A Meta-perspective on Research Activities in UR:BAN Human Factors in Traffic

2

Matthias Graichen, Verena Nitsch, and Berthold Färber

2.1 Introduction to the Project "Urban Driving"

Urban traffic scenarios are characterised by a high variety of different traffic participants, infrastructural features and diverse environmental conditions. As such, they are considerably more complex than traffic scenarios on rural roads or motorways. So far, the development of advanced driver assistance systems (ADAS) was guided by a rather disintegrated function-oriented approach. When it comes to urban traffic scenarios, however, it becomes necessary to consider the various influencing factors more comprehensibly. The design of urban ADAS should follow an approach of an adaptive and integrated HMI to support drivers according to situation- and driver-related requirements, and avoid confrontations with unnecessary information [1].

With this goal in mind, the research initiative UR:BAN conducted numerous data collections pertaining to different research foci. To support a more holistic process of function and HMI development, it is necessary to integrate the diverse research questions, synchronise individual partner activities and evaluate the obtained project results from a broader perspective. This requires a fundamental, project-spanning, structured procedure and coordination. For this purpose, the project *Urban Driving* (abbrev. UF for "Urbanes Fahren") applied a strategy, starting with the beginning of the research initiative, with the objective of monitoring research activities in the four projects *Human-Machine Interaction for Urban Environments* (abbrev. MMI for "Mensch-Maschine-Interaktion"), *Behaviour Prediction and Intention Detection* (abbrev. VIE for "Verhaltensprädiktion und Intentionserkennung"), *Simulation* (SIM) and *Controllability* (abbrev. KON for "Kontrolllierbarkeit"). Hence, research intentions were identified and correspon-

M. Graichen (✉) · V. Nitsch · B. Färber (✉)
Human Factors Institute, Universität der Bundeswehr München
Neubiberg, Germany
e-mail: berthold.faerber@unibw.de

K. Bengler et al. (eds.), *UR:BAN Human Factors in Traffic*, ATZ/MTZ-Fachbuch,
DOI 10.1007/978-3-658-15418-9_2

ding data collections standardised by means of several systematic procedures in order to provide a meta-perspective on the project research activities and results.

2.1.1 General Approach

UF approached its objective of providing a meta-perspective with different strategies on both an operational and a conceptual level. On the operational level, procedures were developed to facilitate inter-project communication processes and inter-project relations. This is particularly pertinent for bigger research initiatives that are often conducted of heterogeneous partners from industry and academia who vary with respect to their terminology, specific background knowledge as well as their strategic research intention (short-term or long-term orientation) Instead of conducting disparate and isolated research activities, synchronised efforts should be initiated for documentation, standardisation, co-ordination and communication of joint or similar project phases, right from the beginning of the project. In UF this was achieved e. g. by synchronising the basic terminology, the form of representation of research objectives and measurements, and also by creating a comparative and clarifying summary of data collections [1].

On the conceptual level it was aimed to obtain a broader perspective on the investigated (assistance)-scenarios, which are composed of various aspects pertaining to the driving situation, the driver and the implemented function (as well as its user interface). With respect to the overall objective of initiating a holistic function development process, the development of a classification scheme for assistance scenarios constituted an essential part of UF. This classification scheme considers and systematically combines a priori driver charac-

Fig. 2.1 Dimensions of the classification scheme for urban assistance scenarios. (Adopted from [2]; reproduced with permission from C. Purucker and A. Neukum)

teristics, situational demands, system design as well as their interplay. Moreover, a user-oriented development and integration process for functional and informational systems can be facilitated with this classification, as well as their adaptive functioning according to current situational demands (Fig. 2.1).

Regarding the UF objective of providing an integrative meta-perspective, the stated classification scheme also allows for inter-project comparisons and discussions as well as evaluations of project results and their assignment to different effectiveness criteria. With this analytical approach, further gaps concerning urban ADAS research and development can be identified and specified [1].

2.1.2 Project Infrastructure

In order to achieve the operational and conceptual objectives, and – as mentioned above – to provide a meta-perspective on the initiative's research activities, a multi-aspect approach was applied (Fig. 2.2), which comprised the following steps:

- Synchronisation of terminology, data acquisition and data formats for the development of internal project standards and conventions.
- Systematic description of assistance scenarios to be investigated based on a classification scheme for urban driving scenarios.
- Systematic evaluation of project results using the classification scheme for urban driving scenarios.

On the operational level the communication and cooperation was guaranteed by a mandatory involvement of the project leaders (PL) in UF. For the exchange and archival of the various partner inputs, a dedicated UR:BAN server was used.

The first two steps focused on defining data standards and the systematic description of investigated assistance scenarios in order to achieve the following objectives:

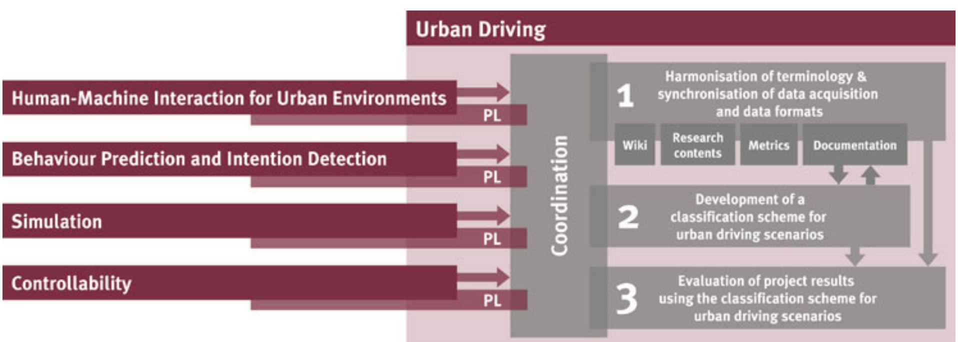

Fig. 2.2 UF objectives

- Increased transparency and comprehensibility of data acquisition.
- Internal coordination (harmonisation and synchronisation) of data acquisition activities.
- Documentation of the obtained data.
- Facilitation of the comparability and interpretability of results by utilising standardised procedures.

