eIMPACT

Main results

Risto Kulmala
on basis of presentations at final conference

Brussels 15 July 2008

Contents

1. Objectives
2. Partners
3. Overview of work
4. Safety impact assessment
5. Traffic impact assessment
6. Cost-benefit analysis
7. Stakeholder analysis
8. Policy options
9. Conclusions

Objectives of eIMPACT

- Socio-economic impact assessment of IVSS
  - Identify the most promising stand-alone and co-operative IVSS technologies
  - Develop market penetration scenarios for IVSS
  - Estimate impacts on traffic safety and efficiency, carried out a cost-benefit analysis for 2010 & 2020
- Perspectives on the market introduction of IVSS
  - integrating the input from the impact analysis, policy options and stakeholder roles
- Geographical Scope:
  - Europe → EU-25

Source: Kerry Malone

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Partners

TNO
DAIMLER
CENTRO RICERCHE FIAT
BMW
MINI
BOSCH Invented for life
ptv traffic mobility logistics.
VTT
bast
CENTRUM DOPRAVNÍHO VÝZKUMU
movea

Source: Kerry Malone

Information Society and Media
eIMPACT Final Conference, 26 June 2008

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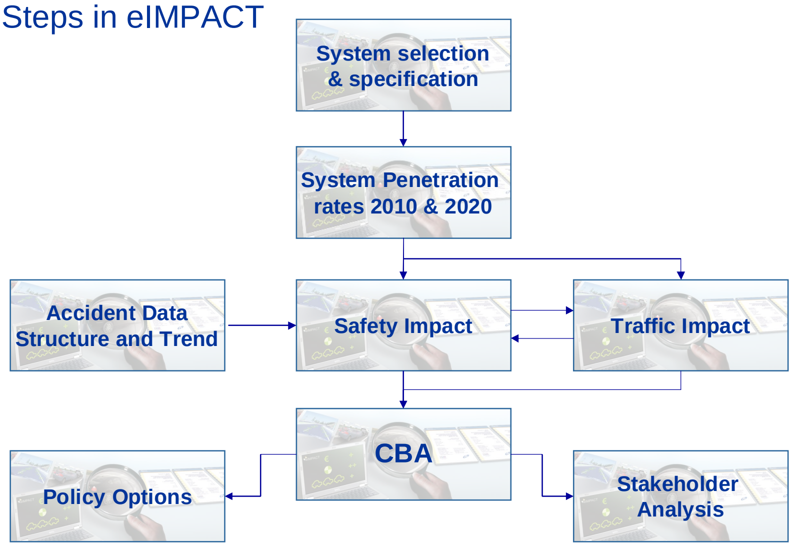
Steps in eIMPACT



Source: Kerry Malone

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eIMPACT principles

- Analyses are based on most recent empirical results, literature review and expert judgment
- Bases of findings are transparent
- Results can be improved when new findings (FOTs, driving simulator, test track) are made available.

Source: Kerry Malone

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Systems assessed

1.	Electronic Stability Control	ESC
2.	Full Speed Range	FSR
3.	Emergency Braking	EBR
4.	Pre-Crash Protection of Vulnerable Road Users	PCV
5.	Lane Change Assistant (Warning)	LCA
6.	Lane Keeping Support	LKS
7.	NightVisionWarn	NIW
8.	Driver Drowsiness Monitoring and Warning	DDM
9.	eCall (one-way communication)	ECA
10.	Intersection Safety	INS
11.	Wireless Local Danger Warning	WLD
12.	SpeedAlert	SPE

Source: Kerry Malone

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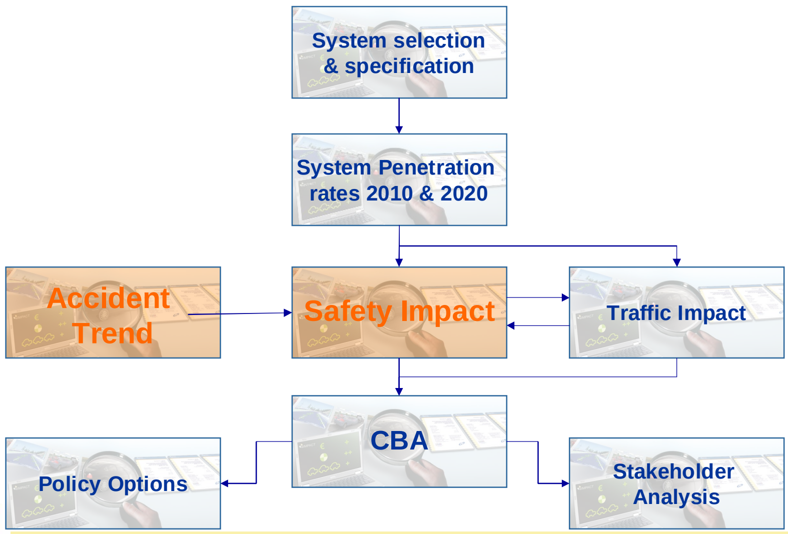
Safety impact assessment in eIMPACT



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Safety mechanisms (1/2)

1. Direct in-car modification of the driving task
   - immediate effects on attention, behaviour, speed, distraction (all)
2. Direct influence by roadside systems
   automatic camera enforcement increases positive effects of SPE
3. Indirect modification of user behaviour
   DDM driver continues driving after long periods of driving
4. Indirect modification of non-user behaviour
   an unequipped driver follows ESC driver in a curve too fast
5. Modification of interaction between users and non-users
   WLD driver forces cars behind to slow down

Source: Risto Kulmala & Pirkko Rämä

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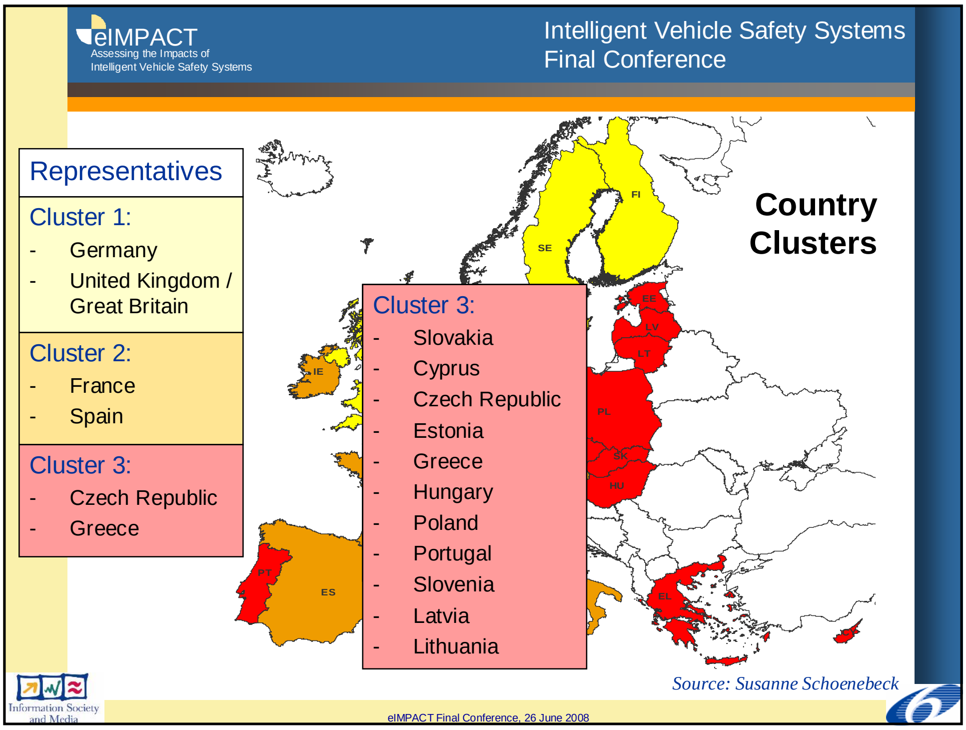
Safety mechanisms (2/2)

