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D3.4 – Workshop iCars Catalogue of Impact Assessment Methods

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Abstract	This deliverable describes the discussions and results from the expert workshop on impact assessment catalogue validation held on 25 March 2010 in Amsterdam.
Keyword list	Impact assessment, evaluation methods, intelligent vehicle systems
Nature of deliverable	Report
Dissemination	Public

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Table of contents

1. Introduction

The iCars Network is a two year project which will contribute to the deployment of transport ICT technologies (or ITS – "Intelligent Transport Systems") by exchanging knowledge and experience on these technologies among a wide variety of stakeholders. For more information on the iCars Network project, see www.icarsnetwork.eu.

Our activity in iCars Network is to exchange knowledge on impact assessment methods for ITS. We exchange experience with the use of different methods, leading to more reliable methods with higher predictive validity. We have drawn up a catalogue of assessment methods, for future reference by any interested party. Impact areas that are covered by the catalogue are socio-economy, environment, traffic safety, driver behaviour, traffic efficiency and mobility.

We presented the draft catalogue of impact assessment methods for Intelligent Vehicle Systems at the InterTraffic in Amsterdam, 25th of March 2010. Experts and stakeholders were invited to attend the expert workshop, to contribute to and improve the final version of the catalogue. Both industrial, public and research parties were welcomed.

The presentations of the workshop will be distributed afterwards to the participants.

2. Objective of the document

This document describes the discussions and results from the expert workshop. The results indicate how the catalogue can be improved in order to be more useful or practical for stakeholders of vehicle safety systems who want to perform an impact assessment.

3. Workshop

3.1. Agenda

The original agenda of the workshop was as follows:

- 14:00 Welcome
- 14:05 Introduction of attendees
- 14:15 Presentation on the Catalogue of Impact Assessment Methods for IVS
- 14:45 First reactions from workshop attendees (according to prepared questions for discussion)
- 15:00 Interactive workshop in groups
  Group 1: Group 1: Driver behaviour and traffic safety
  Group 2: Socio-economic and environmental studies
  Group 3: Traffic flow and efficiency and Mobility studies
- 16:00 Coffee Break
- 16:15 Presentations of workshop results + Plenary discussion
- 16:45 Summarising session

The original agenda was adapted a little bit during the workshop, because the first plenary discussion was very fruitful but took more time than planned. Also, we decided to split into two groups instead of three, in order to meet the interests of the audience the best. The impact assessment areas which had the most interest were traffic safety and driver behaviour, and traffic flow, efficiency and mobility.

The actual agenda during the workshop was therefore as follows:

- 14:00 Welcome
- 14:05 Introduction of attendees
- 14:15 Presentation on the Catalogue of Impact Assessment Methods for IVS
- 14:45 First reactions from workshop attendees (according to prepared questions for discussion)
- 15:45 Coffee Break
- 16:00 Interactive workshop in groups (with introductory presentations):
  Group 1: Driver behaviour and traffic safety
  Group 2: Socio-economic and environmental studies, traffic flow and efficiency and Mobility studies
- 16:45 Presentation of workshop results
- 17:00 Closing

3.2. Attendees

- Michiel Christoph (SWOV, Netherlands)
- András Várhelyi (Lund University, Sweden)
- Isabel Wilmink, (TNO Business Unit Mobility and Logistics, Netherlands)
- Oliver Carsten (Its Leeds, UK)
- Jim Misener (California PATH, USA)
- Eran Reuveni (ITS Israel, Israel)
- Potters, Paul (connect, Netherlands)
- V.A.W.J. Marchau (TU Delft, Netherlands)
- Alkim, Tom (Ministry of Transport, Public Works and Water Management, DVS, Netherlands)
- Francisco Ferreira (European Commission)

The Workshops was led by the following iCars network participants:

- Pirkko Rämä (VTT)
- Risto Kulmala (VTT)
- Gerdien Klunder (VTT)
- Andreas Luedeke (BASt)
- Kai Assing (BASt)
- Jesús Martínez (CTAG)

4.Results

The following questions were discussed during the plenary discussion in the workshop:

1. Is the structure of the catalogue transparent and useful?
2. What should such a catalogue include? What is missing?
3. What is not necessary in the catalogue?
4. Is the catalogue practical for you as a stakeholder in vehicle safety systems?
5. Are the items included relevant for the users of the catalogue?
6. More examples of references or methods to be included?
7. How well are IVS impact assessment methods covered by our methods?
8. Should we, and is it possible to provide information about costs or cost efficiency?
9. What are your reactions to the cost table?

The attendees reacted on these questions, as well as they gave some additional comments. The remarks of the attendees were, in short, the following:

- In practice, impact assessment studies are often iterative processes. The same methods can be reapplied in later phases, e.g. if new results come available. In the process, there are usually several milestones and revisions. This could be described and illustrated in the catalogue.
- User acceptance and adoption of the system should be addressed more in the catalogue. Also, acceptance can be different for different stakeholders, which should be addressed.
- Is the issue of penetration rates addressed sufficiently in the catalogue? Also, could it be indicated which methods are better suited for low penetration rates, or how the method depends on the penetration rate?
- Legal issues, legal framework, organisational issues, consequences for insurances etc. are not mentioned very extensively in the catalogue. Our reaction: this is usually not part of impact assessment studies.
- Technical & organisational evaluations, operational consequences, regulatory aspects, type approval issues, how to add IVS to a car and how to do the maintenance. These are important factors for acceptance. Can these issues be addressed in the catalogue?
- Prototype development, HMI design and testing, software and hardware testing, laboratory tests are not described as separate method. In order to cover assessment methods for all aspects, this should be added. (e.g. HINT project)
- Comments to Figure 3 in the Conclusions section of the report:
  - Focus group studies are not mentioned in the table.
  - Shouldn't every cell in the table be filled in with some method?
  - One dimension for life-cycle is too little; the scaling-up issue doesn't fit in one dimension. Each of the stages can be scaled up.
  - Why are driving simulator studies in the middle of the table? Should be moved up according to Figure 2 in Chapter 2 (since there all starts with driver behaviour). Same for other impact areas; order them according to Figure 2.
  - Simulations could be extended to the right. Our reaction: the most important application of simulations is when there is no real-world

assessment possible, hence in the Idea and Plan phase. We chose the most appropriate method for each phase and impact area, therefore traffic simulation was assigned to the Idea phase.

- Suggested relevant methods to be added:
  - Literature study (Idea phase)
  - Questionnaire study
  - Predictive model of driver behaviour. Takes into account factors such as age, gender etc. Can be used by e.g. system designers. Is being developed now (Magnus Hjälmdahl, Oliver Carsten, EasyPadas?).
  - Willingness to pay approaches.
- Question: why is the catalogue based on methods and not on research questions? Answer: this was part of the proposal as asked by the commission. The aim was to increase knowledge of existing methods. (This was confirmed by Francisco Ferreira)
- Important difference between driving simulator studies and real-world tests: driving simulator studies only study short-term behaviour. Long-term can be studied in real-world. However, for cooperative systems this is a problem, since penetration rates are too low.
- Question: why are driving simulator studies combined with a (small-scale) field test in the catalogue? The combination of driving simulator with field test is useful, since there can be safety issues which cannot be tested in the real world. However, there are more relevant combinations of some other methods as well. Maybe describe all separate and explain in a separate chapter which combinations are useful.
- Emission monitoring: it is not (easily) possible to monitor the effect of IVS on air quality, since penetration rates and the contribution of traffic is too low (TNO showed this in a recent evaluation study). For impact assessment of emissions, a combination of measuring and modelling is the best method. Run emission models with measured speed profiles (is already done, also for impact assessment of IVS, by Oliver Carsten). You can also measure/monitor emissions with a dynamometer in a laboratory.
- Isn't there anything in the catalogue about noise, energy efficiency and fuel consumption? (The latter two are very important for the commission at the moment).
- Are other types of driver behaviour for other vehicle types taken into account, such as commercial and freight vehicles? The current catalogue seems biased towards passenger cars. For mobility studies, movements with other purpose (e.g. goods instead of passengers) are very different. Stig Franzen can provide studies on freight mobility. Our reaction: the methods are not essentially different for other vehicle types.
- For mobility studies, also electronic equipment can be used, better than travel diaries. Not necessarily very expensive, e.g. mobile phones can be used, which is reasonably cheap.
- The effect of modal split: which models/methods are effective to assess that? Maybe take into account as criterium.
- Also scaling up methodologies can be added. There is a paragraph on scalability already, but maybe as separate method, it could be considered as such. A good approach and data are lacking at the moment, but it is a very important issue.
- "Sidewards" scalability, e.g. transferring results from Italy to Germany, is this considered? Yes it is, transferability of results.

- Structure of the catalogue:
  - The structure doesn't follow Figure 2. Change order, start with driver behaviour.
  - It is not a real catalogue, it looks like a description of a project. For a catalogue you need 'entry doors'. Guide the reader into the context, e.g. starting from the development phase or entries from the table.
  - Will it be published on a website, or only as document/ report? Probably only as document. However, also in a document, if digital, hyperlinks can be added.
  - How to continue and maintain the catalogue after the project? Are there any means for that? Cordis could be a means.
  - The catalogue would be much more useful if it contained more references (the referenced documents don't need to be made available by us, the references in itself are sufficient).
  - Maybe also tools and their names (brands) can be mentioned, e.g. for simulation tools.
- Costs:
  - Some cost indication would be useful, for those who have no clue at all.
  - If an impact assessment study is considered expensive, depends also on the research question and the goals of the study.
  - The costs are highly dependent of the type of data acquisition systems. Can also be cheap, e.g. with mobile phones. There is a certain trade-off, you cannot do all types of analysis with cheaper data acquisition systems.
  - You can get access to environmental data from existing measuring devices from cities etc, which is much less expensive than using own measuring equipment.
- Very important research question: How to assess the effects of combinations of systems? How do the effects of one system relate to those of other systems? Which methods can be used to answer this? (Also by function). Could the catalogue address this?
- There is a lack of impact methodologies for specific systems (or functions), e.g. lane keeping systems, blind spot, cooperative systems). Can this be addressed in the catalogue?