As can be seen in Fig. 2.2, the corresponding efforts culminate in the third step which comprises the evaluation of project results by using the developed classification scheme for urban driving scenarios, which will be the main focus of the present chapter. As such, the following section only briefly describes the methodological issues of the stated procedure, which involved several tools and standardised documents for the collection of necessary meta-information on the project activities (for more details of the conceptual development process of these tools, see [1, 3, 4]).

2.2 Methodological Approach

Several methods were applied to achieve the various objectives concerning inter-project communication and internal coordination as well as transparency and comprehensibility of data collection, which are briefly described in the following sections.

2.2.1 Harmonisation of Terminology

To ensure the utilisation of a consistent terminology throughout the project, a central information platform (Wiki) was implemented in the initial project phase. The platform contained the most important terms and definitions (and corresponding references) concerning the investigation of Human Factors and the development of ADAS, which were used identically within all subprojects. Throughout the entire duration of the project, the platform was open for continuous maintaining by any project partner [5, 6]. Experiences from coordinated activities within each subproject have shown that the platform contents were used to stimulate debates not only on formal definitions of specific terms but also on creating a consistent language throughout the project and reporting system.

2.2.2 Synchronisation of Data Acquisition and Data Formats

In accordance with the research initiative's goals, all research activities focused on data acquisition at least once over the duration of the respective projects (e. g. by means of field observation or studies with experimental manipulation). Depending on the individual research objectives, studies or experiments might have been conducted in different research environments, but would likely comprise the same types of traffic participants (motorcar, truck, motorbike, bicycle, or pedestrian). As such, it was considered useful to coordinate the planned research activities in advance of the first data acquisition phase. Thereby, planned activities could be diversified and coordinated between partners to reduce required resources, and acquired data could be shared for related research questions. For example, in projects KON and MMI, similar studies were conducted regarding driving performances in evasion manoeuvres, in order to either investigate comparability of different research environments (Chap. 25) or designing appropriate warning strategies (HMI; Chap. 5), respectively.

In order to achieve this effect of synchronised research activities, three procedures were developed, which aimed at determining consistent standards in data acquisition, and at increasing comprehensibility and transparency regarding the phase of study conceptualisation (Sect. 2.2.2.1) and the phase of data acquisition (Sect. 2.2.2.2 and 2.2.2.3). The following sections briefly outline the applied methods.

2.2.2.1 Matrix of Research Contents and Experimental Settings

The matrix of research contents was initially compiled based on the description of the intended research activities, and was continuously updated throughout the project progress. Planned research activities considered different types of traffic participants (motorcar, truck, motorbike, bicycle, and pedestrian) as well as different research environments (on-road, closed test-track or driving simulator). The different constellations can be seen in Fig. 2.3. Each cell shows the involved partners, who conducted data collections focussing

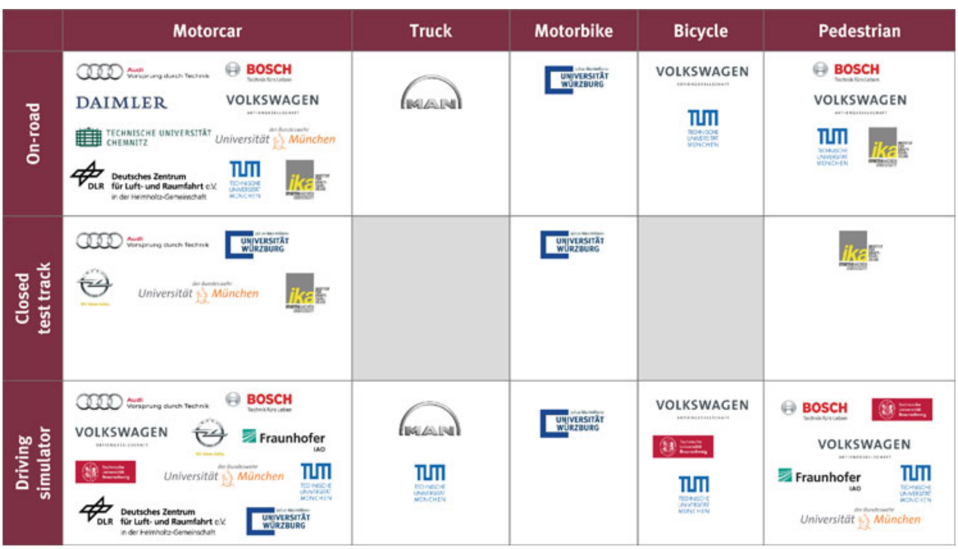

Fig. 2.3 Matrix of research contents, experimental settings and research partners. (Adopted from [1]

on the corresponding type of traffic participants and research environment. Thus, the matrix depicts the complete data pool generated over the duration of project [1].

2.2.2.2 Metrics

A list of metrics had been developed based on the matrix of performance indicators (PI-matrix) in the project FESTA ([7]; as cited in [4]), which aimed at field operational tests for assessing the impact of information and communication technologies systems on driver behaviour and – similar to UF – in an "*integrated and coordinated program of research*" (see http://www.its.leeds.ac.uk/festa/). The matrix was adapted to meet the requirements of the UR:BAN project on relevant contents [4]. Similarly to the Wiki, the list of study metrics stimulated debates within each project on determining comparable measurements (e. g. matching definitions of lane exceedances) as well as defining standards for following data analysis and modelling procedures (e. g. computations of TTC).