6. Modification of road user exposure
   because more comfort tiny amount of extra exposure = mobility
7. Modification of modal choice
   NIW driver used bus more often before
8. Modification of route choice
   motorways are more appealing for FSR driver
9. Modification of accident consequences
   because swifter arrival of help consequences are mitigated for ECA

Source: Risto Kulmala & Pirkko Rämä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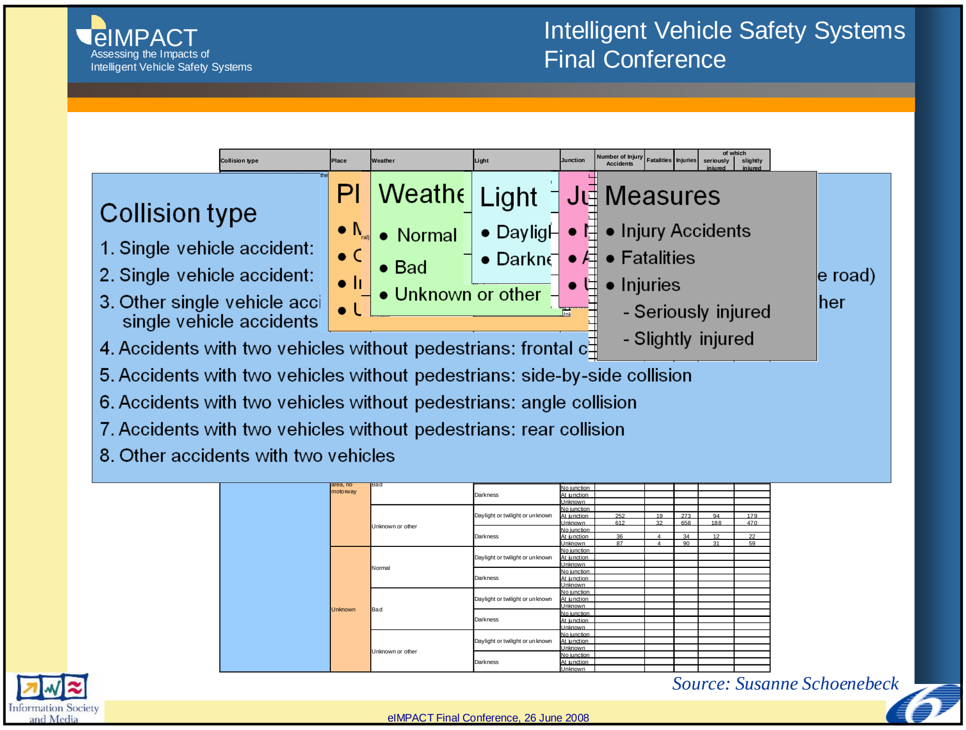
Representatives
Cluster 1:
- Germany
- United Kingdom / Great Britain
Cluster 2:
- France
- Spain
Cluster 3:
- Czech Republic
- Greece
Cluster 3:
- Slovakia
- Cyprus
- Czech Republic
- Estonia
- Greece
- Hungary
- Poland
- Portugal
- Slovenia
- Latvia
- Lithuania
Country Clusters
FI
SE
IE
EE
LV
LT
PL
SK
HU
PT
ES
EL
Source: Susanne Schoenebeck
Information Society and Media
eIMPACT Final Conference, 26 June 2008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Collision type
1. Single vehicle accident:
2. Single vehicle accident:
3. Other single vehicle acci
single vehicle accidents
4. Accidents with two vehicles without pedestrians: frontal c
5. Accidents with two vehicles without pedestrians: side-by-side collision
6. Accidents with two vehicles without pedestrians: angle collision
7. Accidents with two vehicles without pedestrians: rear collision
8. Other accidents with two vehicles
e road)
her
Weathe
• Normal
• Bad
• Unknown or other
Light
• Dayligl
• Darkne
Measures
• Injury Accidents
• Fatalities
• Injuries
- Seriously injured
- Slightly injured
Source: Susanne Schoenebeck
Information Society and Media
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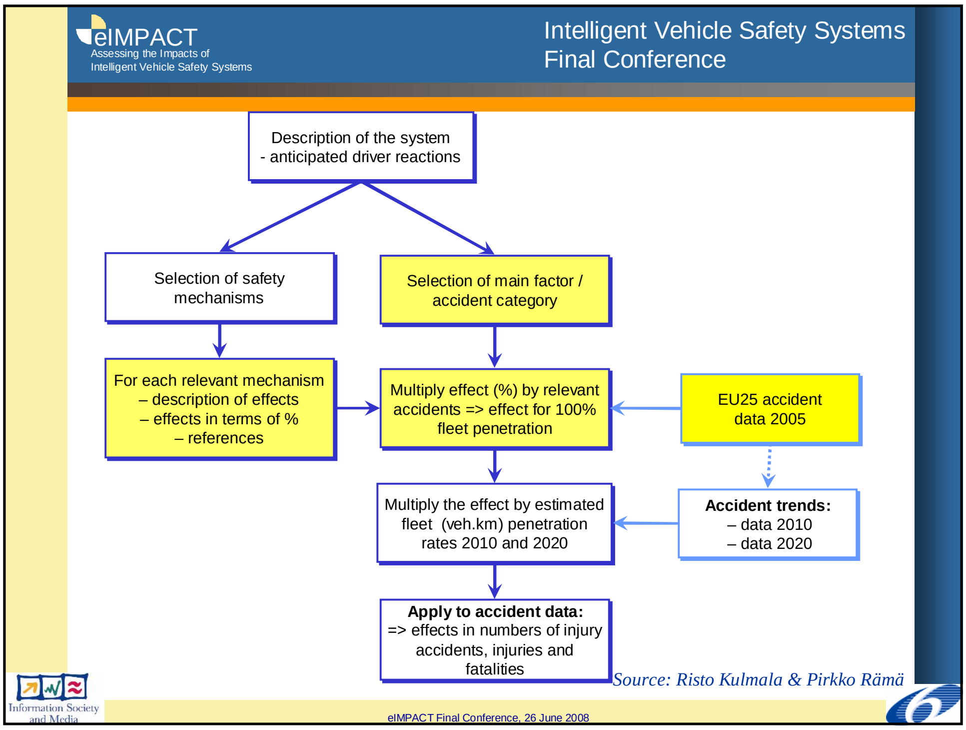
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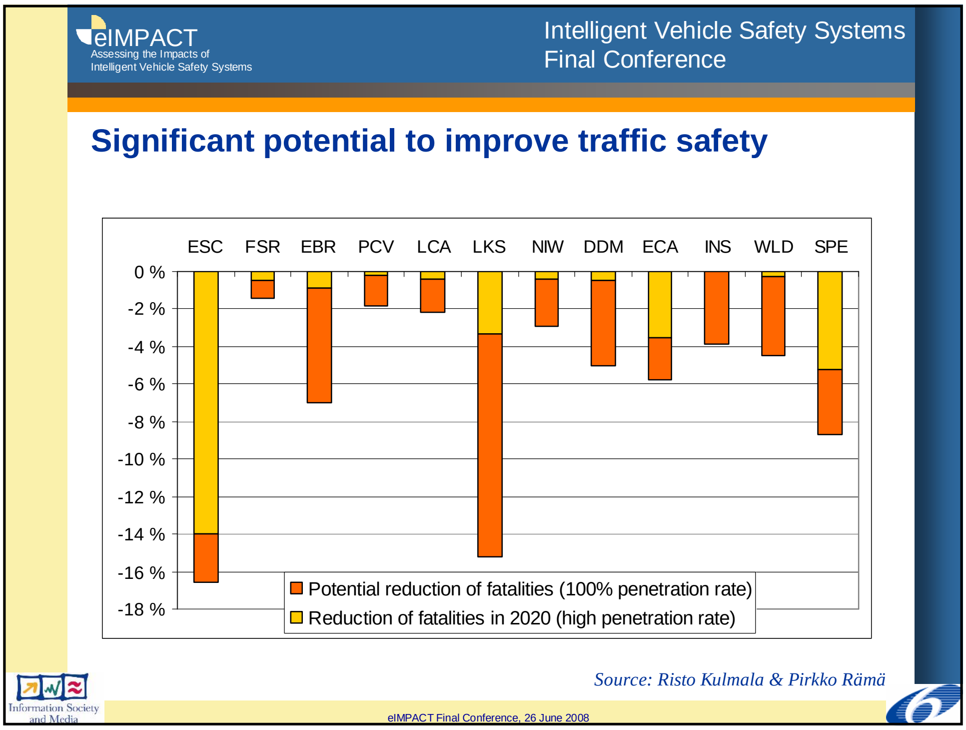
Description of the system
- anticipated driver reactions
Selection of safety mechanisms
Selection of main factor / accident category
For each relevant mechanism
– description of effects
– effects in terms of %
– references
Multiply effect (%) by relevant accidents => effect for 100% fleet penetration
EU25 accident data 2005
Multiply the effect by estimated fleet (veh.km) penetration rates 2010 and 2020
Accident trends:
– data 2010
– data 2020
Apply to accident data:
=> effects in numbers of injury accidents, injuries and fatalities
Source: Risto Kulmala & Pirkko Rämä
Information Society and Media
eIMPACT Final Conference, 26 June 2008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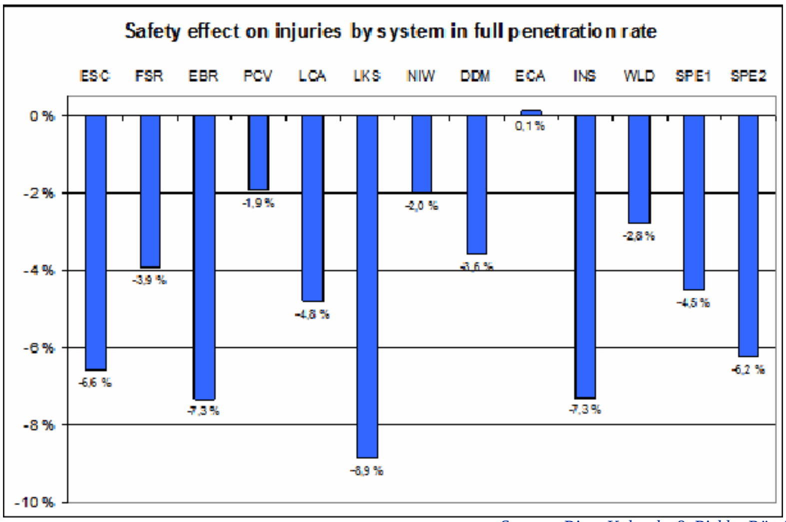
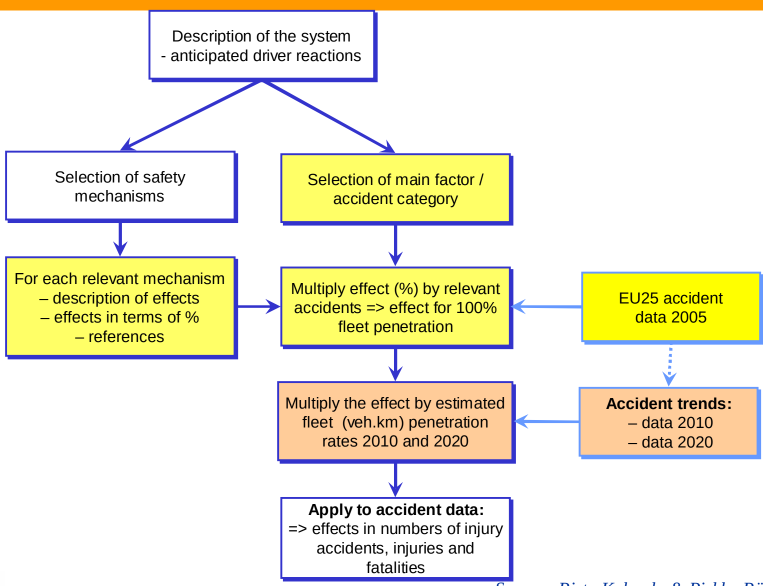
Significant potential to improve traffic safety
ESC FSR EBR PCV LCA LKS NIW DDM ECA INS WLD SPE
0 %
-2 %
-4 %
-6 %
-8 %
-10 %
-12 %
-14 %
-16 %
-18 %
Potential reduction of fatalities (100% penetration rate)
Reduction of fatalities in 2020 (high penetration rate)
Source: Risto Kulmala & Pirkko Rämä
Information Society and Media
eIMPACT Final Conference, 26 June 2008