<u>Group discussions</u>

Purpose of the group discussions was to present more detailed results and to acquire more detailed comments on the different assessment methods.

The total group was split into two groups:
Group 1: Driver behaviour and traffic safety
Group 2: Socio-economic and environmental studies, traffic flow and efficiency and Mobility studies.

Remarks from the group discussions:

Group 1:

- We had a discussion method by method – some references were mentioned

- For safety assessment with crash data there are publications on methods which simulate the crash based on earlier data (should be enough)
- The Delphi method could be an example of expert assessments
- The expert assessment is done implicitly in every method.
- Expert assessment has been compared with citizen assessment in a validation study. The main finding was that citizens were quite good in impact assessments.
- Laboratory studies are useful in assessments of HMI features, like icons. 'Lab rat' effect is a danger in lab studies; it is not a good idea to use students either. 'Limited external validity' was questioned, it was stated that this can be taken into consideration with careful designs and good quality simulators. It was said that drivers behave quite naturally in simulators (get bored with the systems etc). However, instead of this, there is a problem in measuring long-term effects in a simulator test.
- Large-scale and small- scale assessments can be used to complement each other; sometimes small first – start with a limited experiment, sometimes large first and then small, to study in more detail a specific finding
- Typically large-scale FOTs have turned to small-scale FOTs
- The advantage of small scale FOT in controlled design is that some variables can be stabilized, e.g. route, timing effects etc., and the possibility of "simulate" different penetration rates.
- Wiener fahr phrobe (Risser) is a method which has been used in instrumented cars
- The In-car method has been validated (Mark Brackstone).
- Combinations of methods have been done e.g. in ISA studies in Sweden, MASTER project and Collision avoidance system were mentioned as well.
- Some methods like questionnaires, travel diaries and focus groups don't seem very suitable for measuring driver behaviour, but can be very useful in "acceptance/usability assessment". They are usually far cheaper than the others, so they can be used also eventually.

Group 2:

- There are indeed few examples of mobility studies for IVS. The best way for doing mobility studies on IVS is a combination of questionnaires, travel diaries and data acquisition with data loggers. Questionnaires should be added as method to the catalogue (not such an easy method as often thought, making a good questionnaire is difficult).
- Focus group studies: very subjective, depends on knowledge of the participants. Also, you need to have a clear goal. Good preparation is important. It is useful for usability studies and things 'not so easy to grasp', to complement measured data. Not very common in ITS yet, but is becoming more and more popular. E.g. in the Netherlands, Rijkswaterstaat is often asking for focus group studies.
- Weakest point of CBA: it requires a robust impact assessment. It uses hard numbers as input, but the way how these numbers were acquired is usually weak. Also scaling up is a problem. Poor quality of basic traffic data and these data are not easy to get. Also, due to national budgeting (at least in Finland), it is getting harder to get traffic data. They need to make money with traffic statistics.

- MCA: this is no standardized method, there are no standards defined on which weights or criteria to use. Which weights to choose is linked to policy, but there are usually no standardized criteria.
- Emission monitoring: not very useful for IVS impact assessment, since due to low penetration rates, the effects on air quality are difficult to measure. Therefore additional modelling is needed.
- The recent study on ICT and Energy Efficiency for the EC (led by TNO) gives valuable information about impacts of IVS on energy efficiency on European scale. Add this reference to the catalogue.
- Generally all impact assessment methods are underestimated by non-experts. The catalogue will help to reveal all the difficult issues of the methods for non-experts.

5.Conclusions

The workshop can be considered successful. There were 10 participants from outside the iCars Network consortium. Each expert had a very good background in the field of ITS impact assessments and was very active during the workshop.
Many useful comments were made. Some of them are easy to implement into the catalogue, such as changing the order of the method descriptions according to Figure 2. Some others require more effort and need to be discussed, such as guiding the reader with hyperlinks or adding extra criteria on user acceptance, legal issues, organisational issues etc. Also the question on how to assess impacts of combinations of systems is very relevant. An important remark was further that the catalogue would be more practical if more references would be given. This is of course useful, but also requires a lot of extra effort. Furthermore, some suggestions were made for extending the catalogue with some extra assessment methods, such as the large-scale questionnaire study.
All mentioned issues need to be considered and discussed with the EC, in order to determine which suggestions should be addressed in the catalogue, and what is feasible in the remaining time of the project.
Since the project ends in June 2010, the catalogue will be finalized end of June at the latest.
All participants of the workshop will receive this report with remarks from the workshop, the slides of the presentations given and an update of the latest version of the catalogue at the end of the project.

6.Acknowledgement

We would like to thank the attendees of the workshop for their presence and constructive contributions.

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Expert Workshop
iCars Catalogue of Impact Assessment Methods

Pirkko Rämä
VTT
Amsterdam, 25 March 2010

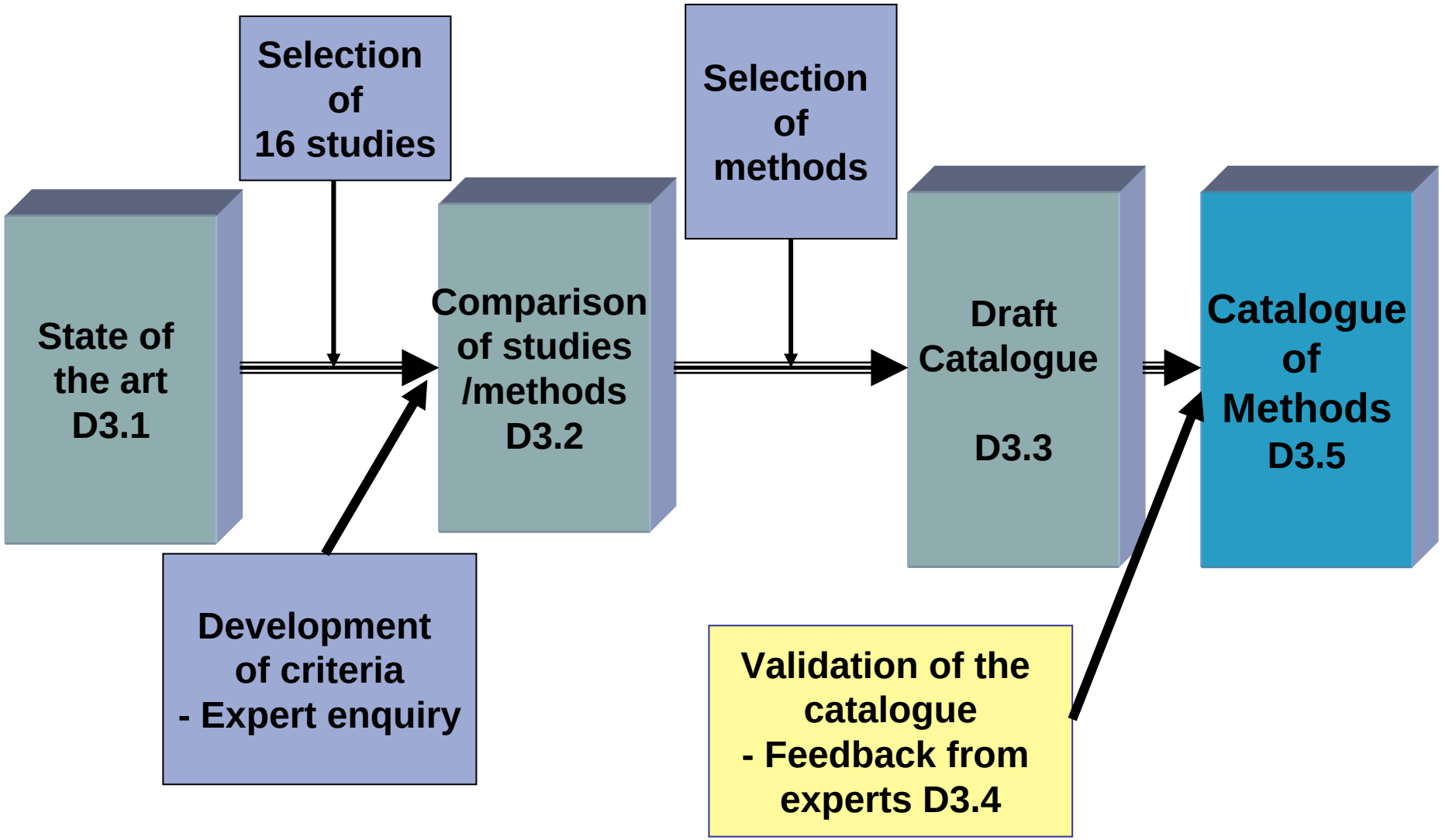
Agenda

- 14:00 Welcome
- 14:05 Introduction of attendees
- 14:15 Presentation on the Catalogue of Impact Assessment Methods for IVS
- 14:45 First reactions from workshop attendees
- 15:00 Interactive workshop in groups
- 16:00 Coffee Break
- 16:15 Presentations of workshop results + Plenary discussion
- 16:45 Summarizing session

Development of the catalogue

- Purpose of impact assessments
  - Knowledge for the design
  - Knowledge for decision making
  - Insight in impact mechanisms
- Purpose of the catalogue
  - To list
  - To describe
  - To focus
  - For all interested parties
- Based on earlier studies
- Validation of the impact assessment studies
- Content of the catalogue, 13 methods
  - Framework to describe

WP3: Impact assessment methods of IVS - overview



Identification of impact assessment methods

Impact area	**Method** (number of studies)
Socio- economy	Cost-benefit studies (2) Multi criteria - analysis (1)
Environment	Emission models (1)
Traffic safety	Statistical study with crash data (1) In-depth study with crash data (1) Expert assessment on safety impacts (1) Combined driving simulator and field test (1)
Driver behaviour	Large scale field study (3) Driving simulator study (2)
Traffic efficiency and traffic flow	Traffic simulation (2)
Mobility	Travel diary and questionnaire (1) Field test on mobility (1)

Added later:

- Small-scale field-test with instrumented vehicles
- Air quality monitoring
- Focus group study

