Innovative guidelines and tools for vulnerable road users safety in India and Brazil [SaferBraIn]. D2.2 Report on transferability audit developed in SaferBraIn

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SEVENTH FRAMEWORK PROGRAMME
THEME 7 – TRANSPORT (INCLUDING AERONAUTICS)

Collaborative Project

Project Acronym: SaferBrain
Project Coordinator: CTL – Centro di Ricerca per il Trasporto e la Logistica – Roma
Proposal full title: Innovative Guidelines and Tools for Vulnerable Road Users Safety in India and Brazil
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Document Title: Report on Transferability Audit

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Project start: 1st October 2009 Duration: 30 Months
Executive summary

The objective of Work Package 2 is to analyse the viability of transferability of the European methodologies, tools and measures and their applicability to the Emerging Economies. WP2 identifies the performance efficiency of practices and methodologies intended to be applied in Emerging Economies compared to their application in Advanced, e.g. European, countries taking into account available experience with those measures e.g. in Europe.

The main outcome of WP2 is the development of a generalized transferability audit allowing Concept and how Human Factors issues influencing Transferability and road safety in general), further develops the theoretical model for Transferability and defines the Transferability Audit and its supporting tools and concepts to be used for assessing the adaptability of the European measures in the Emerging Economies.

The basic structure for Transferability Audit is defined on the one hand by cultural, social, institutional and economic factors (CSIE) of the given country, on the other hand by Road Safety Measures (4 E’s: Engineering, Education, Enforcement, Encouragement). The theoretical model on which the methodology is based is introduced in Chapter 2 and then further developed in Chapter 3. This comprehensive approach allows to extend the consideration of road safety measures which is usually strongly engineering oriented with further very to check the applicability and acceptability of available Road Safety Measures, Guidelines and Tools from European countries to Emerging Economies.

The Deliverable D2.2, starting from the outcomes of the D2.1 (that explained the Transferability important measures as education, enforcement and encouragement. After detailed description of these measures with special attention on vulnerable road users it has been concluded that the 4 E’s are not mutually exclusive. Moreover, they are interdependent and overlapping.

Cultural issues are crucial for the transferability and have therefore to precede any transferability analysis. Chapter 4 introduces considerations about the cultural and human factors aspects explaining the main differences between Europe, Brazil and India. The main targets of this comparison are to ascertain cultural differences of the countries participating in SaferBrain project and to define how they can influence the transferability of Road Safety measures. Aspects like population and its density, literacy rate, religion as well as social systems of Brazil and India were taken into consideration. The cultural model in SaferBrain was developed using the approach of Geert Hofstede. On the basis of his questionnaire more than 200 people were interviewed each in Brazil and India to specify the influence of cultural dimensions (Power Distance, Individualism, Masculinity and Uncertainty Avoidance) on transferability of road safety measures. Connecting the results of cultural research with the theoretical model introduced in Chapter 2 it is obvious that 4 E’s have always to be considered in the respective cultural context. Though, it was assumed that the weight of every “E” can vary within a culture. This assumption will be verified and quantitative interpreted in the further developed Transferability Audit.

To build the bridge to the more measure close and quantitative audit there is a need for further research. For these purpose local works have been performed in an extraordinary volume:

- EU and local methodology and initial list of measures and their description with European conceptions behind them - interviews, workshops for introduction to leading experts and subsequent seminars expanded the consultation to a larger audience
- Photo documentation and description of negative and positive impacts about existing practices and problems with “EU measures” and mistakes made within former transfers
- Evaluation of the positive and negative effects expected in Brazil and India that can influence the transferability of the measures
Chapter 5 presents the Transferability Audit developed in SaferBraIn and synthesizes the main results of practical tests for Brazil and India. A matrix of 4 E’s (Engineering, Education, Encouragement and Enforcement), and its combination with CSIE (Culture, Society, Institutions and Economy) gives a comprehensive possibility for creating a model for Transferability Audit combined with the ranking from evaluation levels that usually are between macroscopic, mesoscopic and microscopic levels. A pyramidal scheme was suggested in order to consider road safety measures in different evaluation resolutions. Further a Problems Priority Matrix (PPM) was developed where rows represent safety concepts-inputs and columns the four Road Safety Space factors (Culture, Society, Economy and Institution). PPM is a checklist designed in order to allow respondents to fill it in by providing scores and weights for each item listed in the rows. A “macro” function in the matrix allows calculations of sums per each row and column, so to have final scores. The last step in TA was to fill in the developed PPM with the local partners during local meetings and workshops that included also introduction of results, their discussion and in a further step adaptation. The PPM matrixes for Brazil and India are shown in Annexes.