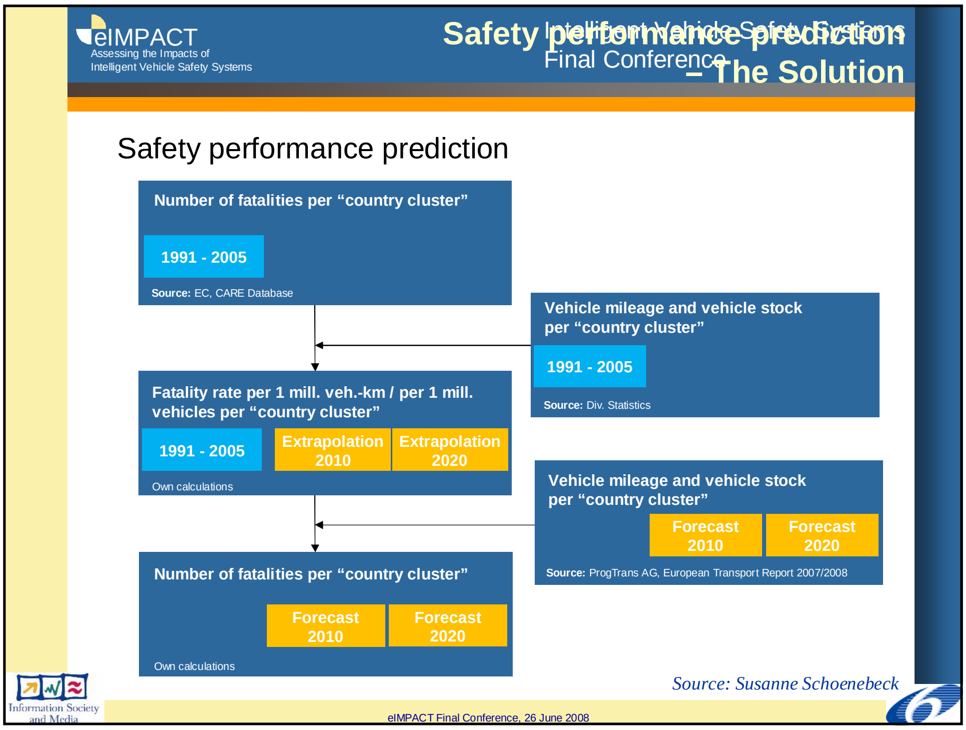
Significant potential to improve traffic safety