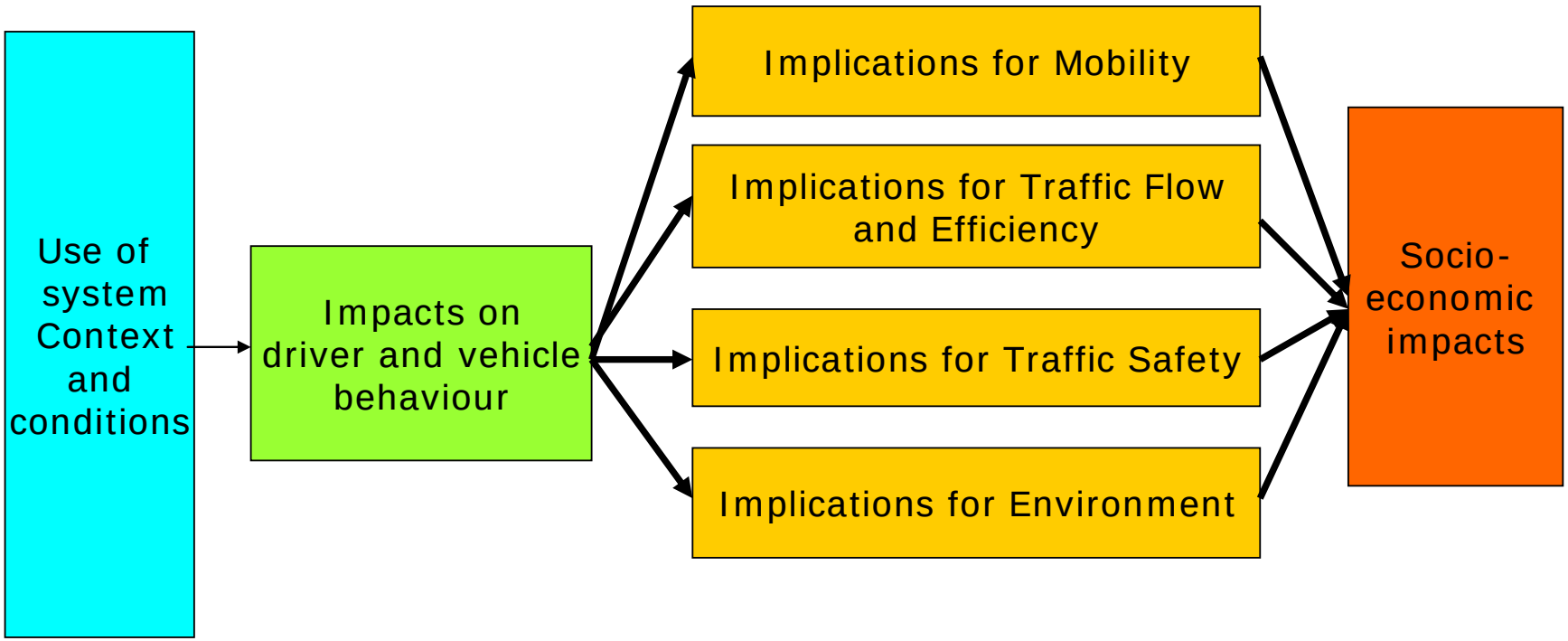
Assessment criteria

- Common criteria
- Criteria for driver behaviour
- Criteria for mobility and travel behaviour
- Criteria for traffic system efficiency and traffic flow
- Criteria for environment
- Criteria for safety
- Criteria for socio-economic assessment

13 methods for the 6 impact areas

1. Driving simulator studies
2. Focus group study
3. Large-scale field study
4. Small-scale field-test with instrumented vehicles
5. Combined driving simulator and field test
6. Travel diaries
7. Traffic simulation
8. Expert assessment on safety impacts
9. Safety assessment with Crash Data
10. Emission modelling
11. Air quality monitoring
12. Cost benefit analysis (CBA)
13. Multi criteria analysis (MCA)

Different levels in impact assessment



Framework for method description (1)

- Short description of the method

- Context of the evaluation
  - Phase – lifecycle of the product / Intelligent Vehicle system
  - Expected outcome, research questions
  - Target group of the outcome (public authorities, manufacturers etc.)
  - Resources needed
    - Organisational/Personnel/Technical/Financial

- Orientation of the method
  - Theoretical / empirical; ex-ante / ex-post
  - Experimental / natural
  - Background

- Focus
  - driver behaviour/ travel behaviour/ traffic flow/ efficiency/ safety/ environment/ mobility/ socio-economy

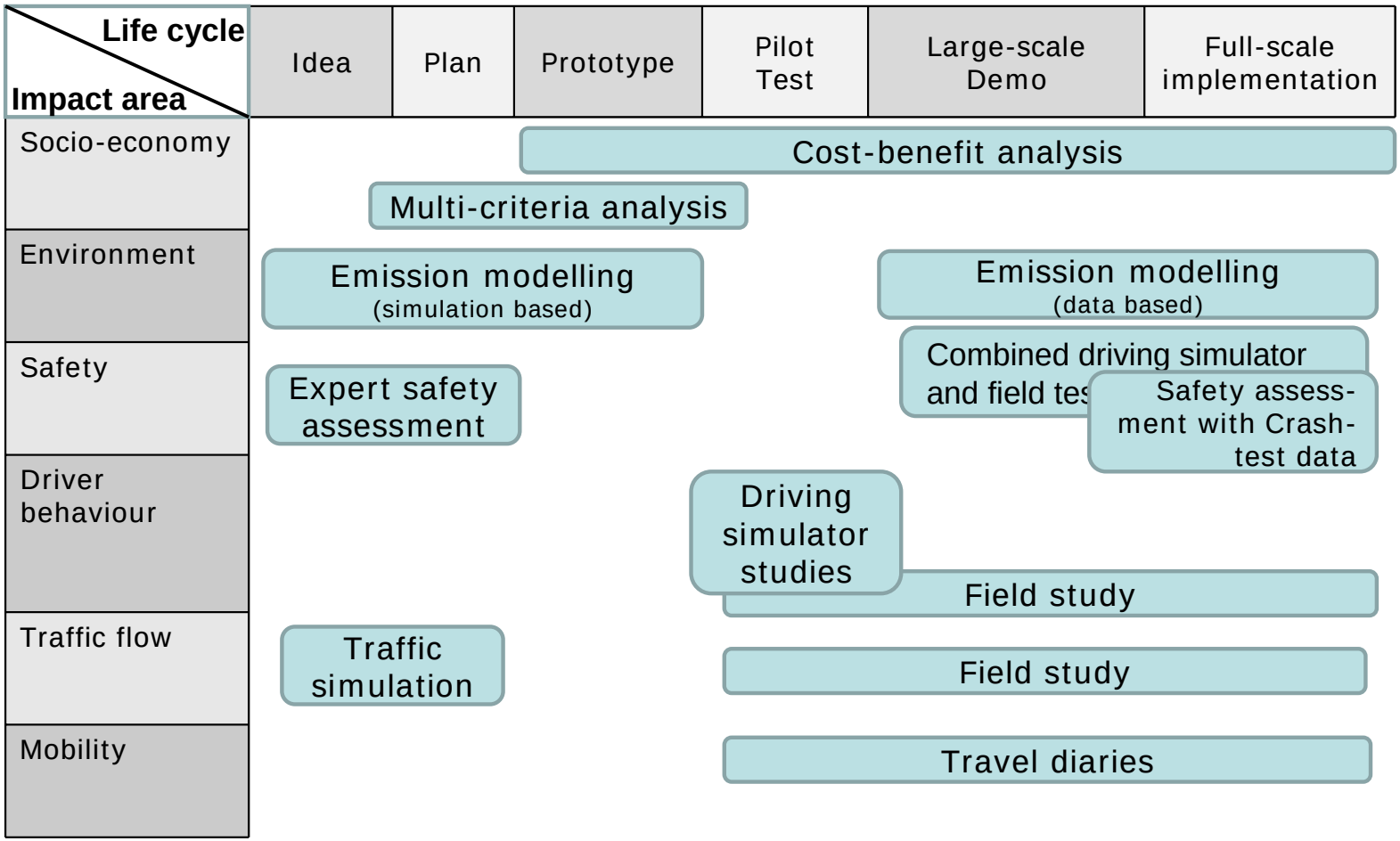
Framework for method description (2)

- Description of the method
  - Type of assessment (desktop, lab, simulator, field, statistics)
  - Process/design
    - Test persons/ Sample size/ Set-up, design/ Measuring equipment/ Data requirements
  - Expertise needed

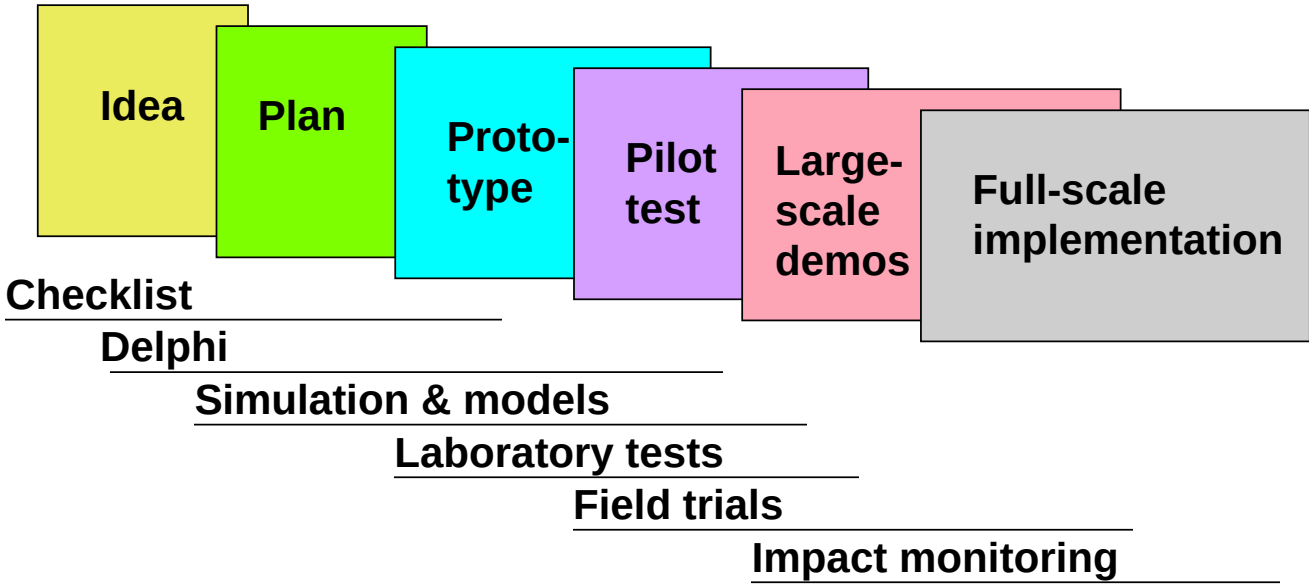
- Results:
  - Parameters / description
  - Type of output
- Restrictions of the method
  - Limitations, Scalability, extension to real world, Reliability and risks