The results of Transferability Audit show that the problem score level in India is in general lower than in Brazil. In fact, India has more balanced maximum and minimum scores, whereas Brazil tends to have bigger deviations from minimum to maximum. While Brazil shows a dominant problem score with Culture/Society Economy problem score is low. On the contrary in India Economy problem score is close to 50% culture and society and institutions are balanced. Also in a common 4E´s comparison significant differences of the problem scores have been detected. In Brazil doubts can be resumed concerning Encouragement whereas Engineering and Education seem to be transferable. In India no big disparities can be seen. Cultural reasons which can provide explanation to this weight distribution are analysed further in Chapter 5.

The final section concludes the deliverable presenting some considerations about the curriculum of Transferability Audit. The success of this process depends on an intercultural team making intercultural communication. The "only presence" of engineers is not sufficient. It should be a constitutional convention of the team to accept the differences and to be ready for an adaptation by the members themselves.

The proposed procedure for Transferability Audit is a flexible scheme to estimate problems for transferability of a described safety category, a safety concept or a single safety measure into another Road Safety space with different CSIE. The use for transferability Audit within the VRU context is a first step. A use for other Road safety issues can be expected to be successful as the system seems to be adaptable enough. The use of the Problem Priority Matrix is helpful to handle the necessary data efficiently.

It has always to be considered that the successful transfer requires the consideration of cultural issues and the involvement of high qualified local partners.
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<tr>
<td>ADB</td>
<td>Asian Development Bank</td>
</tr>
<tr>
<td>ASL</td>
<td>Advanced Stop Line, for cyclists, measure providing a waiting position in front of the vehicle queue of an approach at signalised intersection</td>
</tr>
<tr>
<td>CTB</td>
<td>Código Brasileiro de Trânsito (Brazilian Traffic Code), the basic law setting the rules of the road and the traffic management in Brasil</td>
</tr>
<tr>
<td>CONTRAN</td>
<td>Conselho Nacional de Trânsito (National Traffic Council), the maximum regulationg body in the Brazilian traffic management system</td>
</tr>
<tr>
<td>CET/Sp</td>
<td>Companhia de Engenharia de Tráfego (Traffic Engineering Company), the main executive body of traffic management in the City of São Paulo</td>
</tr>
<tr>
<td>CSIE</td>
<td>Culture, Society, Institutions, Economy</td>
</tr>
<tr>
<td>DMRB</td>
<td>UK Design Manual for Roads and Bridges</td>
</tr>
<tr>
<td>EC</td>
<td>European Commission</td>
</tr>
<tr>
<td>EE</td>
<td>Emerging Economies</td>
</tr>
<tr>
<td>HFF</td>
<td>Human Functional Failure</td>
</tr>
<tr>
<td>HLO</td>
<td>High Level Objective</td>
</tr>
<tr>
<td>IDV</td>
<td>Individualism vs. Collectivism (cultural dimension)</td>
</tr>
<tr>
<td>MAS</td>
<td>Masculinity vs. Femininity (cultural dimension)</td>
</tr>
<tr>
<td>OTS</td>
<td>UK On The Spot accident study</td>
</tr>
<tr>
<td>PDI</td>
<td>Power Distance Index (cultural dimension)</td>
</tr>
<tr>
<td>PPM</td>
<td>Problem Priority Matrix</td>
</tr>
<tr>
<td>RSA</td>
<td>Road Safety Audit, a preventive procedure applied to the design phase of the implementation of road schemes (may include monitoring)</td>
</tr>
<tr>
<td>RSI</td>
<td>Road Safety Inspection, a preventive procedure applied to existing roads based on field reviews by road safety experts (similar to a RSA)</td>
</tr>
<tr>
<td>TA</td>
<td>Transferability Audit</td>
</tr>
<tr>
<td>TS</td>
<td>Transferability Study</td>
</tr>
<tr>
<td>UAI</td>
<td>Uncertainty Avoidance Index (cultural dimension)</td>
</tr>
<tr>
<td>VAS</td>
<td>Vehicle Activated Sign, a variable message sign system activated based in detection or other kind of sensor on or near the road</td>
</tr>
<tr>
<td>VRU</td>
<td>Vulnerable Road User</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organisation</td>
</tr>
<tr>
<td>4 E’s</td>
<td>Engineering, Education, Enforcement, Encouragement</td>
</tr>
</tbody>
</table>
1. Introduction

Road infrastructure design and professional land use planning came into existence before 6,600 years (Lamm et al, 1999). Since that time human mobility increased consistently in terms of annual average distance travelled as well as in importance for managing daily life.

However, increased mobility involves also increased exposure to those risks associated with mobility like road accidents and pollution due to traffic. Every year, almost 1.2 million people are killed in road accidents around the globe (WHO, 2004). Accidents are particular prevalent in low and middle income countries (e.g. Emerging Economies and Developing Countries) where 85 percent of the world’s road fatalities occur (World Bank, 2009a).

