lead to dangerous situations for unequipped car drivers, too.

Ambiguity of signals

In traffic one sometimes meets situations where it is not definitively clear what a signal stands for. Often there is time enough to react adequately to a signal in spite of misinterpretation at first. But if speeds get higher, the time to react and to correct ones reactions decreases. The clearness of signals becomes utterly important. One has to make sure that there will be no optical and acoustical signals which could be interpreted ambiguously (Risser 2004).

Behavioural transfer / Behavioural generalisation

People tend to transfer certain behaviour patterns to other spheres of life (e.g. after having driven under high speed conditions on highways one might still drive faster on ordinary roads, without being aware of the danger). Many new technologies aim at accelerating the traffic (Chaloupka 1991).

Communication

Every new piece of equipment in the car that takes up the drivers` attention has the potential to disturb interpersonal communication. Interpersonal communication, however, is very important for the social climate in traffic. Considering others, showing respect for others` needs and interests, etc. are functions of, and indicators for, efficient communication between road users and thus of the social climate in traffic. The role of verbal communication is thereby rather subordinated. Non-verbal signals prevail (Varhelyi et al. 2004).

Equality of opportunities

If a new system is developed one should see to it that the needs of all target groups are considered in an appropriate way. New technologies have, in theory, the power to improve the life quality of weaker road users, e.g. of impaired people, and may contribute to more equal opportunities in traffic. In particular traffic information systems may help to increase the autonomy of disabled women and men, especially in the public transport area.

Practical examples of psychological and socio-scientific aspects

In the following some examples of new systems for car traffic and very briefly for the public transport system and for vulnerable road users are given. The psychological and socio-scientific aspects will be pointed out.

Car traffic

As mentioned above, two different kinds of measures or systems can be implemented for car drivers: systems that address collective behaviour of car drivers (e.g. section control) or the behaviour of car drivers individually (e.g. IVIS, ADAS).

Collective traffic influencing

Collective traffic influencing systems are different from individual ones. Some measures in this area are obligatory for the car drivers, for instance respecting speed limits displayed by section-control systems, and ignoring them may have negative consequences for the driver (e.g. penalties). The systems in this area mainly aim at an improvement of both traffic flow and the traffic safety.

Behaviour adaptation, acceptance problems and equality of opportunities are topics which are relevant in this area. There, however, is hardly any research done that considers these aspects.

Take for example “Traffic influencing systems”. A “traffic influencing system” is a telematic infrastructure that is so far primarily used on highways at certain sections. With the help of the system the speed limit is adapted to the traffic and weather conditions, lanes can be blocked, if required, if necessary cars at the access of the highway can be permitted drop by drop, etc.

According to several studies (see e.g. Nadler 2004, Schick 2003) “traffic influencing systems” have a positive impact on the capacity of highways and on traffic safety. There, however, was no data available, if such systems have a lasting effect on driving behaviour, if there is any risk compensation (e.g. that people drive faster after the "influenced" road section), if there are changes in communication, or to what degree they are accepted by the population.

Another example is Section Control. Section Control is a special form of a radar unit. With its help you are able to control a certain road section concerning, primarily, speed. Digital photos are taken before you enter the controlled section and after you leave it. If you exceed the displayed speed limits you are penalised. There are mobile and stationary systems.

The main aim of Section Controls is to increase the traffic safety respectively to reduce the number of accidents. Congestion shall be avoided, the traffic flow shall be improved.

Also with regard to section control there was no data available what kind of lasting effect this measure has on the general driving behaviour. As drivers are automatically penalised, if they exceed the speed limit or infringe against any other traffic rule, one can expect a high behavioural acceptance (= car drivers stick to the rules). The attitudinal acceptance (whether car drivers appreciate the measure or not), however, will depend on the way in which this measures is presented to the public (public awareness).

Individual influencing

We called all those systems as Individually influencing systems, that are addressing individual vehicles, or drivers. Two systems can be differentiated: In-vehicle Information Systems (IVIS) and Advanced Driver Assistance System (ADAS). Again, some questions should be discussed in connection with them:

- ✓ Questions of perception and effects on vigilance and concentration, viz. distraction from the physical and social environment; e.g., how is communication between road users affected?
- ✓ Questions of relevance of information that should influence behaviour: What do users actually do with this piece of information? Will information be considered, and if yes, how? How can one optimise the information one gives? How can you find the appropriate degree of redundancy, understandability, recognisability?
- ✓ Questions of adequate adaptation to the target-groups; are the needs of different target groups satisfied? Are they known, at all?
- ✓ Questions of impacts on other road users; do/will systems have effects on vulnerable road users; if so, are vulnerable road users considered well enough by pieces of telematic equipment?

There is, for instance, a wide range of different ADAS-systems and some systems are well documented with regard to psychological and socio-scientific short term effects (e.g. ISA, ACC). However, there is little research done with regard to long term effects.

In general it has been found out that car drivers, who are usually driving above the speed limits are less in favour of ADAS-Systems of ISA type than slower car drivers. Furthermore, fast and risky drivers are more likely to show disadvantageous behaviour adaptation than other drivers – gaines in safety are potentially converted into higher speeds. If this is not possible (ISA) frustration may result.

One main problem with regard to research done in this field is, that various studies result in different outputs. This is because of the use of so many vastly different methods of analysis: behaviour was tested on a simulator or in the field; the test took three months or only a few weeks, 5 persons or 200 persons were tested, etc. etc..

Public transport system

In the public transport area telematic infrastructure mainly aims at an improvement of services and of efficiency. For that reason it is very important to involve the customer, viz. the users. The needs of various target groups have to be evaluated in order to guarantee that new systems are accepted (e.g. the Viennese public transport system "Wiener Linien" offered to buy tickets via mobile phone. They, however, did not make any attitude survey, e.g. how many people use this offer, are those, who use satisfied with the system, etc.) and that, ideally, all people have equal access to public transport services.

For example, electronic traffic information (schedules, information about building works, about accessibility, etc.) can especially be very helpful for disabled or impaired people. Often, however, it turns out that these target groups are excluded from practical use (e.g. websites are not usable for blind people). As already mention it is very important to consider the needs of various target groups and to carry out intensive attitude and motive research.

Unprotected road users

In general pedestrian and cycle traffic plays an unimportant role in transport telematics. In the Austrian Telematic Framework (Pfliegl et al. 2004) pedestrian and cyclists are not even mentioned. There are, however, some systems, that improve the traffic safety and the comfort of pedestrians and cyclists (e.g., pedestrian detectors, GPS navigations systems for cyclists and pedestrians "trekker"). No attitude surveys are available, or any research work, which evaluated, if there is a need for more telematics for pedestrians and cyclists.

Conclusions

The following conclusions can be drawn with respect to psychological and socio-scientific aspects concerning transport telematics:

- ✓ More psychological and socio-scientific research has to be done in connection with telematics. Especially long term studies are necessary, to predict long term effects.
- ✓ If one wants to achieve acceptance, the personal importance for the users has to be higher valued than the degree of innovation.
- ✓ Telematic systems should promote equal opportunities and should help to prevent social exclusion. This means that the needs of various target groups have to be considered.
- ✓ An interdisciplinary approach and the use of interdisciplinary methodology will make it possible to implement only those systems, which actually improve the traffic system.
- ✓ Implemented systems have to evaluated permanently, in order to anticipate e.g. behavioural adaptation in time, and in order to guarantee that the system can continuously be better adapted to different user-groups' needs

Transport telematics are an irrevocable part of our traffic system. Whether the high expectations that are linked to the implementation of new systems and equipment will be fulfilled will depend on the way in which the above mentioned aspects are considered.

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