

# Safety and Security in Public Mass Transportation – the ESY - Guide as a permanent measurement concept

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**Abstract** – Safety and security are important factors for the success of public mass transportation systems. For measuring these factors, new customer- and situation-orientated strategies and approaches are required. Within this paper a measurement concept for interlinking customers' subjective perception regarding safety and security and a real time sensor data network for objective measurement will be presented. The aim of this interdisciplinary approach is to establish a permanent measurement- and prevention-concept to increase the knowledge of these factors.

## 1. Introduction

Public mass transportation systems as critical infrastructures have a fundamental importance for the competitiveness of economics. If a failure occurs the complexity of these infrastructures and their combination to physical as well as logical systems may cause a collapse of the social systems. As a result these systems have to be kept reliable, safe and secure [14]. As an example, changing demographic environment conditions, night traffics or even attacks (e.g. attacks through young people on platforms in Berlin, 2011 or the (attempted) assaults in Cologne, 2006 and London, 2005) [1, 2, 12] have shown the challenges in context of the vulnerability of these systems.

Regarding the improvement of safety and security<sup>1</sup> for passengers in public mass transportation new concepts for permanent data measuring and interpreting must be developed [13]. Therefore the subjective sense of security, related objective safety and security parameters must be analyzed, taking increasing complexity through growing infrastructures, coordination and costs into consideration as well as a high level of customers' acceptance, because of possible negative substantiate feelings regarding monitoring and supervising with cameras or surveys [8].

This new permanent measuring concept (ESY-Guide) for safety and security in public mass transportation combines those subjective and objective data by linking

gathered data logical and fully automated. With the help of sensors objective data is gathered, afterwards linked to the customers' feelings and examined by multi-criteria analysis in order to get detailed information, based on defined scenarios [4].

At first the ESY-Guide's development and application area should be busses for public mass transportation. Afterwards the measuring concept can be adapted and implemented into other mass transportation systems like underground railway. Based on analyzed surrounding conditions, measures offer valuable clues for providing e.g. additional vehicles, security staff, announcements and driver or traveler information. In order to enhance, implement and test safety and security scenarios, IT-systems in vehicles as well as at bus stops and control centers have to be established (ESY-Demonstrator). In addition to the objective detection systems (sensors and their network) also systems for the subjective impressions of the customer have to be considered and integrated. The survey technique for detecting the customer impressions must be an integral part of the mass transportation system. Therefore a touch-screen system has to be integrated which must be reliable in face of vandalism and also safe in the travelling process. The consideration of mutual interferences is important for interlinking different components in the vehicle. The individual components also have to be linked with the system-backend that collects the data, analyzes and displays it e.g. to the scheduler.

## 2. Purpose

The purpose of this interdisciplinary research for safety and security in public mass transportation should be a concept that measures the safety and security feelings of travelers in a situation- and parameter-based way to increase safety and security in public mass transportation. In this first example the concept should, as already

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<sup>1</sup> The following Definition of safety and security is used: the term safety is used if "the hazard directs from one's own object to an exposed object within the environment. The occurrence of hazard is unintended and thus not foreseeable on a temporal basis". In contrast security "includes the intentional creation of hazard to create maximum damage with minimal effort" [13].

mentioned, be applied to a bus. Therefore, as a technical basis, a complex and permanently working sensor system for busses is needed (ESY-Demonstrator). This sensor system should enable an early identification of potentially dangerous situations by using customer feedback. The measurement concept closes the gap between lacking resilient data for the security feeling of travelers by linking objective sensor data like temperature, sound level, quantity of people and air quality with subjective data (voice of the customer collected by survey systems).

The gathered data is the basis for an analysis of human security feelings and a better understanding of individual behavior. The above mentioned exemplary indicators are just only a share of factors influencing the security feeling of passengers [10]. A thorough collection of field data for all kind of factors and indicators is a further, prospective milestone on the way to a broad understanding. Before this, a design has to be developed that is accepted and trusted by the different kinds of stakeholders. Therefore it has to be sorted out which factors generate trust and acceptance [8]. Furthermore it has to be clarified how trust can be achieved so that technical solutions have a positive effect on the passengers.

A technical challenge is the development of a data collection and analysis system. This system has to ensure all legal issues but also the technical components and algorithms for a multi-criteria, anonymous analysis. The development of such an acceptance based, multi-criteria analysis approach has to be accompanied by testing sensor and survey technology in a bus [4].