2.2.2.3 Documentation of Empirical Research and Data

For each data acquisition activity, partners completed a one-sided data sheet which briefly described the applied experimental or observational procedure. The electronic document required basic information concerning the research environment, traffic participants and sample size, as well as a link to the corresponding description of the investigated assistance scenario (if available). Additional information could be given, e. g. on potential deviations from the variables and measures in the list of study metrics or on special technical features [4].

2.2.3 Classification Scheme for Urban Driving Scenarios

With regard to the description of investigated assistance scenarios, UF established categories which consider various aspects of the driving situation, the driver and the implemented function (cf. Sect. 2.1.1). Table 2.1 lists specific categories within these dimensions. The following sections briefly describe the contents of the three scenario dimensions. For a theoretical derivation of the classification scheme for urban driving scenarios and a comprehensive literature review (see [1, 3]).

2.2.3.1 Situation Description

The operating principles of ADAS can be best illustrated using typical traffic situations. The situation description contains static and dynamic aspects of the environmental situation described by text or using illustrating sketches. Dynamic aspects relate to the ego vehicle (and its driving manoeuvres) as well as various aspects of the traffic situation (such as other traffic participants, traffic flow or weather). Static aspects concern the road infrastructure and environmental conditions in which the driver moves. Additionally, the core aspects of the situation were classified according to the potential conflict (or accident) situation and concerned driving manoeuvres. To allow for comparable replications of the

Table 2.1 Classification scheme for urban assistance scenarios. (Adopted from [1, 3])

RESEARCH OBJECTIVES			
	- Collision avoidance - Controllability - Manoeuvring assistance - Intention detection	- Methods - Simulation systems - Usability - Validation	- Efficiency enhancement - Emission reduction - Infrastructure development - Effectiveness - …

SITUATION	DRIVER	FUNCTION
Situation description	**Driving task**	**Function description**
Situation sketch (Images)	**Requirement level of driving task**	**Information/intervention depth** - Information - Warning - Intervention (assisted, partly/highly/fully automated)
Description of conflict situation	**Secondary tasks** - Sensor modality - Type of interaction - Interruptibility - Information coding	**Technical system** - Objective description - Technical implementation - Sensory input variables - Description of operational sequence
Manoeuvre type	**Driver characteristic** - Age and sex - Personality - Driving skills - Driving experience - Driving style - Driver state	**HMI** - Objective description - Technical implementation (visual, auditory, haptic) - HMI phases
Traffic situation - Description of ego vehicle - Description of traffic participants - Situation-dependent visibility - Traffic flow - Operational parametrisation		
Environmental and road conditions - Type of road - Road condition - Weather - Lighting condition - Time of day		

experimental design, all necessary parameters were documented. The results of a detailed situation analysis can be used for:

- Deduction of safety-relevant requirements for the development of assistance functions,
- Effective comparisons of functions and
- Identification of synergy effects.

2.2.3.2 Driver Description

The driver description contains the specification of the driving task and a determination of corresponding levels of task requirements. Secondary tasks while driving can also be described with various details, as these tasks can limit the driver's attentional resources and thus reduce the effectiveness of assistance systems. Moreover, additional information can be provided regarding the general driver characteristics (e. g. age, familiarity with the route or driving experience) and driver state, as these might have a moderating impact on the driving task performance as well as on the interaction process with the assistance system.

2.2.3.3 Function Description

The function description contains specifications regarding the purpose and functionality of the respective function as well as the intended extent of the intervention (e. g. ranging from just informing to warning the driver). It is further differentiated between functions that involved driver-system interactions and those that do not directly involve interaction. Examples of the former include warning or information systems, which can be described, e. g. with respect to the sensory modality of warning signals. Examples of the latter include the automatic monitoring of vehicle dynamics or environment-related sensory data.

A minimum amount of information must be provided on these three dimensions in order to describe adequately an assistance scenario and to provide a sufficient data basis for successive qualitative analyses. Elaborate details were omitted from the descriptions in order facilitate completion and processing. Some of the comprised categories aimed at providing a quick overview of the investigated assistance scenario and a mutual understanding between projects. Other categories could be filled with precise details concerning the technical implementation of a system or the specific design of a HMI interface. These were optional and aimed at a detailed bilateral exchange. The final document was implemented as a digital checklist, which allowed for easy export of into a database. This facilitated the project-spanning synopsis of the investigated assistance scenarios.

2.3 Evaluation of Project Results

In order to provide an integrative meta-perspective of the diverse research activities and project results, the obtained information from the described assistance scenarios must by condensed to their core aspects and merged with specific situation- or assistance-related key results of the individual project activities. This allows for a qualitative evaluation of the project results and potential analysis regarding the effectiveness criteria. However, not all project activities focused on situation- or assistance-related research questions. Each project also engaged in methodological and/or conceptual work (e. g. development of a HMI tool kit, potential analysis of signals for manoeuvre prediction, development of linked simulators, or the expansion of the methodological inventory for controllability studies), which was also to be considered with an integrative view on project results. In the following section, these results are referred to as "core messages".

The following sections describe the strategies for obtaining the core messages and key results, and culminate in an integrative meta-perspective on the project's research activities by means of text-based summaries and comprehensive visual representations of project results.

2.3.1 Project Core Messages

The project core messages reflect the main results of each project which focus on methodological or conceptual aspects that are independent of the specific dimensions (situation, driver, or function) of an assistance scenario. The underlying main objectives of each project are listed below (Table 2.2) and are elaborated in the corresponding chapters for each project in this book.