- Examples of use
  - Authors / Developers, key references to the method and its application to ITS
  - Availability of an electronic version

Methods related to impact areas and life-cycle phase



Development life cycle



– **Suggestions / comments**

	Impact area					
	Socio-economy	**Environment**	**Traffic safety**	**Driver behaviour**	**Traffic efficiency and traffic flow**	**Mobility**
Large-scale field study	x	x	x	x	x	x
Small-scale field-test with instrumented vehicles		x	x	x	(x)	(x)
Combined driving simulator and field test		x	x	x	(x)	
Expert assessment (on safety impacts)			x	x		
Safety assessment with Crash Data			x		(x)	
Cost benefit analysis (CBA)	x					
Multi criteria analysis (MCA)	x	x	x	x	x	x
Emission modelling		x				
Air quality monitoring		x				
Focus group study		(x)	(x)	x	(x)	x
Traffic simulation		x	x		x	
Driving simulator studies			x	x	(x)	
Travel diaries			(x)		(x)	x

		Development phase					
		Idea	**Plan**	**Prototype**	**Pilot test**	**Large-scale demos**	**Full-scale implementation**
Costs	**low cost**	Expert assessment on safety impacts Multi criteria analysis (MCA) Traffic simulation	Expert assessment on safety impacts Multi criteria analysis (MCA) Traffic simulation	Expert assessment on safety impacts Multi criteria analysis (MCA) Focus group study Traffic simulation	Expert assessment on safety impacts Cost benefit analysis (CBA) Focus group study Traffic simulation	Expert assessment on safety impacts Cost benefit analysis (CBA) Focus group study Travel diaries	Expert assessment on safety impacts Safety assessment with Crash Data Cost benefit analysis (CBA) Focus group study Travel diaries
	medium cost	Emission modelling Driving simulator studies	Emission modelling Driving simulator studies	Emission modelling Driving simulator studies Small-scale field test with instrumented vehicles	Combined driving simulator and field test Small-scale field test with instrumented vehicles Air quality monitoring	Combined driving simulator and field test Air quality monitoring	Combined driving simulator and field test Air quality monitoring
	high cost					Large-scale field study	Large-scale field study

Plenary discussion

- Is the structure of the catalogue transparent and useful?
- What should such a catalogue include? What is missing?
- What is not necessary in the catalogue?
- Is the catalogue practical for you as a stakeholder in vehicle safety systems?
- Are the items included relevant for the users of the catalogue?
- More examples of references or methods to be included?
- How well are IVS impact assessment methods covered by our methods?
- Should we, and is it possible to provide information about costs or cost efficiency?
- What are your reactions to the cost table table?

Thank you!

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Expert Workshop
iCars Catalogue of Impact Assessment Methods

Group discussion
Safety and Driver Behaviour

Jesús Martínez
CTAG

Amsterdam, 25 March 2010

Safety and Driver Behaviour assessment methods

- Safety methods:
  - Safety assessment with crash data
  - Expert assessment on safety impacts

- Driver behaviour methods:
  - Driving simulator studies
  - Small scale field-test with instrumented vehicles
  - Combined driving simulator and field test

Safety assessment with crash data

- *This method involves analysing a set of crash data and estimating how some incidents could be avoided with an IVS system. The objective is to find out the effect of the system in terms of number of fatalities that could have been prevented.*

- More suitable for last development phases.
- Results are very accurate, as they are based on real data.
- Best results with post-crash systems.
- Limitations:
  - A complete record with crash data is needed.
  - The crash analysis should be made by experts in several fields.

- References:
  - Frampton R., Thomas P. (2007). Efectiveness of Electronic Stability Control Systems in Great Britain. Loughborough Universit.
  - Virtanen N. (2005). Automattisen hätäviestijärjesttelmän vaikutukset onnettomuustilanteessa [Impacts of an automatic emergency call system of accident consequences]. AINO-publications 14/2005. Ministry of Transport and Communications, Helsinki.

Expert assessment on safety impacts

- *A group of experts try to estimate the expected changes in the driver behaviour based on the system specification. These predicted behavioural changes help to estimate the safety impact. The objective is to estimate the impact of the IVS system in terms of numbers of fatalities and injuries in the selected target years.*

- Early phases of the system development.
- Outcome can be used as an input for a Cost Benefit Analysis.
- Limitations:
  - Experts with high experience in impact estimations are needed
  - The predictions rely on the assumptions made.
  - Availability of data will improve the estimates

- References:
  - Socio-economic assessment of cooperative system deployment. CODIA project, final report.
  - Vehicle Safety Systems, eImpact Project. Deliverable D4.

Driving simulator studies

- *A driving simulator study for impact estimation of IVS involves a number of test persons using the IVS system in several traffic situations in a driving simulator. The objective is to measure the changes in the behaviour of the drivers with the IVS system while driving normally or in a specific situation.*

- More suitable for development and test phases.
- Allow to test dangerous and limit situations, as it is risk-free.
- Internal validity.
- Limitations:
  - Rather high amount of resources needed.
  - Limited external validity.

- References:
  - Driving simulator study for intelligent cooperative intersection safety system (IRIS) (part of the European research project SAFESPOT).
  - Feenstra P.J., Hogema J.H. (2007). Driving simulator assessment for human factors research. In Proceedings 6th European Congress and Exhibition on Intelligent Transport Systems and Services, Aalborg, Denmark.
  - Driving with Intelligent Vehicles – Driving behaviour with ACC and the acceptance by individual drivers.
  - Hoedemaeker M. (1999). Driving with Intelligent Vehicles, Driving behaviour with Adaptive Cruise Control and the acceptance by individual drivers. TRAIL Thesis Series T99/6. Delft University Press. Delft, The Netherlands.
  - Minderhoud M.M. (1999). Supported Driving: Impacts on Motorway Traffic Flow. TRAIL Thesis Series T99/4. Delt University Press. Delft, The Netherlands.

Small-scale field-test with instrumented vehicles

- *This method is similar to a large-scale field-test, but the number of test persons is reduced and usually the drivers' own cars are not used, but special instrumented vehicles. The objective is to observe and measure the drivers' behaviour recording data in a real-world setting from a set of instrumented cars.*

- Last phases of life cycle.
- External validity.
- Limitations:
  - Resources needed (instrumented cars, test persons, etc.).
  - Limited amount of cars doesn't always give statistically significant results

- References:
  - Van der Horst, A.R.A. & Bakker, P. (2006). Driver behaviour in transitions in car following situations on motorways (Rep. No. TNO report TNO-DV3 2006-M034). Soesterberg, Netherlands: TNO Defence, Security and Safety BU Human Factors.

Combined driving simulator and field test

- *This method involves testing a system both in a driving simulator and in a real car. The objective is to observe the drivers' behaviour and eventually predict an accident reduction due to the ITS system used.*

- Last phases of the life cycle.
- Wide range of situations covered (also dangerous situations in driving simulator).
- Limitations:
  - Resources needed (simulator, test cars, test persons, etc.).
  - Limited amount of cars and test persons doesn't always give statistically significant results

- References:
  - Carsten O., Fowkes M. (2000). External Vehicle Speed Control.

Discussion topics

- How well are the areas ”Safety” and ”Driving behaviour” covered?
  - Are there any methods or important studies missing?
  - What is the most ’typical’ use of the methods?
  - What are strong and weak points of these methods (not yet mentioned)?
  - How to manage error variances/inaccuracies?
- Costs of impact assessments – cost efficiency
  - Should we, and is it possible to provide information about costs and cost efficiency?
- What is missing in the catalogue concerning these methods?
  - How should the methods be further developed in the catalogue?
  - Which information would be most useful for you or other users of the catalogue (Industry/Researchers/Public)
- How to increase quality/ reliability of the methods and their outcomes?
  - Available methods?
  - Practical experiences?

Thank you!

