Principles of Quality Management for Traffic Signals in Japan

Kurzfassung der Vertieferarbeit von Axel Küßner

Nowadays, many cities face increasing traffic demand and in conclusion, traffic congestion often becomes chronic and traffic accidents accumulate. One of the main instruments to control the traffic in the road network are traffic signals and they are established to cope with these problems. However, traffic signals are subject to changing requirements and conflicts of goals. In addition, questions arise regarding the establishment of a quality management system following the example of manufacturing and service processes. In this context, the thesis compares the principles of quality management for traffic signals between Japan and Germany in a comprehensive way.

In the beginning, the thesis explains the vocabulary of the quality management, which has to be assigned to traffic signals. The European Standard DIN ISO EN 9000:2000 primarily distinguishes the terms ‘process’ and ‘product’. Hence, traffic signals also have to be examined in respect of the process-related and product-related quality. Former emphasises characteristics of development processes and operating safety as well as aspects of economic efficiency and compatibility to the environment of the used means. Thus, the process-related quality refers to the system ‘traffic signal’ as a technical device, whose planning and operation incorporates various actors, boundary conditions and processes. In contrast, the product-related quality refers to the traffic control, which is realised by the supplier. The purpose of the traffic control with traffic signals is to indicate the right behaviour for the road user when approaching a signalised junction.

In Germany, the present investigations in this field uncovered some existing approaches to quality management for traffic signals, such as the accident committee or the safety audit for roads. Despite these approaches, there is no cohesive quality management, which meets the requirements and recommended procedures of the European Standard, but it could be necessary in the future, e.g. if the trend leads to privatised traffic signals. Therefore, some researchers began to describe traffic signal elements in detail to find out the range a quality management system has to cover. They also started to develop a knowledge base, which includes both traffic safety and traffic flow aspects and helps to find appropriate countermeasures for single junctions.

The second part of the thesis introduces the organisational boundary conditions in Japan, which are influenced by responsibilities of different authorities and organisations. The government, the National Police Agency and the Ministry of Land, Infrastructure and Transport represent the authorities, which have the power to enact laws, guidelines and standards concerning the establishment and operation of traffic signals. In addition, some organisations take part in the process of analysing traffic data and developing as well as evaluating appropriate countermeasures. Regarding traffic safety, the Institute for Traffic Accident Research and Data Analysis plays an important role. Their researches conduct in-depth investigations in order to reconstruct and simulate the course of events of traffic accidents and to form a comprehensive basis for the development of countermeasures. In respect of the effectiveness of traffic flow, the Universal Traffic Management Society of Japan is the most meaningful organisation in Japan. They develop a wide range of countermeasures to alleviate traffic congestion and to ensure traffic safety. Therefore, it develops, establishes and evaluates systems, which apply infrared beacons and other state-of-the-art vehicle detectors representing the key infrastructure of the Universal Traffic Management Systems.

The second part also gives an overview of the Japanese road network data and the variety and number of the traffic safety facilities as well as the technical equipment, which is installed at the roadside.

The third part of the thesis is dedicated to the description of quality criteria. The quality criteria are primarily assigned to traffic safety and traffic flow. Regarding traffic safety, Japan and Germany do not have appreciable differences in the application of quality criteria. Common quality criteria are the number of fatalities, casualties and injuries, parameters describing the road environment (including traffic signals and signal controls) and parameters of drivers and vehicles. In respect of parameters of traffic flow, Japanese authorities prefer queue length, traffic volume, speed and occupancy, while the delay is the most important parameter to assign levels of quality in Germany. In contrast, the delay is only used for capacity analyses and the process of designing traffic facilities in Japan, but not for the assessment of the current effectiveness of traffic flow. In addition, the Universal Traffic Management Society of Japan emphasises a third field of quality criteria, namely the environmental impacts of pollution caused by road traffic.

In consequence, the choice of quality criteria has various influences on the strategic planning and the development of countermeasures. Some examples of the application of these quality criteria are to give an own phase to pedestrians at junctions with high accident risk, to adjust signal controls with regard to an aging traffic society, to establish green waves during commuter traffic peak hours, to optimise the junction design and to prioritise the public transportation.

The existing principles of quality management for traffic signals are examined in the fourth part. Starting with principles regarding traffic safety aspects, the procedures such as traffic accident data collection, data analysis, development of countermeasures, evaluation and documentation are discussed. These procedures are supported by two traffic accident databases: the ‘comprehensive database on traffic accidents’ and the ‘micro investigation database’. The data collection, analysis and also the documentation of these database-related processes are standardised by the National Police Agency and the Institute for Traffic Accident Research and Data Analysis. Therefore, the development of countermeasures has a comprehensive fundament to build on and traffic safety facilities can be improved and optimised in an appropriate manner. In addition, the ‘Manual on countermeasures for intersection accidents’ contributes helpful information how to find black spots (accident accumulations) and how to derive adequate countermeasures to eliminate the causes of black spots. Although the manual mentioned above is not mandatory in Japan, it holds a large potential for a standardised traffic accident analysis regarding e.g. local police headquarters as operator of a traffic control centre. Finally, the section dealing with traffic safety aspects shows an example of a ‘before-after’ evaluation, which assessed the benefit of installing or upgrading traffic safety facilities between 1992 and 1996.

Afterwards, the principles regarding traffic flow aspects are examined. The procedure of the traffic control centre operators and local police headquarters concerning data collection, data analysis, development of countermeasures, evaluation and documentation are investigated. The application of state-of-the-art technical equipment to reduce traffic congestion also takes a centre stage. Two recent examples (‘MODERATO’ as a new traffic control system and ‘Smooth Tokyo 21’ dealing with illegally parked vehicles at junctions) show the possibilities of the two-way communication, which is the key infrastructure of the latest developments. In this context, the high degree of standardisation of the technical infrastructure is described,

also regarding maintenance aspects. In addition, the influence and development of a complaint management is explained in this section.

In the next step, the role of the Universal Traffic Management Systems is examined in respect of being a part of a quality management system. One important quality aspect is the definition of objective fields and services, which had been developed regarding the requirements and defects of the present traffic situation. Many efforts have been undertaken later to develop standards for technical equipment and they were suggested to the National Police Agency. Nevertheless, the Universal Traffic Management Systems do not cover a cohesive quality management system and merely emphasise vehicle traffic and pedestrians, latter in traffic safety aspects above all.

Finally, the quality management approach is described for aspects of environmental impacts caused by pollution, which is a single treated topic in Japan in contrast to Germany. The Environment Protection Management System aims to reduce the pollution level by adjusting the signal control and by displaying pollution information to the road users.

The last part of the thesis summarises the strengths and weaknesses of the principles of quality management for traffic signals in Japan. It shows that the term ‘quality management’ is often not incorporated by Japanese engineers in discussions about traffic safety and effectiveness of traffic flow.

In conclusion, some potential for the German progress regarding quality management for traffic signals is derived from the Japanese procedures. The main suggestions, which can be seized, belong to the effectiveness of a modern technical infrastructure and to the establishment of environmental impacts as an own field of quality. It can be assumed that quality management for traffic signals does not only lead to a reduction of traffic accidents and traffic congestion, but also to economical benefits for the whole country. Hence, traffic signals have to be seen as an important component of the key technology 'traffic'.