Source: Risto Kulmala & Pirkko Rämä



Source: Risto Kulmala & Pirkko Rämä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Safety performance prediction – The Solution
Safety performance prediction
Number of fatalities per "country cluster"
1991 - 2005
Source: EC, CARE Database
Vehicle mileage and vehicle stock per "country cluster"
1991 - 2005
Source: Div. Statistics
Fatality rate per 1 mill. veh.-km / per 1 mill. vehicles per "country cluster"
1991 - 2005
Extrapolation 2010
Extrapolation 2020
Own calculations
Vehicle mileage and vehicle stock per "country cluster"
Forecast 2010
Forecast 2020
Source: ProgTrans AG, European Transport Report 2007/2008
Number of fatalities per "country cluster"
Forecast 2010
Forecast 2020
Own calculations
Source: Susanne Schoenebeck
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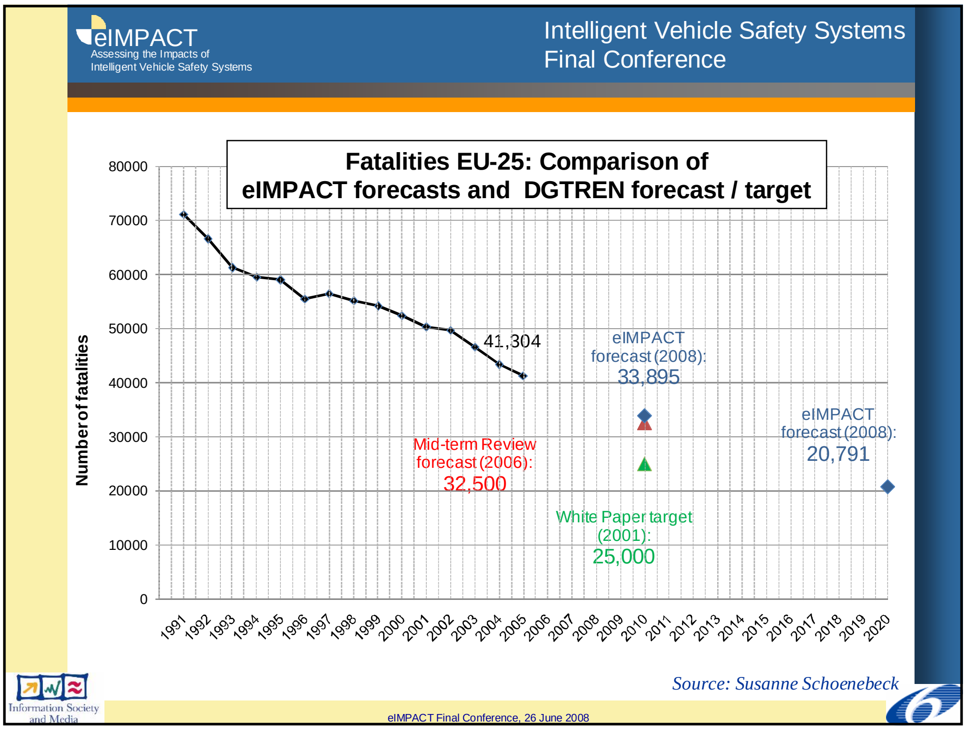
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Fatalities EU-25: Comparison of eIMPACT forecasts and DGTREN forecast / target
Number of fatalities
80000
70000
60000
50000
40000
30000
20000
10000
0
41,304
eIMPACT forecast (2008): 33,895
eIMPACT forecast (2008): 20,791
Mid-term Review forecast (2006): 32,500
White Paper target (2001): 25,000
1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
Source: Susanne Schoenebeck
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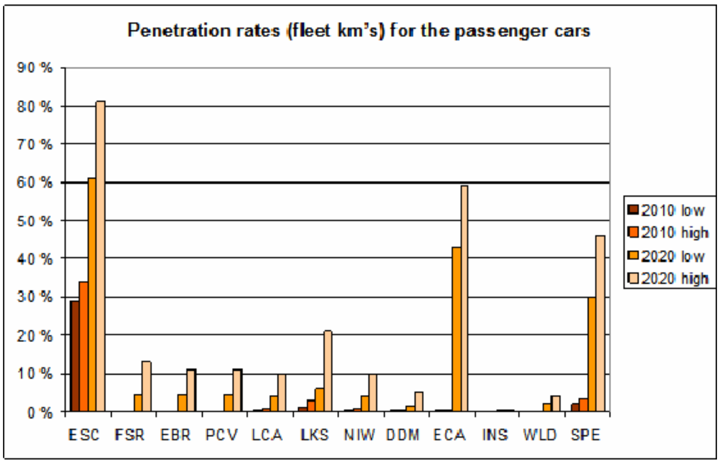
Low fleet vehicle km penetration estimates for many systems



Source: Risto Kulmala & Pirkko Rämä

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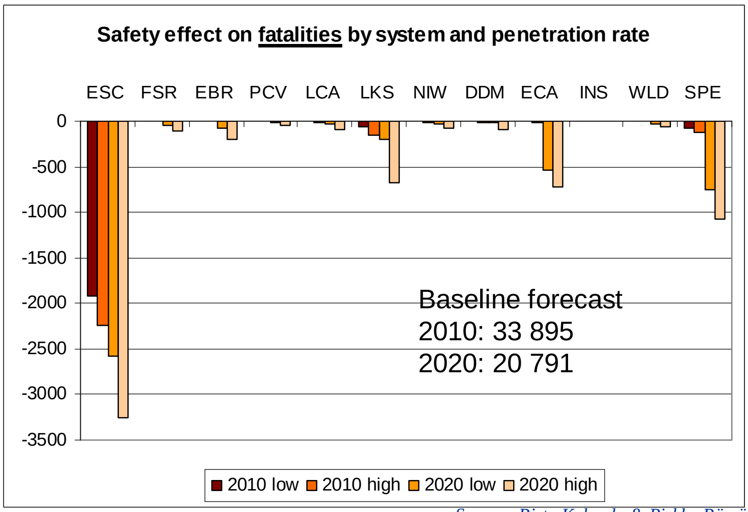
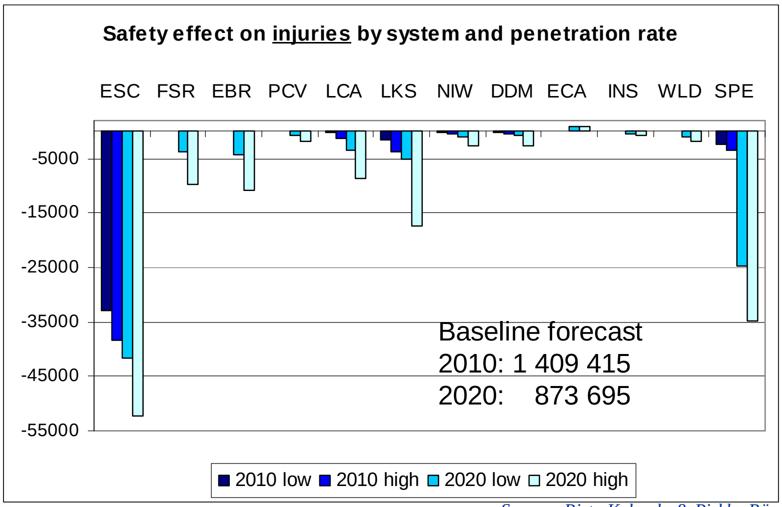
Estimated effects on fatalities in 2010 and 2020