Jesús Martínez,
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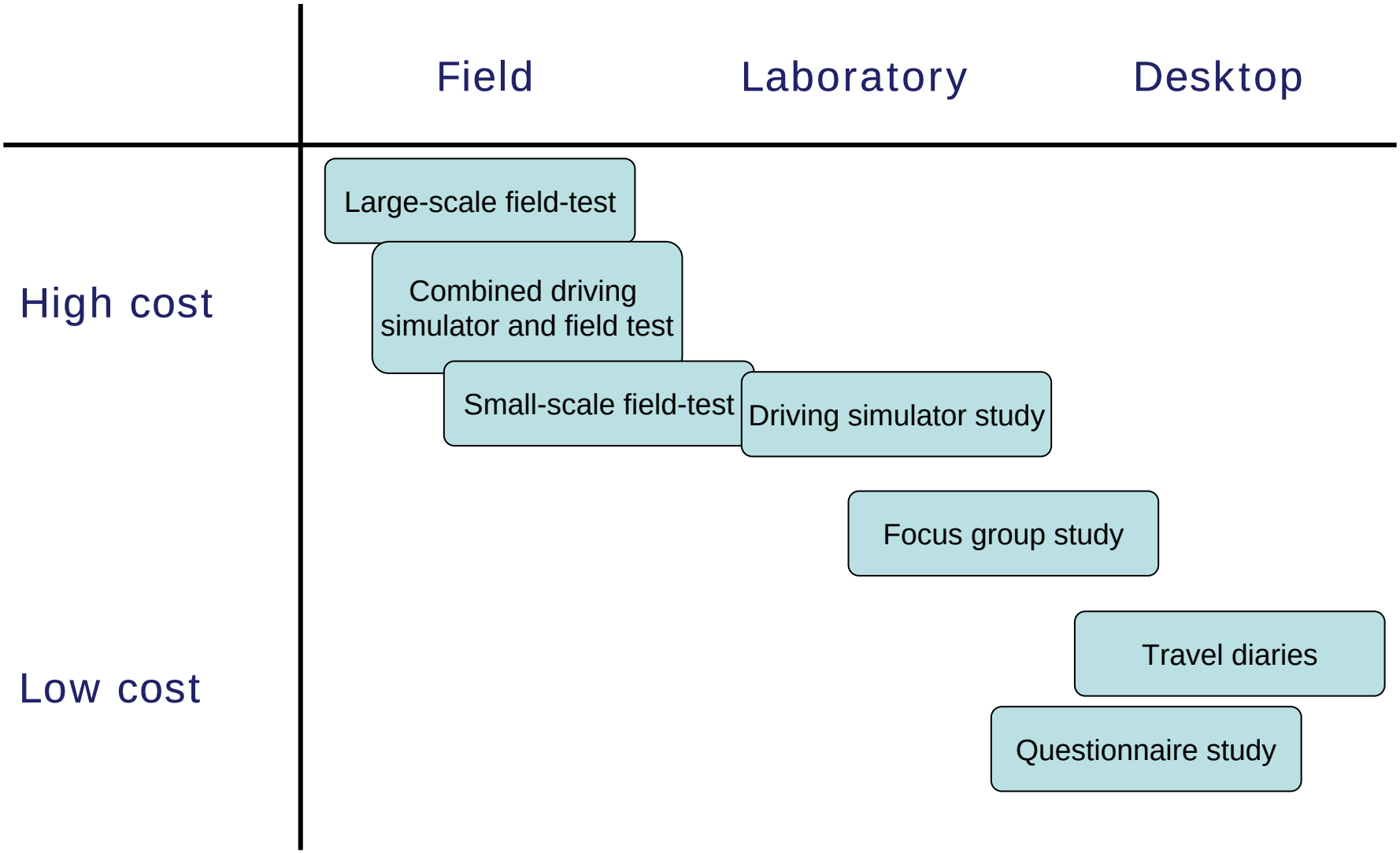
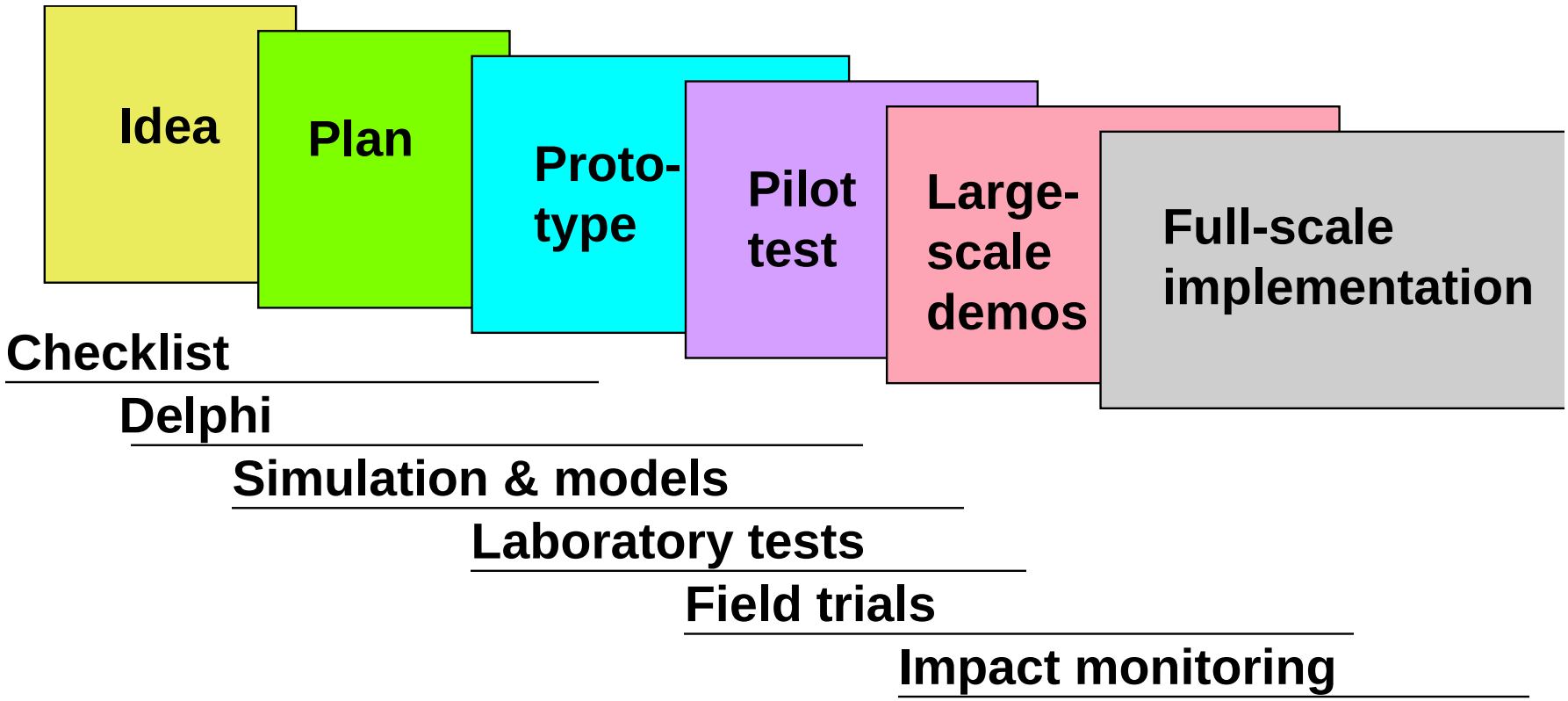
Backup slides

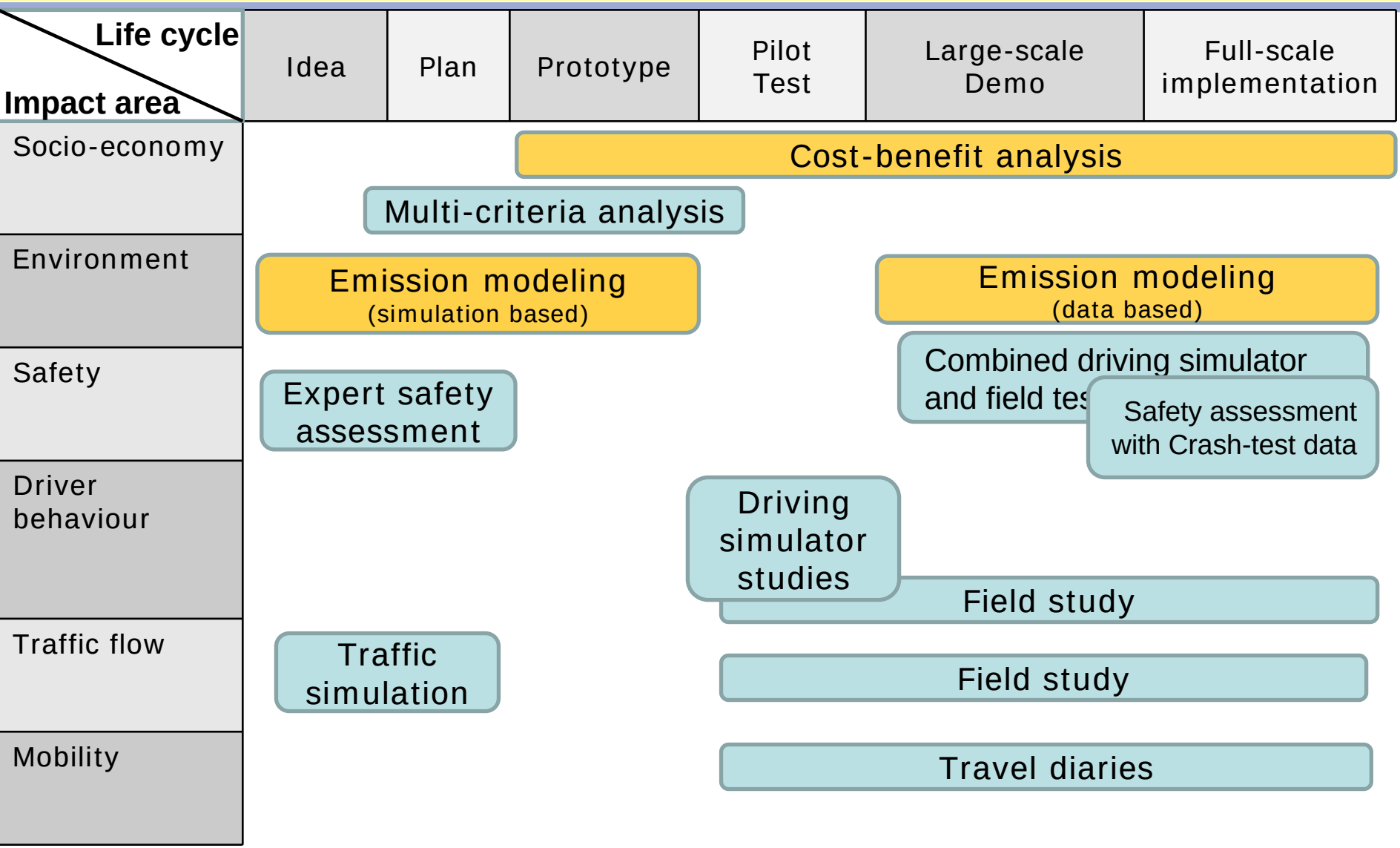
Driver behaviour methods



Life-cycle of the product/ Intelligent vehicle system



Relation of methods to impact areas and development phase



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iCars Network

Expert Workshop iCars Catalogue of Impact Assessment Methods

Group discussion Environmental and socio-economic assessment

Andreas Lüdeke
BAST

Amsterdam, 25 March 2010

Impact area: Socio-economy and environment

- Methods ”Environment”
  - 4.10 Emission modelling
  - 4.11 Air quality monitoring

- Methods “Socio-economy”
  - 4.12 Cost-benefit analysis (CBA)
  - 4.13 Multi-criteria analysis (MCA)

Emission modeling

"Estimation of traffic emission when vehicle fleet or its activity changes; changes to be derived by micro-/ macro-simulation models or field data"

- Local emission effects are derived by using micro simulation and regional/national effects by macro simulation
- Simulation results based on stochastic processes can be described by e.g. standard deviation, confidence limits,...
- Limitations: Micro simulation is restricted to representative network sections and a restricted number of scenarios (sometimes lack of realism)
- References:
  - ADVISORS (2003), CODIA (2008)

Air quality monitoring

"Monitoring of air quality with measuring instruments to evaluate the effect of IVS on e.g. CO2, NOX, PM10 emissions; to determine the effect in relation to the IVS also the number of passing vehicles equipped has to be monitored."