Despite the apparent distinctiveness of these objectives, projects exhibit mutual interdependencies. Behaviour prediction and intention detection (VIE) is a precondition for an adequate, transparent and accepted support or intervention. However, intention detection will sometimes change system behaviour. For example, a system which warns the driver of an insufficient distance to a preceding vehicle might omit this warning, if it predicts that the driver will turn right. Thus, system behaviour is not necessarily consistent over time and the driver needs to understand under which circumstances what kind of system action can be expected.

The communication of system stages, planned and actually performed actions to the driver is part of the project HMI. It offers a strategy and a toolkit for comprehensible and user-centred interaction, specifically for the challenges of urban traffic.

Even if drivers' intentions are correctly identified and system actions are displayed in a transparent and non-overloading manner, the question remains whether the system is controllable by the driver (KON); in other words, whether s/he can override the system if necessary or is willing to transfer control to the system for a while.

Table 2.2 Main objectives of the projects MMI, VIE, SIM and KON

Human-Machine Interaction for Urban Environments	Behaviour Prediction and Intention Detection	Simulation	Controllability
– Conception and development of a generic HMI-Toolkit – Development of a structure for HMI-strategies – Elaboration of the HMI strategies "Warnings and Interventions", "Lateral and longitudinal control", and "Recommended action"	– Determination of systems approaches and applications – Determination of boundary conditions – Potential analysis of signal usage – Determination of prediction quality and restrictions	– Determination of metrics for the quantification of social interaction – Development of linked simulation systems and investigation of interaction effects – Investigation of effects of assisted drivers on non-assisted drivers – Microscopic simulation of interaction behaviour	– Choice of research environment – Determination of validation and evaluation criteria – Enhancement of the methodical inventory – Differentiation from traditional criteria of controllability – Investigation of driver performance – Implications

Many aspects of driver behaviour prediction as well as controllability can be tested in specific experiments and testing environments. However, to get a deeper insight in the behaviour and mutual dependence of traffic participants' actions, simulations are necessary. SIM therefore investigates effects of the interaction of traffic participants (drivers and pedestrians/cyclists) and of interactions of drivers with highly automated and "conventional" cars.

2.3.2 Situation- or Assistance-related Project Key Results

The numerous described aspects of the assistance scenario checklist were filtered for relevant and meaningful variables, and then aggregated into core statements using an iterative strategy. Linking core statements obtained from the described assistance scenarios with scenario-specific key results constituted a particular challenge. Additional data sources were queried, such as the internal report system (e. g. [8–16]) public presentations (e. g. posters of the final presentation; see UR:BAN, [2]) as well as several partner publications, which are listed in the project reports or the projects website (see http://www.urban-online.org/de/publikationen/).

Based on the obtained data from the assistance scenario checklists and the extracted project key results, the classification scheme for urban driving scenarios was restructured with an integrative view on the developed functions. In a workshop with the participation of UF partners as well as the project leaders, this revision was discussed and the potential effectiveness criteria were identified, which aimed at the potential evaluation of the obtained project results. The workshop results are listed below (see also Fig. 2.4):

The scenario data have been aggregated into three global driving scenarios in urban environments:

- Roads without constrictions or visibility constraints.
- Roads with constrictions or visibility constraints.
- Intersections and crossroads.

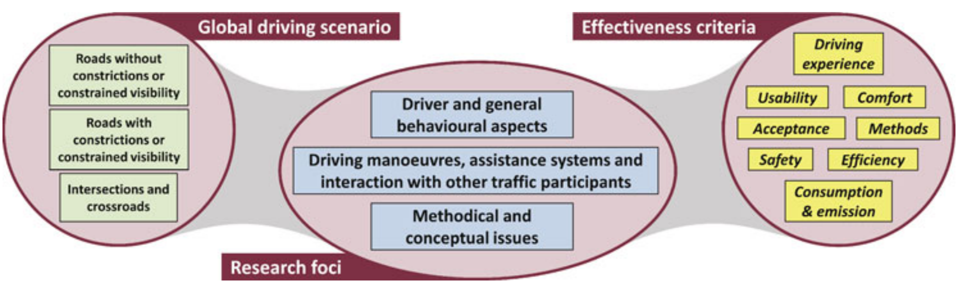

Fig. 2.4 Revised classification scheme for research activities and potential criteria for effectiveness and efficiency

Within these scenarios, research activities focused on various aspects which could be classified into three categories:

- Driver and general behavioural or cognitive aspects (e. g. individual characteristics, perception, distraction, workload, or driver experience).
- Driving manoeuvres, assistance systems and interaction with other traffic participants.
- Methodical and conceptual issues (Comparison of research environments, development of multi-party driving simulations, and development of an integrative HMI concept and toolkit).

Analogously to these categories, the following effectiveness criteria were identified:

- Driver related: Acceptance, comfort, driver experience, usability.
- System related: Safety, efficiency, consumption and emission.
- Research related: Methods.

In order to establish the basis for a qualitative analysis of project results and potential analyses with regard to the identified effectiveness criteria, an integrative and intuitive visual representation type was preferred and implemented for each global driving scenario (see Figs. 2.5, 2.6 and 2.7). Within these scenarios the specific key results can be described and assigned to the identified research foci and effectiveness criteria.