### 3. Approach

The approach is based on different concepts and methods which have to be integrated in an interdisciplinary proceeding. The methodology is based on safety and security-critical scenarios like large events, school transportation etc.

One part of the approach is the systematic recording and differentiation of data. Data is collected through technical systems (survey data, touch screens, mobile applications, QR-code, sensors, cameras etc.) which have to be brought together through multi-criteria analysis. This data processing to information has to be carried out in the system backend and afterwards brought into information output (e.g. displays for scheduler). In order to the various aspects like scenarios, sensors and indicators a process-oriented and customer-focused approach is needed. This is realized through the Generic Customer Satisfaction Measurement (GCSM) concept. The GCSM concept consists of different methodical approaches which are linked together (see Figure 1).

First customer relevant processes have to be analyzed. This is carried out with the help of the “Service Blueprinting”. With the help of this method, customer and business processes are visualized and linked in a logical sequence [5, 7, 9]. As a result contact points can be figured

out. Afterwards the evaluated services on the contact points are attributed through indicators, which are later on deposited in a performance cluster (database). The performance clusters links customer survey and sensor data to the given processes with the help of an applied, multi-criteria logic.

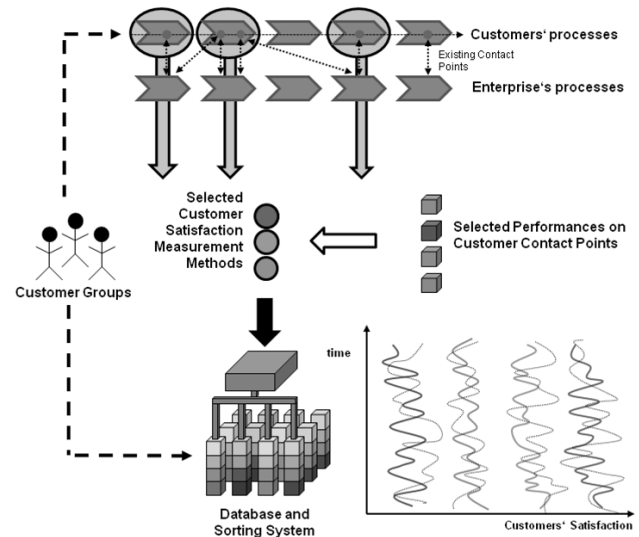


FIG. 1 : GENERIC CUSTOMER SATISFACTION MEASUREMENT (GCSM) CONCEPT [6]

Gathering data consists of two systems, in a case an objective and subjective measuring system. The first system handles the objective detected data (such as temperature or the number of people who travel in the bus). The subjective gathers direct information from customers' view. The interlinking of data yields customers' opinion respectively the safety and security feelings in dependency to real services (in this case safety and security related services).

While sensors are used in order to detect objective data, subjective data from the customer is gained simultaneously from surveys. Afterwards both data sets are linked within the system backend. The collection of objective data is carried out by sensors, which allow an automated, permanent measurement. The analysis of trust in the used technology as well as the collection of subjective data is carried out by surveys.

Those surveys can be composed by the “poll-lights” concept. This concept is based on the GCSM method. The customer evaluates his impressions related to influences by using a colored scale (green means “does apply”, red means “does not apply”, yellow means “abstention”) [3, 9]. The performance of this questioning technique – which was used in the research project VerSiert, funded by the BMBF – using printed cards and accordant slot boxes, turned out to be too staff- and cost-intensive for a permanent use [10]. To use the advantage of the high amount of feedback (the rate of return in the project

VeRSiert was about 30% [10]), the survey technique has to be technically realized.

To avoid the mentioned disadvantages of the staff- and cost-intensive use touch screens, mobile phone applications and QR-codes can support the method in a much more effective way.

With the given amount of data and the need for an automatic analysis it is necessary to implement a database which configuration complies with the requirements of GCSM. For example “riding a bus” results in an analysis of the given influences on customer contact points as well as customer surveys and afterwards linking them with each other in a performance cluster. The results of the surveys and the measurement records of the influences have to be integrated into this performance cluster in order to create a basis for a multi-criteria analysis that deploys direct intervention and further improvements.

The analysis of gathered measurement and survey data that is carried out in a system-backend is also based on the performance cluster of GCSM.