- Method is costly and time consuming and requires a lot of experience; but valuable data can be gathered.
- Requires sufficient number of equipped vehicles to get statistical significant results
- Problem of scalability since results very much depend on local traffic situation
- References:
  - ATM Monitoring and Evaluation, Active Traffic Management on the M42 motorway UK, Monitoring and Evaluation Report (2008)

Cost-benefit analysis (CBA)

"Comparison of benefits with costs of IVS by converting impacts into monetary terms by multiplying impact units with cost-unit rates"

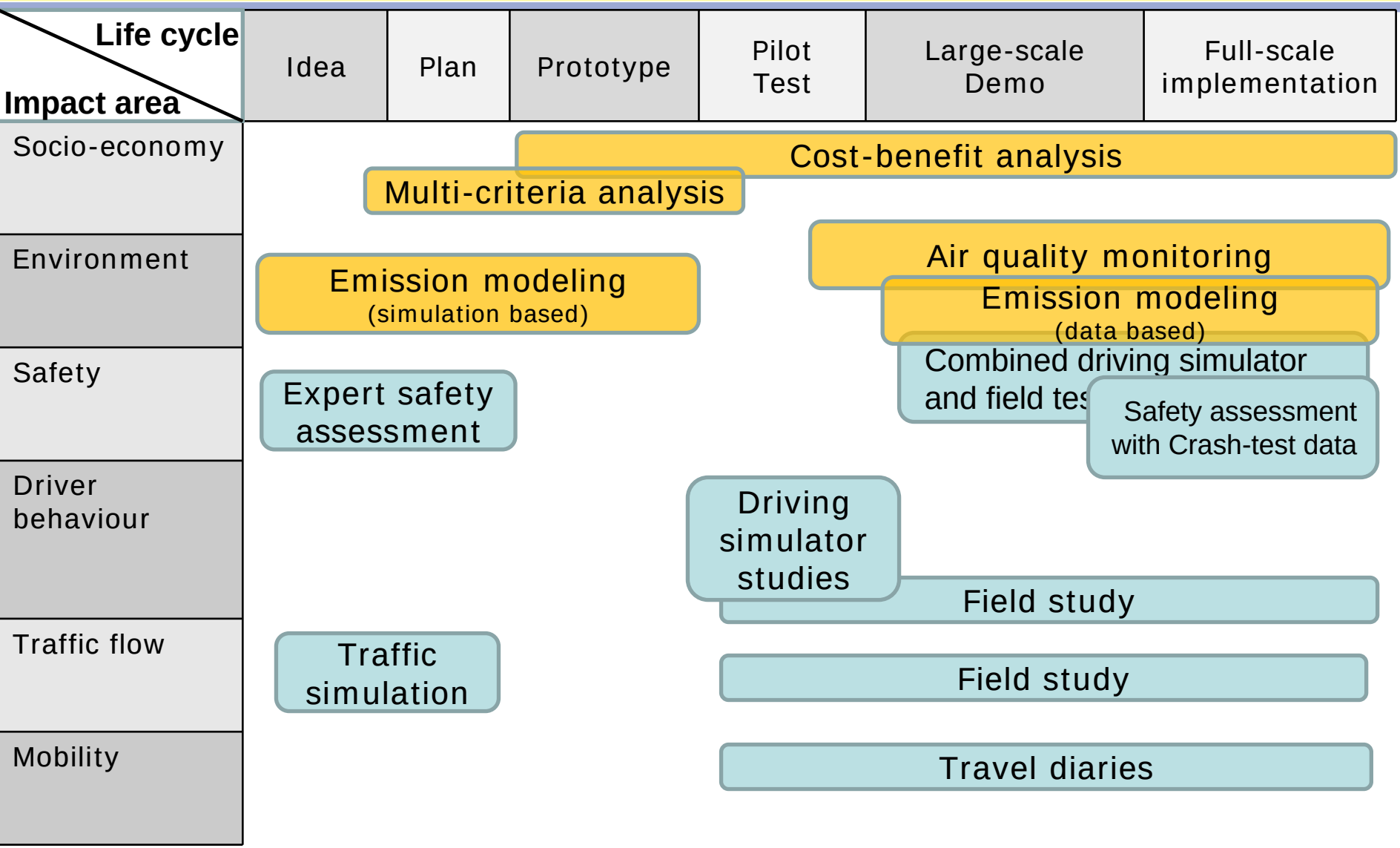
- Providing an overall assessment of IVS
- Assessment of IVS has to be based on forecasting of accident trend, market diffusion of IVS, vehicle fleet, …
- Target group of CBA are especially decisions makers in public authorities
- Limitations
  - if not all impacts converted to monetary values
  - no stakeholder perspective
- References:
  - SEISS (2005), CODIA (2008), eIMPACT (2008)

Multi-criteria analysis (MCA)

"Measuring performance of an IVS by scoring against established criteria (safety, driver comfort, environmental impact, travel time reductions); criteria are based on objectives of the decision making group (e.g. experts, relevant stakeholders)"

- Early application in plan/prototype phase of development life-cycle
- Outcome: Ordinal ranking of different alternatives of an IVS
- Limitation: Valid only given the objectives of assessment, and for the group of experts ("subjective"); Generalisation is difficult!
- References:
  - ADVISORS (2003), eIMPACT (2008)

Relation of methods to impact areas and development phase



Discussion topics

- How well are the impact areas “socio-economy” and “environment” covered by the methods?
  - Are there any methods or important studies missing?
  - What is the most “typical” use of the methods?
  - What are strong and weak points of these methods methods (not yet mentioned)?

- What is missing in the catalogue concerning these methods?
  - How should the methods be further developed?
  - Which information would be most useful for you or other users of the catalogue (Industry/ Researchers/ Public)?

- How to increase quality/ reliability of the methods and their outcomes?
  - Available methods?
  - Practical experiences?

- Costs of impact assessments – cost efficiency
  - Should we, and is it possible to provide information about costs and cost efficiency of method?

Thank you!