2.3.2.1 Roads without Constrictions or Visibility Constraints

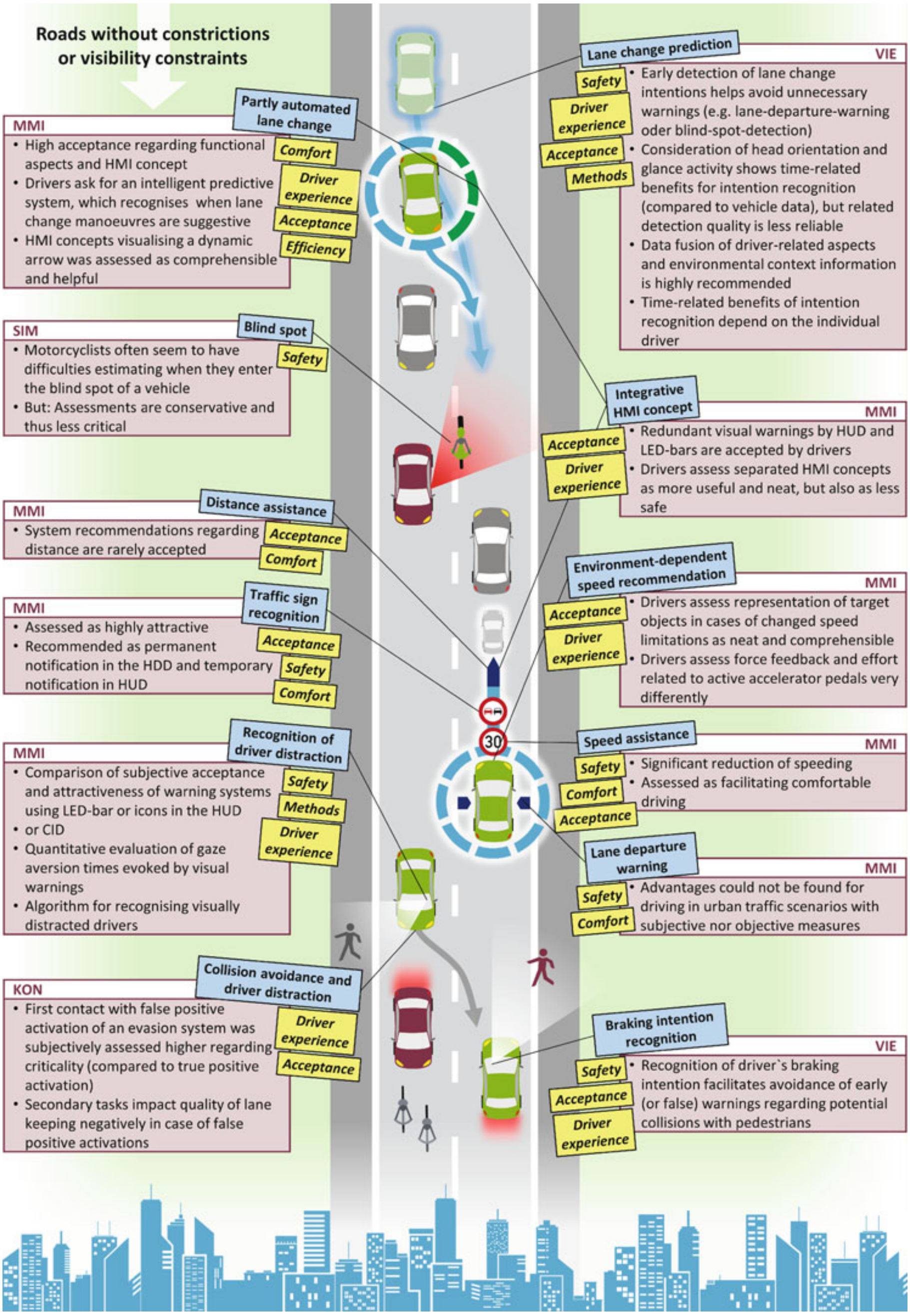

Fig. 2.5 Roads without constrictions or visibility constraints

2.3.2.2 Roads with Constrictions or Visibility Constraints

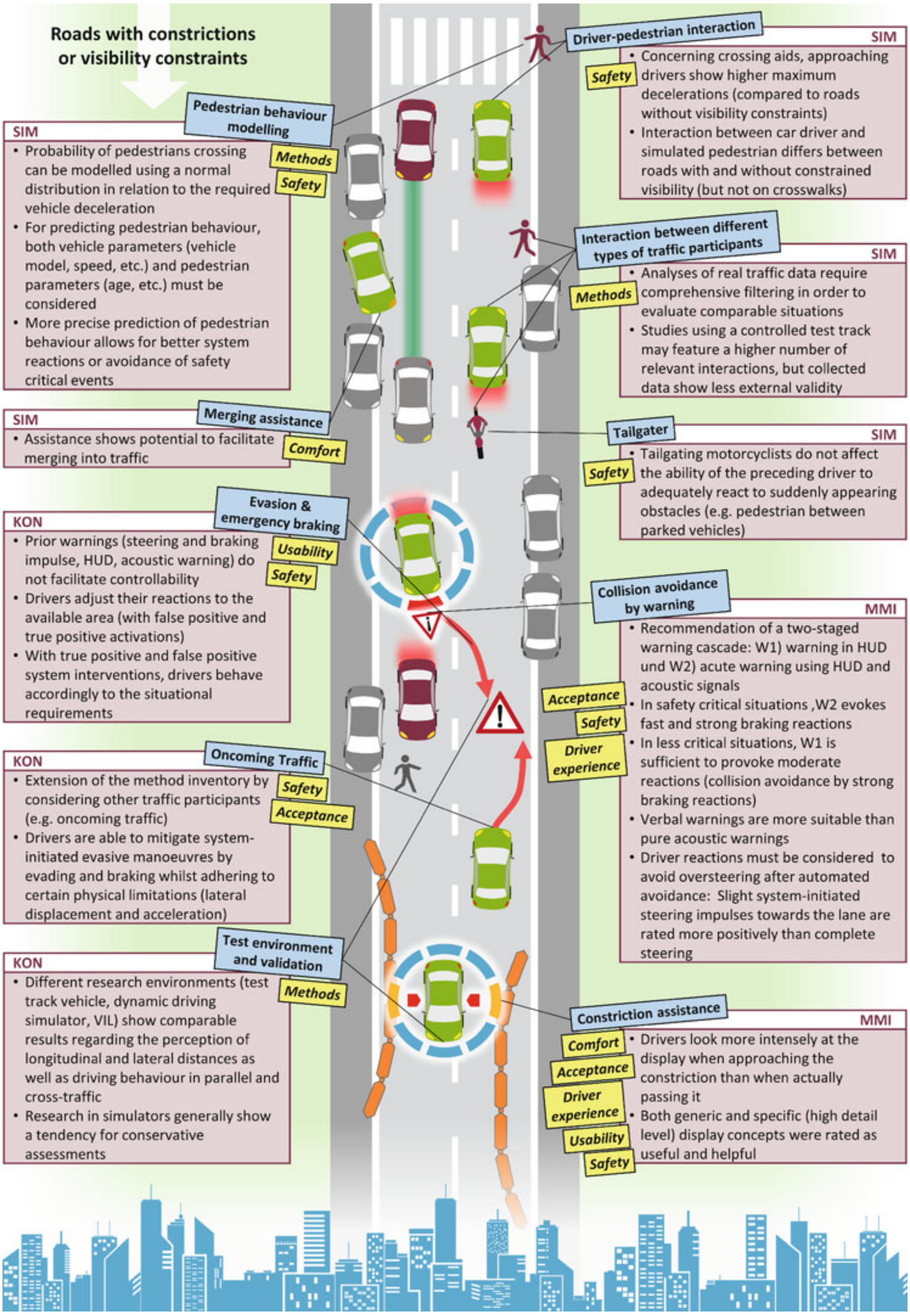

Fig. 2.6 Roads with constrictions or visibility constraints

2.3.2.3 Intersections and Crossroads

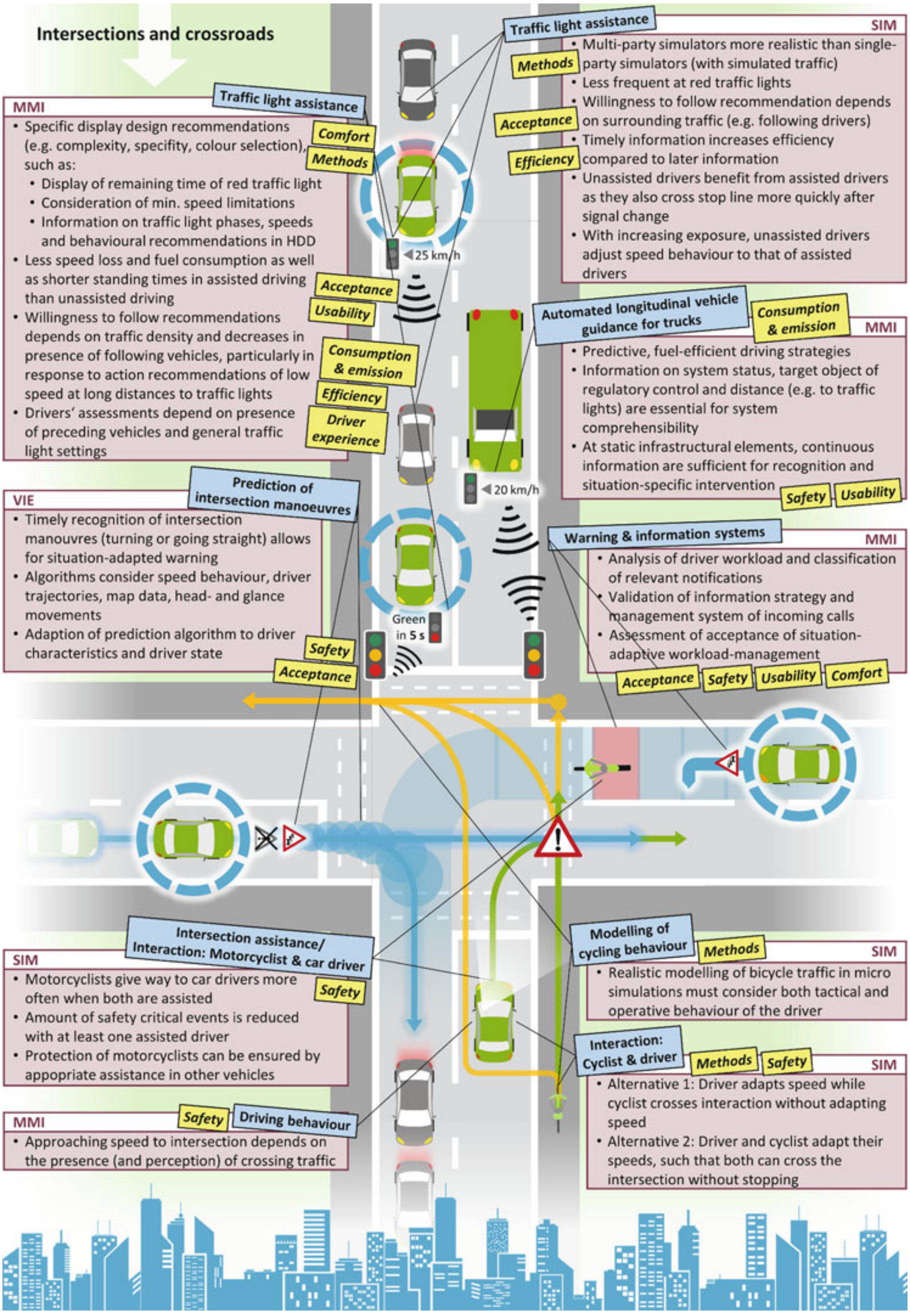

Fig. 2.7 Intersections and crossroads

2.3.3 Road Map to Key Results

Roads without constrictions or visibility constraints	*MMI*	Chap. 6: HMI Strategy – Lateral and Longitudinal Control
	VIE	Chap. 10: Predicting Strategies of Driving in Presence of Additional Visually Demanding Tasks: Inverse Optimal Control Estimation of Steering and Glance Behaviour Models Chap. 11: Lane Change Prediction: From Driver Characteristics, Manoeuvre Types and Glance Behaviour to a Real-Time Prediction Algorithm Chap. 12: Fusion of Driver Behaviour Analysis and Situation Assessment for Probabilistic Driving Manoeuvre Prediction Chap. 13: Human Focused Development of a Manoeuvre Prediction in Urban Traffic Situations Based on Behavioural Sequences Chap. 14: Application of a Driver Intention Recognition Algorithm on a Pedestrian Intention Recognition and Collision Avoidance System
	SIM	Chap. 22: A New Approach to Investigate Powered Two Wheelers' Interactions with Passenger Car Drivers: the Motorcycle – Car Multi-Driver Simulation Chap. 23: Multi-Road User Simulation: Methodological Considerations from Study Planning to Data Analysis
	KON	Chap. 29: Integrating Different Kinds of Driver Distraction in Controllability Validations
Roads with constrictions or visibility constraints	*MMI*	Chap. 5: HMI Strategy – Warnings and Interventions Chap. 6: HMI Strategy – Lateral and Longitudinal Control
	SIM	Chap. 16: Methodology and Results for the Investigation of Interactions Between Pedestrians and Vehicles in Real and Controlled Traffic Conditions Chap. 23: Multi-Road User Simulation: Methodical Considerations from Study Planning to Data Analysis
	KON	Chap. 25: Validity of Research Environments: Comparing Criticality Perceptions Across Research Environments Chap. 26: Emergency Steering Systems – Controllability Investigations with the Vehicle in the Loop Chap. 27: Considerations of the Available Evading Space for the Evaluation of the Driver Reaction to Emergency Steering Interventions