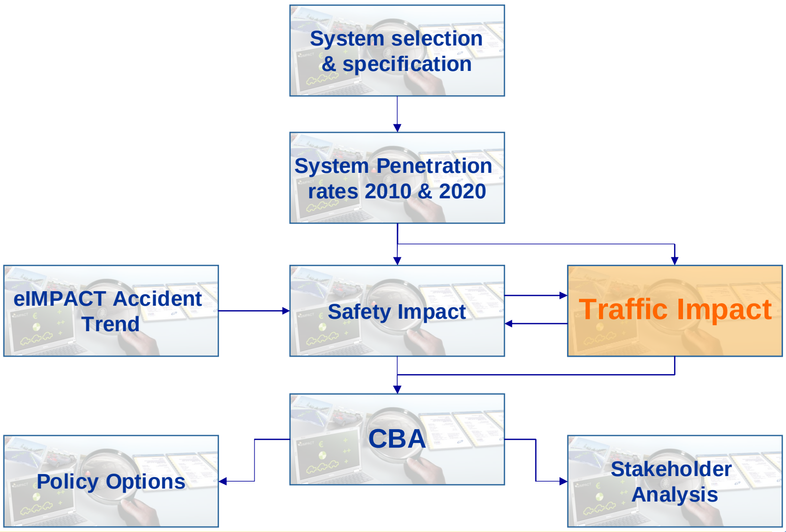
Source: Risto Kulmala & Pirkko Rämä

Estimated effects on injuries in 2010 and 2020



Source: Risto Kulmala & Pirkko Rämä

Traffic impact assessment in eIMPACT



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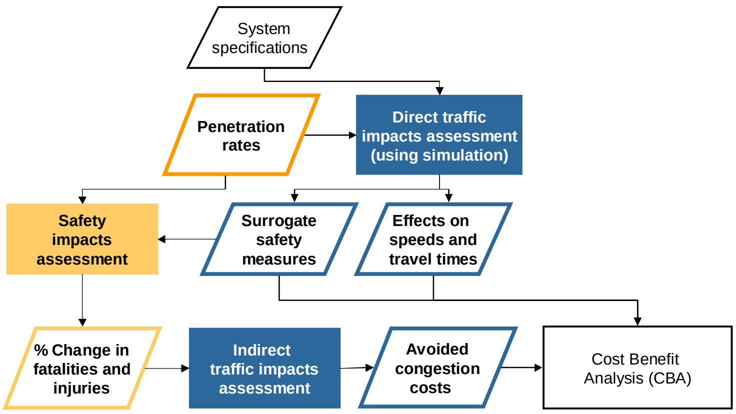
Methodology traffic impact assessment



Source: Isabel Wilmink

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Methodology: direct traffic effects

- Based on micro-simulation of traffic flows to enable modelling of systems analysed in eIMPACT
- System specifications translated into models for vehicle, infrastructure and driver behaviour and communication
  - same assumptions as in safety impact analysis

VISSIM (PTV)	ITS modeller (TNO)
Intersection Safety	SpeedAlert
Full Speed Range ACC	Wireless Local Danger Warning
Night Vision Warn	

- Choice of output indicators analysed are based on needs of safety impact assessment and cost-benefit analysis
  - Speeds & travel times
  - Safety indicators (time-to-collision, headways, variation in speeds etc.)

Source: Isabel Wilmink

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Methodology: indirect traffic effects

For all systems

average avoided congestion costs per avoided accident (with fatality or injury)

disaggregation:
- three road types
- four periods of the day

assumed avoided costs
- per road type
- per period

Per system

 # avoided fatalities & injuries

disaggregation:
- three road types
- four periods of the day

expected shares of accidents
- per road type
- per period

X

Avoided congestion costs (by road type and period)

Source: Isabel Wilmink

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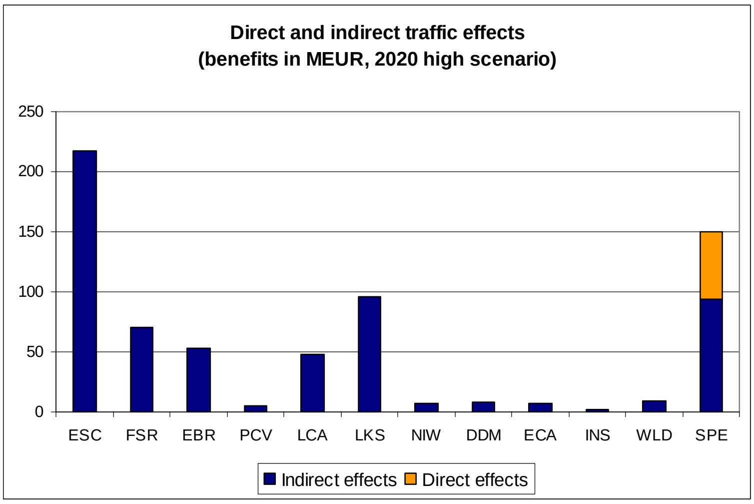
Direct and indirect effects (MEUR)



Source: Isabel Wilmink

Simulation results (direct effects)

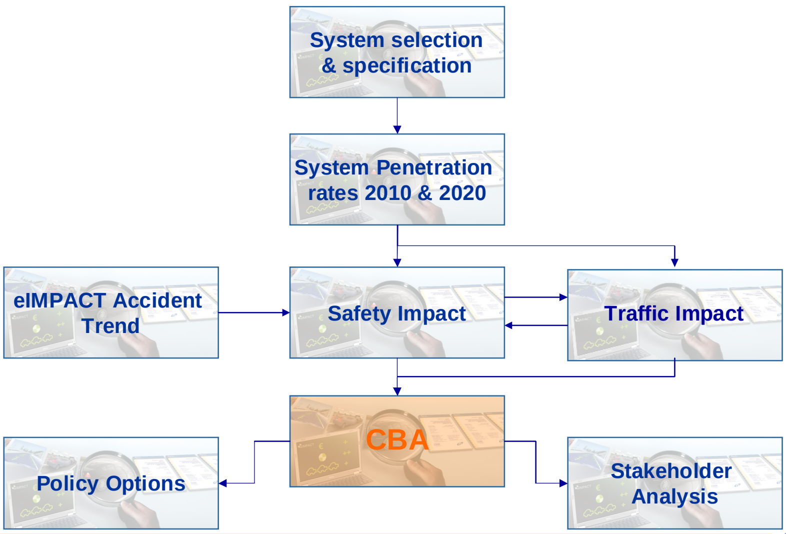
- All simulated systems have effects locally (at a cross-section)

Change in speed	**Earlier braking**	**Fewer small headways**	**Change in gap acceptance**
SPE WLD FSR NIW	WLD FSR NIW	FSR (SPE)	INS

- Effects on network level are very small to negligible
  - low penetration rates
  - “rare” events
  - local effects of IVSS cancelled out by other traffic flow characteristics (e.g. delays at traffic lights)

Source: Isabel Wilmink

Cost Benefit Analyses in eIMPACT



Procedure of CBA

Assumptions for 2010 / 2020

Vehicle stock
Vehicle mileage
Discount rate
Lifetime
D3

Accident data
Penetration rate (two scenarios)
Share of driven mileage
D4

Physical impacts – benefits

Safety (fatalities, injuries)
Direct traffic effects (average velocities)
Indirect traffic effects (congestion)
D4

Cost-unit rates

Benefits / Costs = BCR

Costs

Penetration rate **D4** * Vehicle stock **D3** * System costs

Sensitivity analysis

- Discount rate (3 % vs. 8 %)
- Lifetime (12 years vs. 16 years)
- Safety impact (most probable vs. optimistic vs. pessimistic)
- Accident trend

Source: Ulrich Westerkamp

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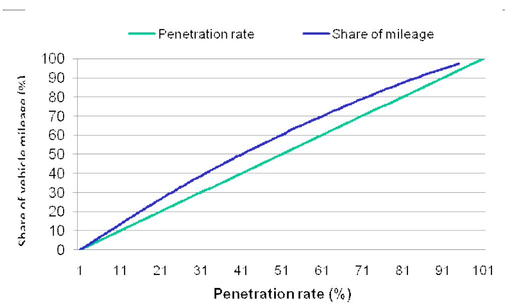
The benefits are dependent from the share of driven mileage



Newer vehicles have a higher mileage on average; IVSS are bought by drivers with a high mileage.