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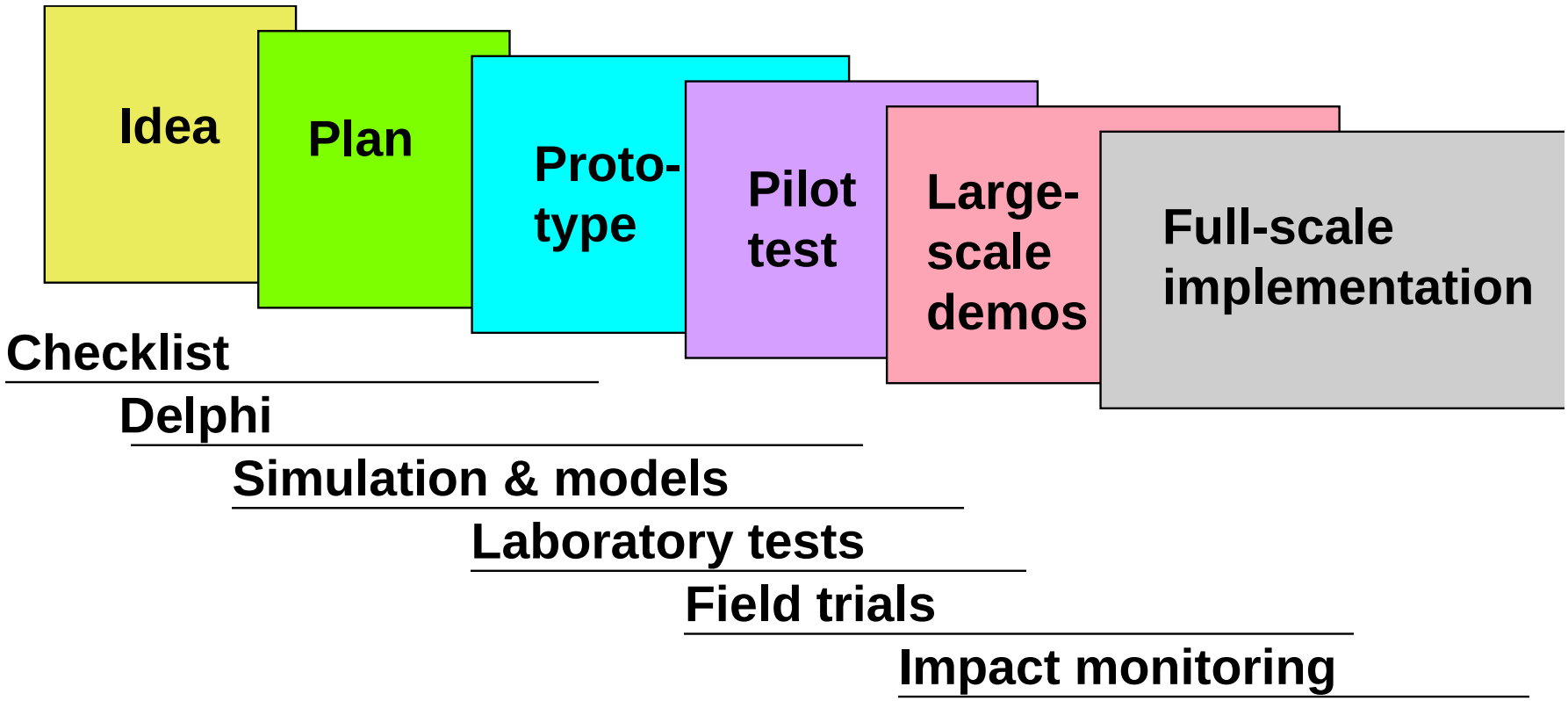
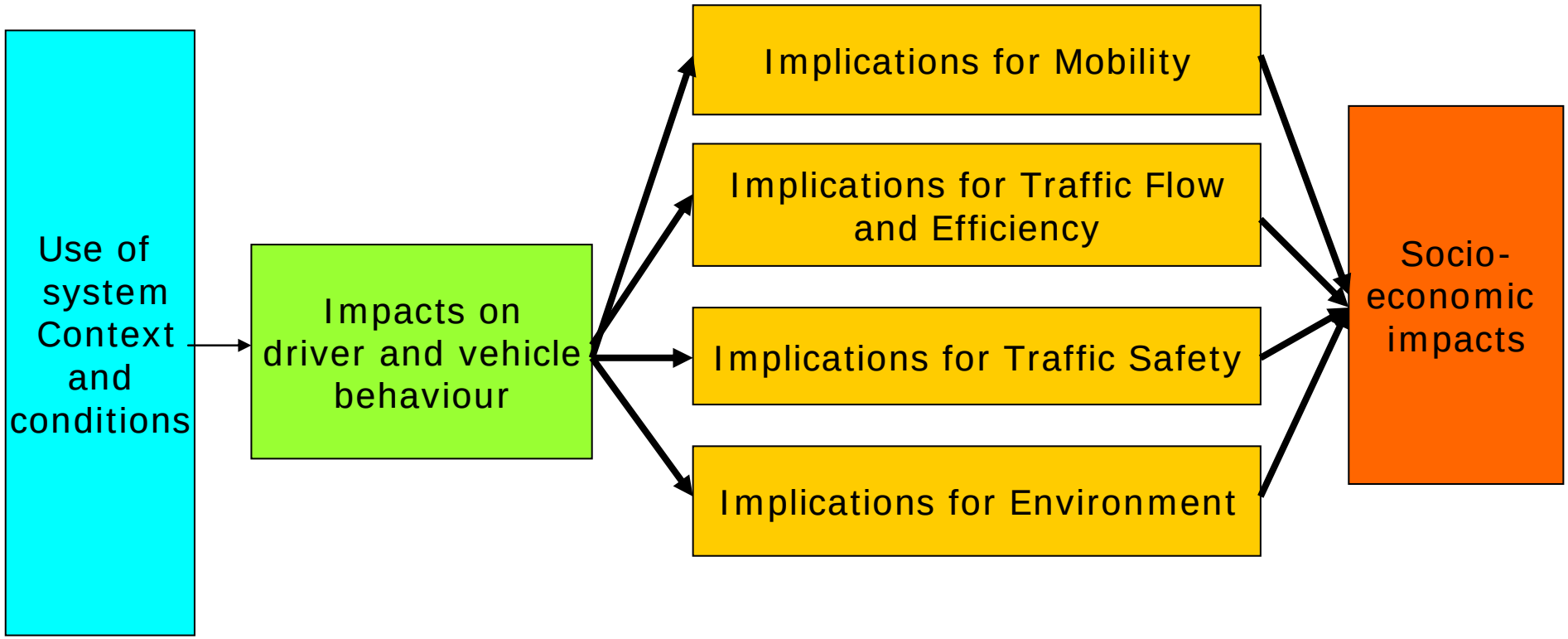
Backup slides

Life-cycle of the product/ Intelligent vehicle system



Impacts are mediated via driver behaviour



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iCars Network

Expert Workshop
iCars Catalogue of Impact Assessment Methods

Group discussion
Traffic flow, efficiency and Mobility

Gerdien Klunder
VTT / TNO

Amsterdam, 25 March 2010

Traffic Flow, efficiency and Mobility assessment methods

- Methods Traffic Flow and efficiency :
  - **Large-scale field study**
  - Small-scale field-test with instrumented vehicles
  - Combined driving simulator and field test
  - Expert assessment
  - Multi criteria analysis (MCA)
  - **Traffic simulation**
  - Driving simulator studies

- (Additional) Methods Mobility:
  - **Travel diaries**
  - **Focus group study**
  - Large-scale questionnaire study

Large-scale field study

- *A field study involves observing drivers while they are using the IVS system while driving normally. The objective is to measure the impacts in large-scale use with a considerable amount of test users to get statistically significant results.*

- Very informative and reliable method
- Last phases of life cycle
- Limitations:
  - High amount of resources, equipment and test persons needed
  - Learning effect and behaviour is affected when the test persons know their behaviour is recorded

- References:

  - Mazzae E. et al. (2001). NHTSA Light Vehicle Antilock Brake SystemResearch Program Task 7.1: Examination of ABS-Related Driver Behavioral Adaptation – License Plate Study.
  - TAC SafeCar Project. On-Road Evaluation of Intelligent Speed Adaptation, Following Distance Warning and Seatbelt Reminder Systems: Full Report
  - Hjälmdahl, M. (2004). In-vehicle speed adaptation. On the effectiveness of a voluntary system (Doctoral dissertation).
  - FESTA Handbook (2008). FESTA (Field operational test support Action) consortium. European Commission DG Information Society an Media, 7th Framework Programme.

Traffic simulation

- *"A computer program that uses mathematical models to conduct experiments with traffic events on a transportation facility or system over extended periods of time" (HCM). By simulating a change in the traffic situation, such as the introduction of an IVS, the effects on the traffic flow in a network can be studied.*

- Different types of traffic models for different levels of detail and network sizes (micro/meso/macro)
- Large effort for calibration/validation
- Mainly for impact assessment on traffic flow; for impact assessment on environment, additional models are needed. Impact assessment on traffic safety is difficult and not very reliable (better driver models are needed)
- Reliability/accuracy: not very high, since it is based on simulation instead of (or added to) real-world observations. Often for situations for which no real-world application exists. However, often it is the only option.
- Most traffic models don't offer the possibility of modelling IVS and changed user behaviour in detail

- References:
  - Network effects of Intelligent Speed Adaptation Systems
  - eIMPACT, "Socio-economic Impact Assessment of stand-alone and co-operative intelligent vehicle safety systems (IVSS) in Europe", http://www.eimpact.info/results.html
  - S. Ossen. "Longitudinal Driving Behavior: Theory and Empirics", Ph.D. thesis TU Delft, 2008

Travel diaries

- *A method whereby each survey subject records each trip made over a specified period of time in a diary*
- Low costs
- Most used and most suitable method for mobility studies and transport system planning
- Composition of suitable group of test persons is important; should have the desired distribution over relevant aspects such as gender, age etc.

- References:
  - Andreas Allström, e.a. (2006). Changes in travel habits in Stockholm County – Effects of the Stockholm Trial. Trivector Traffic, Report 2006:67

Focus group study

- ***A focus group is a form of qualitative research in which a group of people are asked about their attitude towards a product, service, concept, advertisement, idea, or packaging. Questions are asked in an interactive group setting where participants are free to talk with other group members***
- Strong points:
  - Very efficient way to get user feedback and initial reactions
  - Produces data and insights that would be less accessible without interaction found in a group setting
  - Not costly (e.g. less expensive than conducting interviews)
- Limitations:
  - Does not provide quantitative or objective measures
  - Only considers self-reported behaviour
  - Groups are quite variable and can be tough to get together.
  - Focus groups are "One shot case studies"
  - Severe issues of external validity
  - Participants need to own or have used the system already (system needs to be on the market)

- References:
  - A test method for evaluating safety aspects of ESC equipped passenger cars – A prototype proposal (Mattias Hjort e.a., VTI)
  - A focus group approach towards an understanding of drivers' interaction with in-vehicle technologies (Pereira, M. e.a., INTERACTION)

Concluding remarks

- Field tests are more realistic and reliable than modelling and simulation, but more expensive and more difficult to analyse and interpret.
- There are much less examples found of mobility studies and evaluation methods than for traffic flow efficiency studies. Travel diaries seems the best method for mobility studies.
- Focus group studies can give valuable insight with low-costs. Recomendable method to apply more often, especially in combination with field studies
- Most of these methods are also suitable for other impact areas
- Cost information is difficult, since it depends heavily on the experimental design and set-up

Discussion topics

- Reactions on concluding remarks
- How well are the areas ”Traffic flow and efficiency” and ”Mobility” covered?
  - Are there any methods or important studies missing?
  - What is the most ’typical’ use of the methods?
  - What are strong and weak points of these methods (not yet mentioned)?
  - How to manage error variances/inaccuracies?

- Costs of impact assessments – cost efficiency
  - Should we, and is it possible to provide information about costs and cost efficiency?

- What is missing in the catalogue concerning these methods?
  - How should the methods be further developed in the catalogue?
  - Which information would be most useful for you or other users of the catalogue (Industry/Researchers/Public)

- How to increase quality/ reliability of the methods and their outcomes?
  - Available methods?
  - Practical experiences?

Thank you!