Inter-sections and cross-roads	*MMI*	Chap. 6: HMI Strategy – Lateral and Longitudinal Control Chap. 7: HMI Strategy – Recommended Action
	VIE	Chap. 9: Analysing Behavioural Data from On-Road Driving Studies: Handling the Challenges of Data Processing
	SIM	Chap. 17: Understanding Interactions Between Bicyclists and Motorist in Intersections Chap. 18: Analysis and Modelling of the Operational and Tactical Behaviour of Bicyclists Chap. 20: Encounters Between Drivers with and Without Cooperative Intelligent Transport Systems Chap. 21: The Multi-Driver Simulation: A Tool to Investigate Social Interactions Between Several Drivers Chap. 22: A New Approach to Investigate Powered Two Wheelers' Interactions with Passenger Car Drivers: the Motorcycle – Car Multi-Driver Simulation Chap. 23: Multi-Road User Simulation: Methodical Considerations from Study Planning to Data Analysis

2.4 Summary and Conclusion

UF aimed to support a holistic function development process for urban ADAS that takes situational, environmental and driver-related aspects into consideration, as they are featured in urban traffic scenarios. For this purpose, several strategies were applied that generated synergies between the research projects by integrating the various research questions, harmonising individual partner activities and evaluating the obtained project results from a broader perspective. This comprised the development of internal project standards and conventions, and a classification scheme for the investigated urban driving scenarios. On this basis it was possible to structure communication and interaction with experts working on function development in UR:BAN Cognitive Assistance and traffic information management in UR:BAN Networked Traffic System.

Moreover, particularly the classification scheme raised awareness of the numerous factors that affect driving in urban traffic scenarios and it directed efforts from a predominantly function-oriented development towards an integrative approach. By extracting core messages and aggregating obtained information, a qualitative analysis and potential evaluation could be performed – culminating in a meta-perspective on the overall research activities.