#### 4. Application of the approach

In this approach objective and subjective data, customer data and information about trust and acceptance by the customer have to be combined. A basic concept for this already exists [4, 9, 10]. The research focuses on sensors themselves, their combination and the linking with automated survey-tools. Only by using such an all-embracing system incident-related data can be measured in busses.

The development of such a system, called the ESY-Demonstrator (see Figure 2), has to include a multi-criteria analysis that can analyze the correlations of several parameters that influence the security feelings of bus travelers. After achieving this milestone the ESY-Guide can be accomplished to offer prevention measures in the field of mass transportation systems.

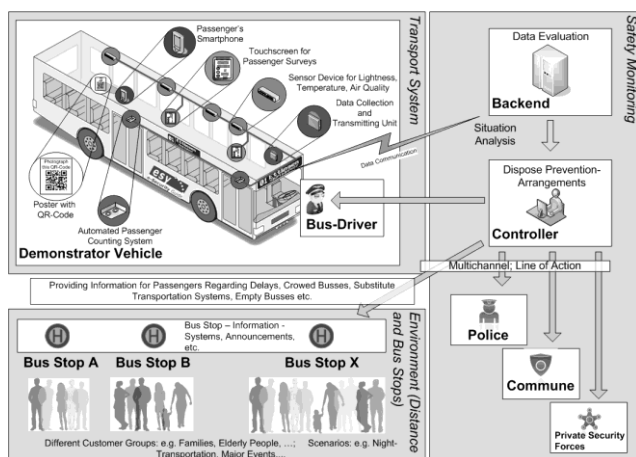


FIG. 2 : APPROACH OF THE ESY-DEMONSTRATOR

In detail a bus has to be equipped with sensors for objective measurements. Additionally touch-screens, QR-codes and mobile phone applications for the collection of

subjective data have to be installed respectively offered in the passenger areas. Those set ups are connected to a mobile data processing unit.

The received data is processed via a system-backend. Afterwards the system-backend provides the information about the safety and security feelings of the bus passengers e.g. to a scheduler in the control center. It is important to design the equipment as well as the process of handling information in a user and customer oriented view. Only this way the acceptance of the customers and a high return rate can be achieved.

The considerable value of this approach is the situation based evaluation by the customer himself. Safety and security are no longer evaluated by a third party but actively through the customers. The detection of the safety and security feelings of mass transportation customers requires measurements in real situations in order to gain accurate data. The survey must not restrict the action of the customers. This means the survey should cost the customers only a minimum of time [3, 10].

In order to ensure a transfer to other application areas the ESY-Guide and the components of the ESY-Demonstrator are designed and developed on a modular base. It should be possible to take different kinds of scenarios into consideration. So this innovative system does not only set new technology- and security-standards for busses but also for the entire public mass transportation system.

For a continuous measurement of the safety and security feelings a concept was already designed during the research project VeRSiert. It was defined what (which customer relevant processes), where (which contact-points) and how (which technique and which method) it has to be measured. A permanent, automated solution using touch-screens, mobile applications and QR-Codes is the next step for the measurement concept as well as the poll-light technique to become a salable concept.

Furthermore there is still a lack of prevention concepts that use safety and security feelings of mass transportation customers. According to this the detection of safety and security feelings related to several parameters is a new approach. This also creates the need for appropriate algorithms for the system-backend and a new multi-criteria analysis. Also the integration of the mass transportation customer into the prevention concepts is an innovative approach.

#### 5. Conclusion and Outlook

Summing up the situation, there are two main challenges that have to be accomplished. On the one hand different approaches of a customer integrated safety and security system have to be combined. Therefore several scientific and industrial disciplines (e.g. sensor technologies, quality management, acceptance measurements and regulatory frameworks for mass transportation systems) have to be

linked with each other in order to create a common system that offers customer-oriented safety and security concepts. Only by linking the different partners of industries and academic disciplines it is possible to elaborate a realization of this above drafted system.

On the other hand there is a need for a multi-criteria analysis. The combination of performances, influences, safety and security parameters and also process workflows demands the development of a multi-criteria, empirical data analysis to understand the reasons and the effects of dangerous situations in the field of public mass transportation.

Therefore the ESY-Guide with its ESY-Demonstrators sets a base for advancing safety and security in public mass transportation.

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