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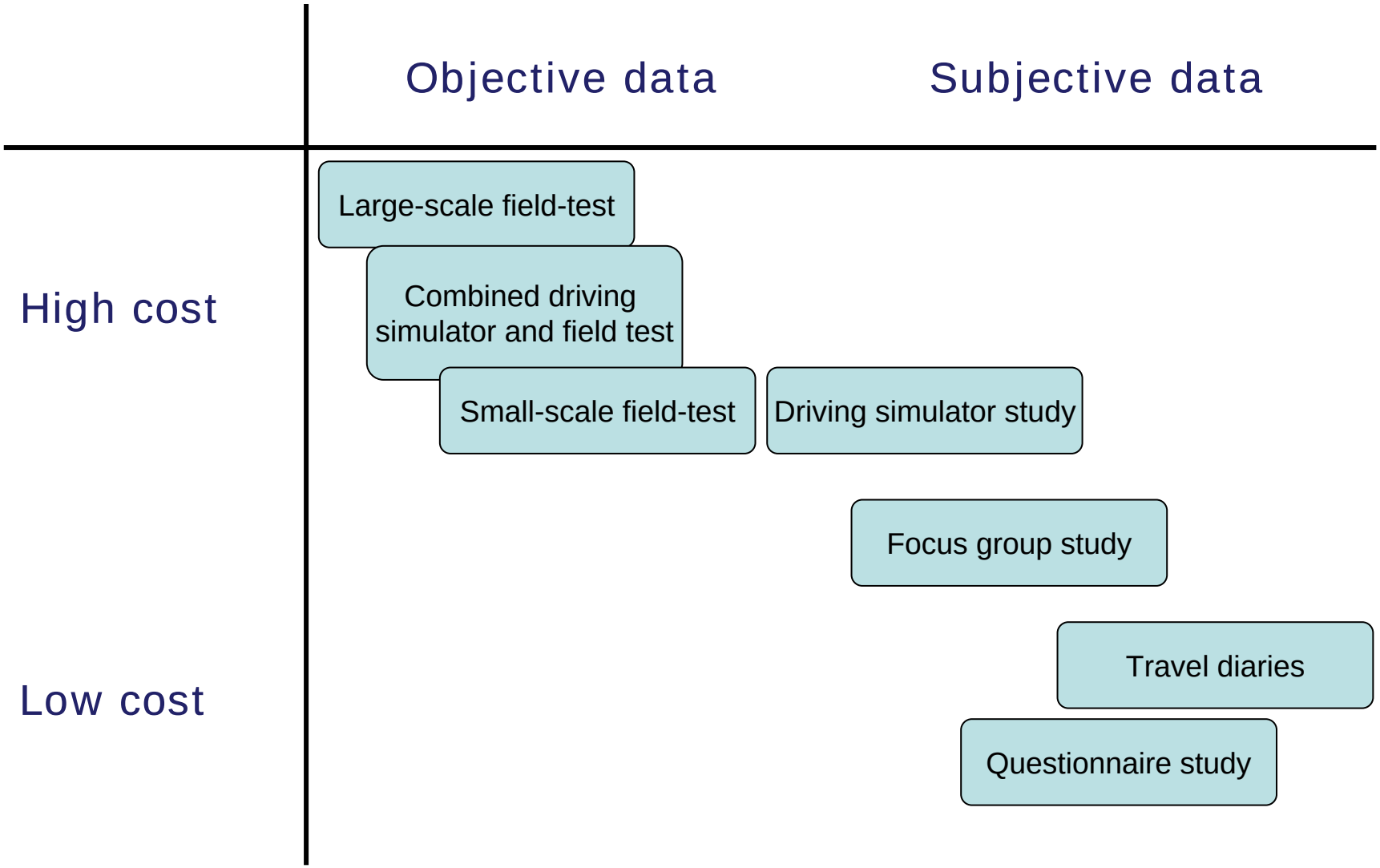
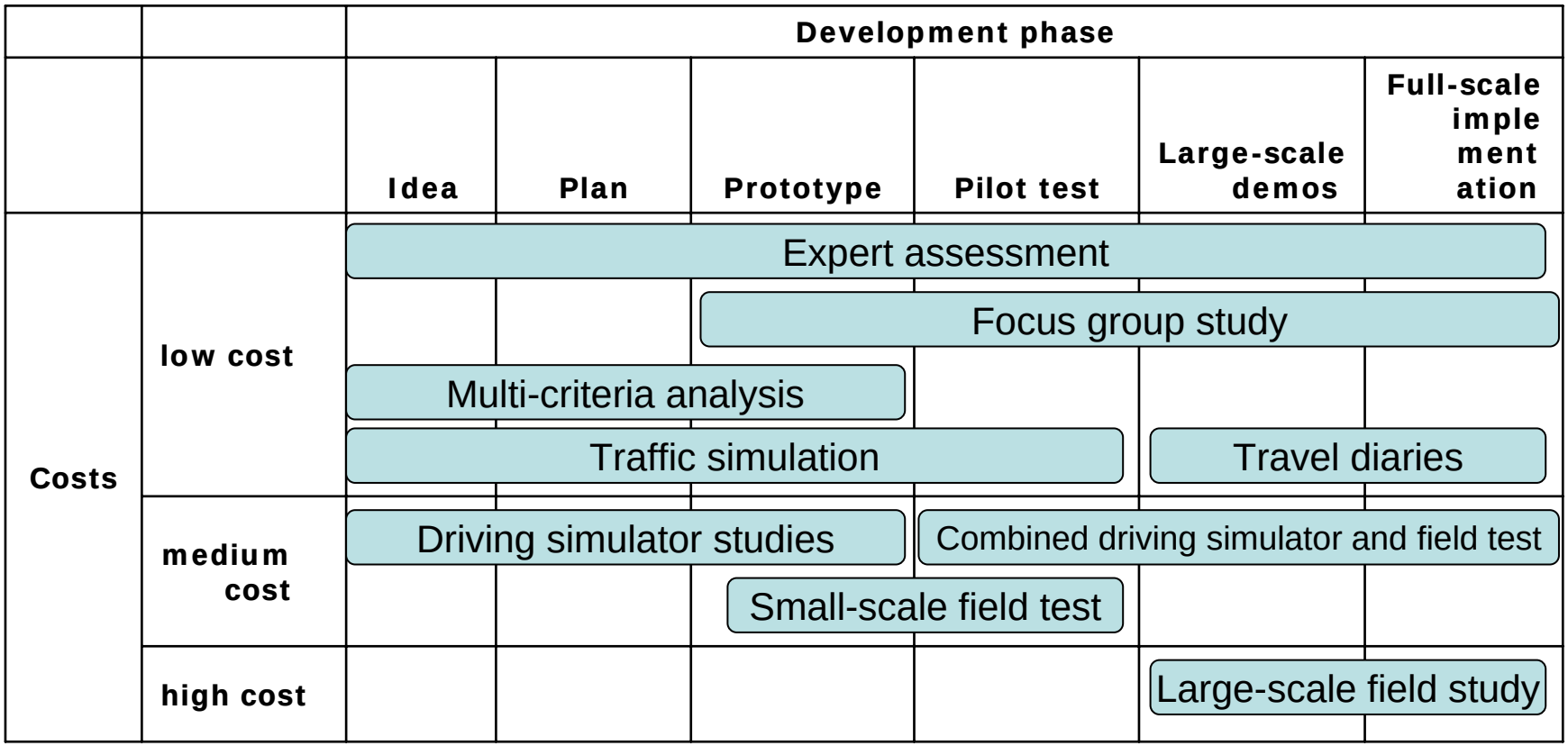
Backup slides

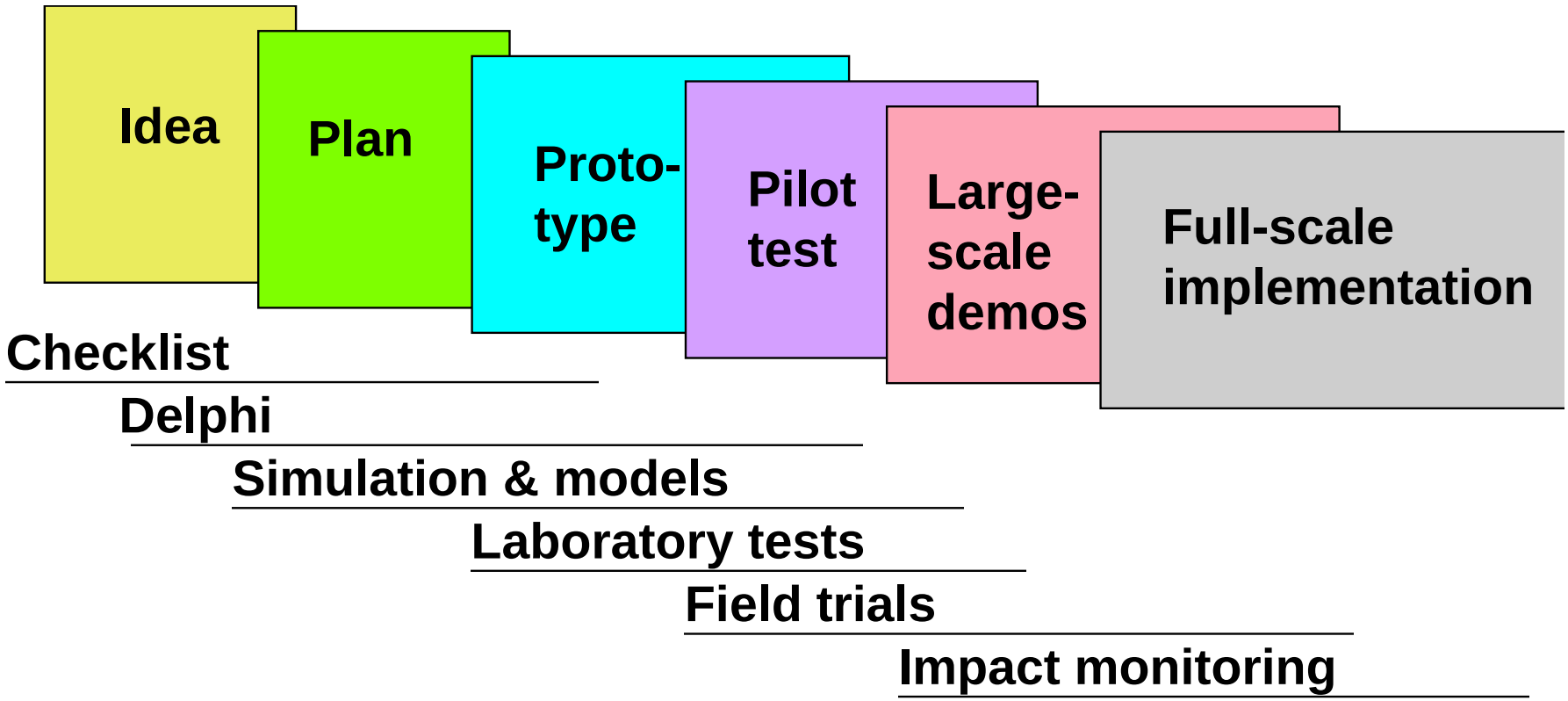
Driver behaviour methods



Costs vs. development phase



Life-cycle of the product/ Intelligent vehicle system



Relation of methods to impact areas and development phase