The analysis evaluated the project results in three global driving scenarios that featured in urban environments with respect to various effectiveness criteria. Integrative visualisations of the project results give insights into the main research achievements of the projects and showed in which way the obtained results will positively affect the UR:BAN objectives of safety, comfort and efficiency.

Experiences from former comparable research initiatives, such as PROMETHEUS [17], MoTiV [18], INVENT [19] and AKTIV [20], highlighted the importance and challenges of cross-project coordination and its potential contribution towards the overall project success (as well as to the public image; cf. [1]). The presented strategies and results of UF have shown that these challenges can be met by applying appropriate strategies for documenting and harmonising the diverse research activities over the entire duration of the project. Moreover, viewing the project activities and results from an integrative meta-perspective provides valuable insights, which go beyond the presentation of results in isolated project reports or public presentations and emphasise the necessities which justify research initiatives of this type a fortiori. With this holistic view on UR:BAN *Human Factors in Traffic,* it can be seen to which extent we are ready to meet the requirements of assisted urban driving and what still needs to be addressed in future research initiatives.

Acknowledgement
Sincere thanks to Andreas Pütz and Christian Purucker who developed the standards for data acquisition, the classification scheme as well as the checklist for describing the assistance scenario respectively. Moreover, Matthias Graichen thanks Julia Drüke for supporting the initial development process of the holistic perspective on the project results. Furthermore, without the support of all project partners and project leaders, and their diligent document completion and valuable feedback in numerous communication and coordination processes, the present work could not have been completed.