Source: Ulrich Westerkamp

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Main findings

- All systems contribute to the societal goal of improving road safety
- The clear majority of investigated IVSS is profitable from the society point of view
- The development of the total benefits is mainly driven by the safety effects which contribute the largest share to it
- Benefits resulting from indirect traffic effects represent an add-on to the safety benefits
- Costs go down from 2010 to 2020 because of economies of scale, learning effects and sharing of components (costs will however not vary between low and high in a considered year)
- BCR's tend to go down mainly due to general safety progress, this will be different when we do not consider safety progress

Source: Ulrich Westerkamp

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The results – overview of the BCR

	2010		2020	
	low	high	low	high
ESC	4.4	4.3	3.0	2.8
FSR	n.a.	n.a.	1.6	1.8
EBR	n.a.	n.a.	3.6	4.1
PCV	n.a.	n.a.	0.5	0.6
LCA	3.1	3.7	2.9	2.6
LKS	2.7	2.7	1.9	1.9
NIW	0.8	0.9	0.7	0.6
DDM	2.5	2.9	1.7	2.1
ECA	2.7		1.9	
INS	n.a.		0.2	
WLD	n.a.	n.a.	1.8	1.6
SPE	2.2	2.0	1.9	1.7

n.a. not available

For *eCall* and *Intersection Safety* only the potential case is given. This is due to their infrastructure requirement.

Source: Ulrich Westerkamp

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Decreasing BCR with the time do not mean that the systems are getting less efficient.

This can be shown by a shift-and-share analysis. In this analysis the accident data base for 2010 is fixed for 2020:

	2010		2020	
	low	high	low	high
ESC	4.4	4.3	4.6	4.4
FSR	n.a.	n.a.	2.6	2.9
EBR	n.a.	n.a.	5.8	6.6
PCV	n.a.	n.a.	0.9	1.0
LCA	3.1	3.7	4.8	4.3
LKS	2.7	2.7	3.0	3.1
NIW	0.8	0.9	1.2	1.0
DDM	2.5	2.9	2.8	3.5
ECA	2.7		3.1	
INS	n.a.		0.3	
WLD	n.a.	n.a.	2.9	2.6
SPE	2.2	2.0	3.0	2.8

n.a. not available

Source: Ulrich Westerkamp

The BCR information has to be enriched with other information available from CBA.

Halving the number of road deaths by 2010.
(European White Book on Transport)

1. Calculate the BCR for each IVSS for two scenarios: penetration rate low and high. (done)

2. Calculate a figure which shows the effectiveness in terms of avoiding fatalities: costs / avoided fatalities
   This figure should be less than the cost-unit rate for fatalities

➢ With this information a ranking is possible.

Source: Ulrich Westerkamp

Now a ranking of the IVSS is possible.

In terms of BCR – increasing the safety level on roads (BCR>1).

top: ESC LCA EBR

follower: DDM FSR WLD ECA LKS SPE

NIW INS PCV

In terms of reducing the number of road fatalities.

top: ESC EBR ECA

follower: LKS FSR LCA DDM SPE WLD

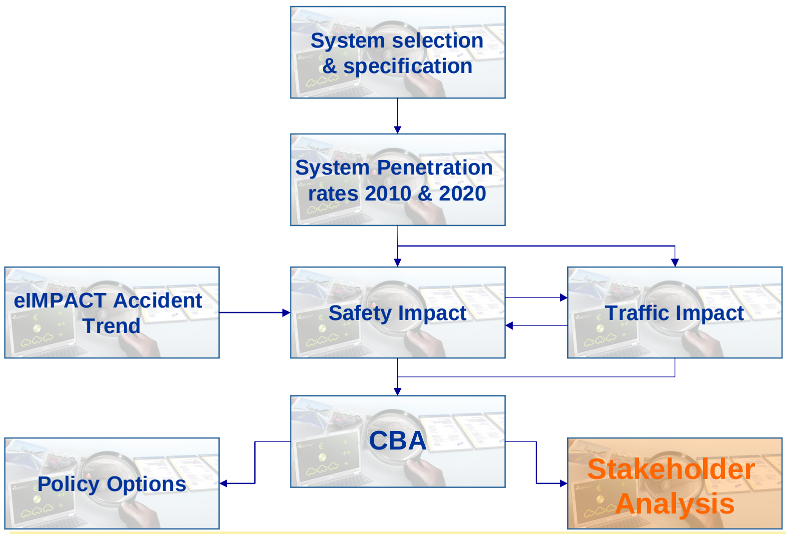
NIW PCV INS

ESC EBR* ECA LKS DDM SPE WLD* LCA FSR

* not available in 2010

Source: Ulrich Westerkamp

Stakeholder Analysis in eIMPACT



Why stakeholder analysis?

CBA as preferable method for assessing IVSS on society level

- sound methodological background
- widespread international practice

Limitations of CBA in a multi-stakeholder environment

- CBA does not distinguish between who incurs the benefits and who bears the costs (my cost, your benefit)
- Macro-economic impacts (production, income, employment) and income distribution effects are not taken into account in CBA

Need for stakeholder analysis

- Enlarged framework of socio-economic impact assessment
- Stakeholder analyses provide quantitative information which is complementary to CBA results
- Stakeholder analyses within eIMPACT address system users, the automotive and the insurance industry and public authorities

Source: Torsten Geissler

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The toolbox of stakeholder analyses

STAKEHOLDER	ANALYT. GOAL	ECONOMIC TOOLS
System users Automotive industry Insurance Industry	Benefits and costs on user level, industry level…	Break-even analysis
Public Authorities	Fiscal effects	Financial analysis
	Employment effects	Input-output analysis
	Income distribution effects	Incidence analysis

Source: Torsten Geissler

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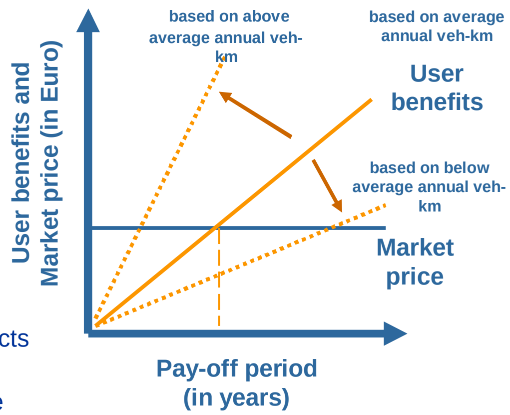
Break-even analysis for the users – Methodology

- Segmentation of user groups according to vehicle mileage
- Market prices instead of cost prices
- Safety impacts appraisal with willingness-to-pay values
- Environmental benefits not relevant in private pay-off considerations
- Relevance of comfort aspects – if applicable –
- Market-based discount rate
- Result can be provided as pay-off period, threshold for annual vehicle kilometers…



Source: Torsten Geissler

Break-even analysis for the users – Results

Systems	System User Groups according to 1,000 kilo-meters driven per year	Year			
		2010		2020	
		Low	High	Low	High
Electronic Stability Control	SUG 1: < 5	-	-	-	-
	SUG 2: 5 – 10	+	++	+	++
	SUG 3: 10 – 15	+	++	++	++
	SUG 4: 15 – 20	++	++	++	+++
	SUG 5: 20 – 30	++	+++	+++	+++
	SUG 6: > 30	++	+++	+++	+++

Annotations:
- Break-even point is not reached within lifetime of the passenger car
+ Break-even point is reached within lifetime of the passenger car
++ Break-even point is reached in the first six years
+++ Break-even point reached in the first two years

Source: Torsten Geissler

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Break-even analysis for the users – Results

Systems	System User Groups according to 1,000 kilo-meters driven per year	Year			
		2010		2020	
		Low	High	Low	High
Speed Alert	SUG 1: < 5	-	-	-	-
	SUG 2: 5 – 10	-	-	-	-
	SUG 3: 10 – 15	-	-	+	+
	SUG 4: 15 – 20	-	-	+	+
	SUG 5: 20 – 30	-	-	+	++
	SUG 6: > 30	-	-	++	++

Annotations:
- \- Break-even point is not reached within lifetime of the passenger car
- \+ Break-even point is reached within lifetime of the passenger car
- ++ Break-even point is reached in the first six years
- +++ Break-even point reached in the first two years