References

1. Bengler, K., Pütz, A., Purucker, C., Götze, M., Färber, B.: Das UR:BAN Assistenzszenario als Konstrukt für die Entwicklung und Bewertung integrierter Fahrerassistenzsysteme. Z Arbeitswiss **69**(2), 37–42 (2015)
2. UR:BAN: Abschlusspräsentation, 7. und 8. Oktober 2015, Messe Düsseldorf. Poster (2015). http://urban-online.org/de/downloads/-redirect/downloads-redirect.html?idcat36=&fid=1008. Accessed 17. Apr. 2017
3. Purucker, C., Neukum, A., Götze, M.: Systematik der Assistenzszenarien. UR:BAN, Teilprojekt Urbanes Fahren (UF) [projektintern]. Würzburg (2013)
4. Pütz, A.: Handbuch Datenstandards. UR:BAN, Teilprojekt Urbanes Fahren (UF) [projektintern]. Aachen (2013)
5. Götze, M., Bengler, K.: Meilensteinbericht 1 – Q4: Anforderungsentwicklung – Definition relevanter Szenarien. UR:BAN, Projekt MV, Teilprojekt UF [projektintern]. München (2013)
6. Götze, M., Bengler, K.: Meilensteinbericht 2 – Q8: Potenzialanalyse und Systematik. UR:BAN, Projekt MV, Teilprojekt UF [projektintern]. München (2014)
7. Kircher, K., Gelau, C., Vierkötter, M., Rakic, M., Bärgman, J., Kotiranta, R., Rämä, P.: A comprehensive framework of performance indicators and their interaction. D2.1 (2008). http://www.its.leeds.ac.uk/festa/downloads.php. Accessed 17. Apr. 2017
8. Petermann-Stock, I. (2013). 1. Meilensteinbericht (Q4): MMI Baukasten - Strategie zur systematischen Ableitung von MMI Konzepten. UR:BAN, Projekt MV, Teilprojekt MMI [projektintern]. Wolfsburg.

9. Petermann-Stock, I., & Werneke, J. (2014). 2. Meilensteinbericht (Q8): Funktionsspezifische MMI Konzepte und nutzerbezogene Evaluationsergebnisse. UR:BAN, Projekt MV, Teilprojekt MMI [projektintern]. Wolfsburg.
10. Werneke, J. (2015). 3. Meilensteinbericht (Q12): Implementierung funktionsspezifischer MMI Konzepte in Funktionsträger und Demonstatoren. UR:BAN, Projekt MV, Teilprojekt MMI [projektintern]. Wolfsburg.
11. Manstetten, D.: Meilensteinbericht 3: Algorithmische Konzepte. UR:BAN, Projekt MV, Teilprojekt VIE [projektintern] (2015)
12. Baur, M. (2014). Bericht zu Meilenstein 2: Versuche, Datenanalyse und Ergebnisse. UR:BAN, Projekt MV, Teilprojekt SIM [projektintern]. München.
13. Hoffmann, S. (2015). Bericht zu Meilenstein 3: Versuche, Datenanalyse und Ergebnisse. UR:BAN, Projekt MV, Teilprojekt SIM [projektintern]. München.
14. Neukum, A.: Bericht zum Arbeitspaket 1000: Systematik und Status quo der Methodik. UR:BAN, Projekt MV, Teilprojekt KON [projektintern]. Würzburg (2013)
15. Neukum, A.: Bericht zum Arbeitspaket 2000: Empirische Darstellung. UR:BAN, Projekt MV, Teilprojekt KON [projektintern]. Würzburg (2015)
16. Neukum, A.: Bericht zum Arbeitspaket 3000: Determinanten der Kontrollierbarkeit und ihre Gestaltung. UR:BAN, Projekt MV, Teilprojekt KON [projektintern]. Würzburg (2016)
17. Daimler Communications: 1986: Start of the PROMETHEUS research program (2007). http://media.daimler.com/marsMediaSite/de/instance/ko.xhtml?oid=9913541&ls=L3NlYXJjaHJlc3VsdC9zZWFyY2hyZXN1bHQueGh0bWw_c2VhcmNoU3RyaW5nPVBST01FVEhFVVMmc2VhcmNoSWQ9MCZzZWFyY2hUeXBlPWRldGFpbGVkJmJvcmRlcnM9dHJ1ZSZyZXN1bHRJbmZvVHlwZUlkPTQwNjI2JnZpZXdUeXBlPWxpc3Qmc29ydERlZmluaXRpb249UFVCTElTSEVEX0FULTImdGh1bWJTY2FsZUluZGV4PTAmcm93Q291bnRzSW5kZXg9NQ!!&rs=5. Accessed 17. Apr. 2017
18. Sterbak, R.: Die bessere Wahl: intermodal (2000). http://www.spektrum.de/magazin/die-bessere-wahl-intermodal/826911. Accessed 17. Apr. 2017
19. INVENT: German companies launch research initiative INVENT (2001). http://www.invent-online.de/downloads/INVENT_Pressrelease_01-09-18.pdf. Accessed 17. Apr. 2017
20. AKTIV: AKTIV: An active approach to mobility (2006). http://www.aktiv-online.org/english/img/061218-AKTIV-Press%20Release-PI1.pdf. Accessed 17. Apr. 2017

http://www.springer.com/978-3-658-15417-2

UR:BAN Human Factors in Traffic
Approaches for Safe, Efficient and Stress-free Urban Traffic
Bengler, K.; Drüke, J.; Hoffmann, S.; Manstetten, D.; Neukum, A. (Eds.)
2018, XIV, 519 p. 244 illus., Hardcover
ISBN: 978-3-658-15417-2