Source: Torsten Geissler

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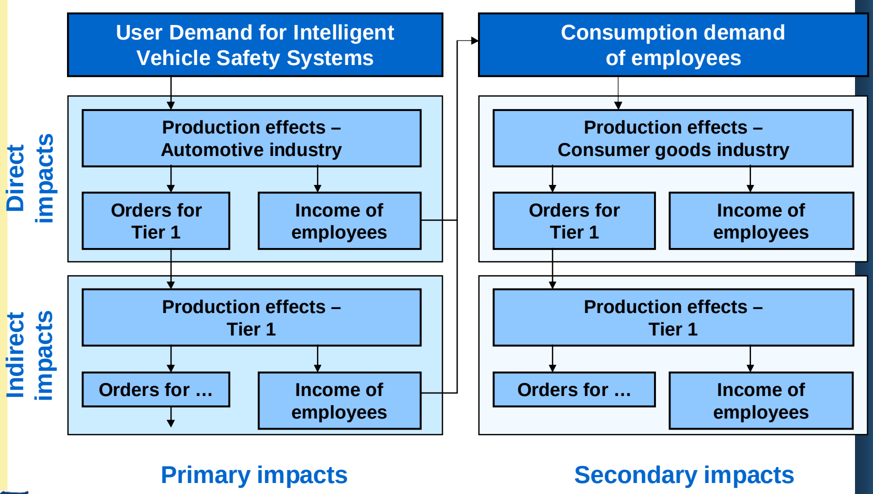
Employment effects – Methodology of Input-output analysis



Source: Torsten Geissler

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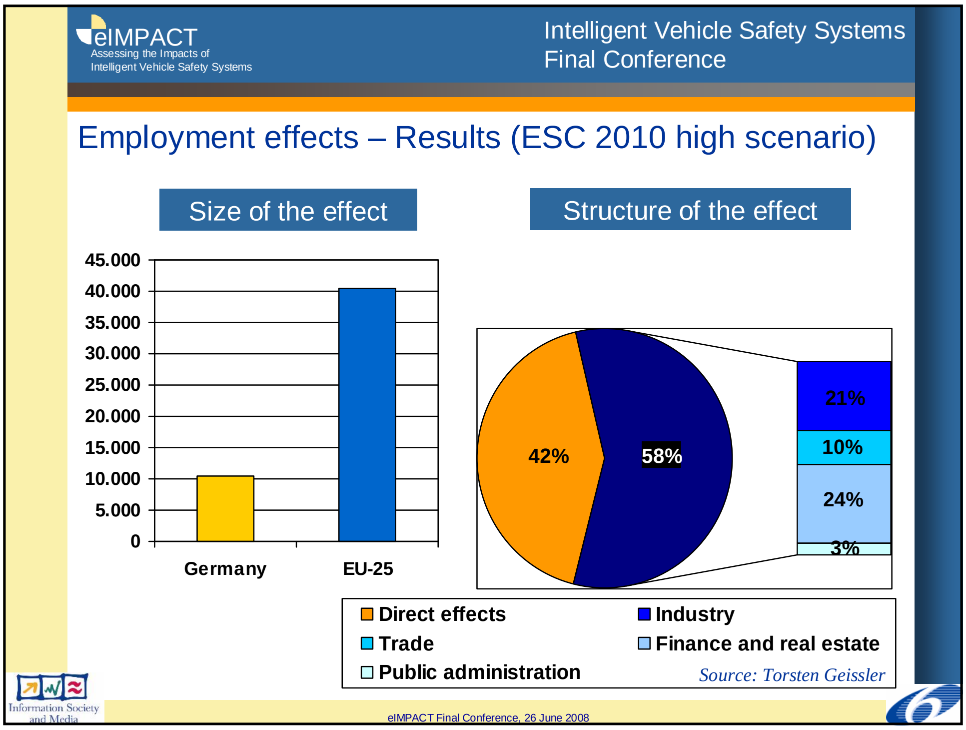
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Employment effects – Results (ESC 2010 high scenario)
Size of the effect
Structure of the effect
45.000
40.000
35.000
30.000
25.000
20.000
15.000
10.000
5.000
0
Germany
EU-25
42%
58%
21%
10%
24%
3%
Direct effects
Industry
Trade
Finance and real estate
Public administration
Source: Torsten Geissler
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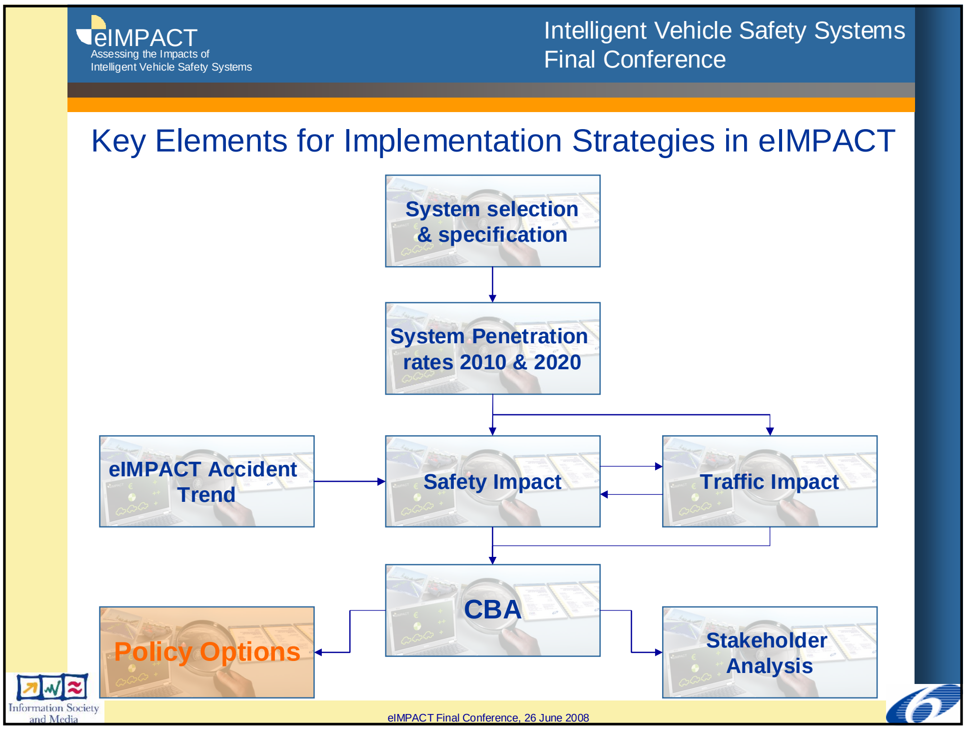
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Key Elements for Implementation Strategies in eIMPACT
System selection & specification
System Penetration rates 2010 & 2020
eIMPACT Accident Trend
Safety Impact
Traffic Impact
CBA
Policy Options
Stakeholder Analysis
Information Society and Media
eIMPACT Final Conference, 26 June 2008

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Policy Options Methodology

- Barriers
- Instruments
- Stakeholder interviews
- Stakeholder workshop
- Strategies
- SWOT analysis
- Recommendations

Source: Tom Alkim

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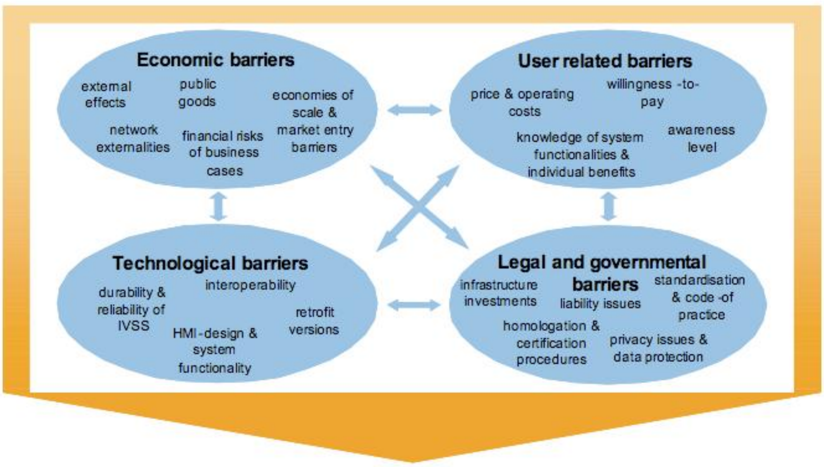
Main results – Barriers



Source: Tom Alkim

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Main results – Instruments

instruments	description
awareness campaigns	Use of different media channels to provide information on benefits and system function in order to improve user awareness and understanding
advertising media	Promotion of system via different media channels
driver education / training	Driver information and education about systems and training how to use them
cooperative research	Research conducted in the cooperation among various organisations in order to achieve more valid results.
awards	Use of awards to label products to convince customers to use or buy the system
field operational tests	To verify the functions and benefits of a specific system under real conditions in large-scale and/or long-term use
system as standard equipment	The OEMs voluntarily provide the systems in all vehicles

Source: Tom Alkim

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Main results – Interview results

60 stakeholders from 8 countries (OEM, supplier, public sector, etc.)

Difference in instruments deployed and perceived effective

rank	Instrument deployed	rank	Instrument perceived effective
1	**Awareness campaigns**	1	Legislative mandatory equipment
2	Cooperative research	2	System as standard equipment instead of optional
3	Driver education - driver training	3	Insurance premium reduction
4	Field operational tests	4	Tax reductions
5	Advertising media	5	**Awareness campaigns**

Source: Tom Alkim

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Example from stakeholder workshop: SpeedAlert

Stakeholder	Instrument 1 (score)	Instrument 2 (score)	Instrument 3 (score)	Instrument 4 (score)	Instrument 5 (score)
OEM	field opera-tional tests 2.41	Cooperative Research 2.27	Advertising media 1.72		
Supplier	field opera-tional tests 3.31	Cooperative supportaction 3.08	Awareness Campaigns 2.74	Advertising Media 1.96	
Road operator	Voluntary Agreement 3.46	field opera-tional tests 3.09	Cooperative Research 2.89	Awareness Campaigns 2.71	Cooperative supportaction 2.34
Public sector	Awareness Campaigns 3.28	Tax Reduction 3.01	Voluntary Agreement 2.90	legislative mandatory Equipment 2.75	driver ed / training 2.62
Automobile club	Cooperative supportaction 3.23	field opera-tional tests 3.20	insurance pr Reduction 2.96	Awareness Campaigns 2.80	driver ed / Training 2.15
Research institute	Cooperative supportaction 3.52	Cooperative Research 3.27	field opera-tional tests 3.08	driver ed. / Training 2.11	Awareness Campaigns 2.08
Other	Cooperative Research 2.86	Cooperative supportaction 2.71	field operat-ional tests 2.53	Voluntary agreement 1.99	Awareness Campaigns 1.52

Source: Tom Alkim

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Example from stakeholder workshop: SpeedAlert

	Instrument 1 Awareness campaigns	Instrument 2 Cooperative support actions	Instrument 3 Field Operational Test	Instrument 4 Voluntary agreement
OEM	2.07	-	2.79	-
Supplier	2.06	2.92	3.50	-
Road operator	2.65	3.27	3.53	-
Public sector	2.83	-	-	3.24
Automobile club	2.37	4.10	3.50	-

Source: Tom Alkim

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Conclusions 1

- High safety potential
- In general safety systems have no negative effect on traffic flow at the penetration rates examined
  - Positive indirect effects
  - Safety benefits compose approximately 95% of all benefits
- Regarding the IVSS and the vision of “zero fatalities” there is no ‘either / or’ but ‘and’
- Several IVSS are more easily deployed than others, other IVSS have a long realization horizon

Source: Kerry Malone

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Conclusions 2

- Clear majority of the IVSS investigated is distinctly profitable from a society point of view
  - Systems with BCR <1 should not be discarded
    - e.g. not efficient under current estimated conditions
- Stakeholder Analysis
  - Break-even results are determined by the kilometres per year
  - Mature systems and systems with low market prices perform better in Break-even analysis
  - There are considerable wider economic impacts (e.g. employment effects, tax revenues)

Source: Kerry Malone

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Conclusions 3

- There is a wide variety of deployment instruments available to stakeholders
  - Each stakeholder has a limited set of instruments to deploy
  - Large difference between the instruments perceived to be most effective, and those most often deployed by stakeholders
- Process for forming multi-stakeholder deployment strategy developed and empirically tested
- Deployment strategy involves key stakeholders, making use of their most viable instruments in a logical combination

Source: Kerry Malone

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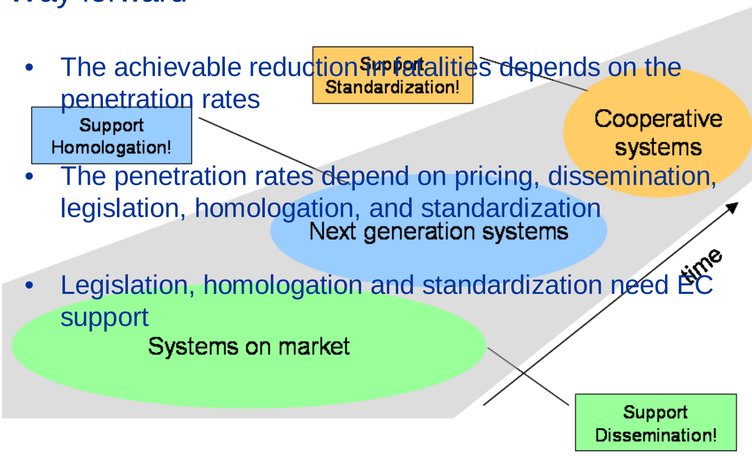
Conclusions 4

- Methodology used in eIMPACT:
  - Methodology is complete and exhaustive
  - Helps for future systems as well as systems already on the market
    - shows the potential value of systems in development

Source: Kerry Malone

Way forward

- The achievable reduction in fatalities depends on the penetration rates
- The penetration rates depend on pricing, dissemination, legislation, homologation, and standardization
- Legislation, homologation and standardization need EC support



- To accelerate deployment of IVSS, bring together all relevant stakeholders in appropriate forums

Source: Kerry Malone

Basic conditions for IVSS introduction

- The customer needs to understand the benefits of IVSS
  - The customer first must be aware
  - Only then can the customer judge if the (price/benefit) ratio is attractive to the customer
- Sequence of introduction has to fit into stakeholder strategies, e.g.,
  - Car manufacturers' product philosophy
  - Road authorities' priorities (environment, safety, throughput)
- System introduction will follow maturation of technologies
  - Systems will be bundled because of cost reasons, if they use the same components
  - Safety systems follow comfort systems e.g. ACC – Emergency Brake

Source: Kerry Malone

Recommendations for the EC

- Safety impacts and BCR are extremely sensitive to accident trend, thus future analyses can be improved by:
  - Continued efforts toward a unified EU general accident database (including harmonized definitions of injuries,…)
  - To take potentials of new safety systems into account in the EU road safety prognoses
- Field Operational Tests can provide empirical driver behavior, attitudes, risk, exposure and cost data needed for evidence, improved assessments and systems

Source: Kerry Malone

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Future Research Needs and "lessons learned"

- Single system analysis ➡ future combinations of systems
  - Which combinations?
  - What is the business case? (related to deployment strategies)
- CBA of deployment strategies should be considered
  - What are efficient marketing and deployment strategies (awareness raising, promotion and deployment)
- eIMPACT consortium composed of the "right" partners
  - excellent cooperation in system specification, consistency checks, integration of results and way forward
  - multi-stakeholder approach effective & highly recommended for future endeavors

Source: Kerry Malone


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For further information: www.eimpact.eu
Kerry Malone
Deliverable 10:
Final Report and Integration of Results and
Perspectives for market introduction of IVSS
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and Media
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