At such rapid national economy growths, as it can be observed in Emerging Economies like India and Brazil, the number of motor-vehicles as well as fatalities and injuries from traffic accidents are likely to increase too, since motorized traffic competes with slower moving non-motorized and more vulnerable traffic for road space, especially if measures are not taken to mitigate the problem.

Most of the victims of road accidents are not even in a motor vehicle. Pedestrians, cyclists and motorcycle riders are the most vulnerable road users and account for the majority of traffic fatalities in Emerging Economies. In Delhi, India, pedestrians and bicyclists account for around 61 percent, and pedestrians, bicyclists and motor cyclists account for over 87 percent of the total traffic fatalities (Mohan, 2009).

The human and economic damage caused by traffic accidents is largely preventable. Flaws in applying safety measures, coupled with inappropriate road user behaviour, can be overcome with concerned effort.

In particular, crucial are behavioural habits of road users in Emerging Economies having a different social / cultural background and safety awareness experience that can be commonly expected from Advanced Economies in Europe, North America or Japan. So it makes it difficult simply to transfer already tested safety measures from Europe or other advanced regions to those Emerging Economy regions or countries.

Therefore, WP2 aimed to identify the performance efficiency of practices and methodologies intended to be applied in Emerging Economies compared to their application in European countries taking into account available experience with those measures e.g. in Europe. The main outcome of WP2 is the development of a generalized transferability audit allowing to check the applicability and acceptability of available Road Safety Measures, Guidelines and Tools from European countries to Emerging Economies.

The Deliverable D2.2, starting from the outcomes of the D2.1 (that explained the Transferability Concept and how Human Factors issues influencing Transferability and road safety in general), further develops the theoretical model for Transferability and defines the Transferability Audit and its supporting tools and concepts to be used for assessing the adaptability of the European measures in the Emerging Economies.

Chapter two presents some considerations about Transferability synthesizing some of the outcomes of D2.1 and introducing the theoretical model on which the methodology is based. This model is then further developed in Chapter 3. Next section (Chapter 4) introduces considerations about the cultural and human factors aspects explaining the main differences between Europe, Brazil and India. Chapter 5 presents the Transferability Audit developed in SaferBrain and synthesizes the main results of practical tests for Brazil and India. The final section (Chapter 6) concludes the deliverable presenting some considerations about the curriculum of Transferability Audit.
2. Considerations about Transferability

2.1. The meaning of transferability

Generally speaking, “transferability” means the quality of being transferable or exchangeable, which, for road safety problems, becomes the possibility to implement in a given context measures successfully adopted elsewhere. The basic assumption behind is “what proved to be effective in a place may confirm to be useful again, in another place” but the translation of the concept into practice is more challenging and in some cases even tricky.

Indeed, “transferability” is often mistaken for the selection of measures which could be fit a given situation, whereas it is a process in which the feasibility of implanting measures from an origin city to a receptor city is assessed; in other words, the former is just a kind of recommendation of transferable best or good practice, the latter deals with both the selection of measures to transfer and an evaluation of the efforts and resources required for the measures to succeed (including also an analysis of the barriers to overcome). Consequently, “performing a transferability exercise requires not only some discipline in following a suitable methodology but, ultimately, also a wise judgement on its overall fitness” (Macario & Marques, 2004: 6).

The following (WHO - World Health Organisation, 2004: 12) statement sheds a light on another important facet of the transferability issue, i.e. the proper knowledge of both origin and receptor contexts, which are of the utmost importance for the definition of the above mentioned barriers (and drivers, too):

“in high-income settings, new strategies and programmes for traffic injury prevention generally require considerable analysis and planning before implementation. In developing countries, though, because of the scarcity of resources, the priority should be the import and adaptation of proven and promising methods from developed nations, and a pooling of information as to their effectiveness in the imported settings among other low-income countries”

Factors influencing origin and/or receptor contexts belong to three different domains:

- the institutional domain (i.e. the totality of legal, regulatory and standardisation tools which authorise the enforcement of a given measure and which may markedly differ from one Country to another);
- the funding availability (i.e. the amount of money, personnel and technical know-how required to implement a given measure);
- the society/culture (i.e. the cultural status which makes a community aware of the need to adopt a given measure and willing to accept it / long term developed traditions and heritage which also influences transport behaviour).

Each domain can affect the others, can have both a local (case study, pilot study, urban area) and a general (state, nation) influence, may involve more study areas than the usually involved ones (i.e. safety and mobility): from psychology to anthropology, from public health to security, etc.

It is clear that the deeper the four main domains are analysed, the easier will be the identification of promoters and barriers to support the transfer feasibility. At the same time the impossibility to deal with the three domains according to a univocal, quantitative point of view prompted (King, 2005) to address the problem by the elaboration of an innovative concept: the “road safety space” (Figure 1), i.e. a kind of “environment” where, theoretically, a Transferability Study can take place and where all the mutual influences among the above mentioned domains occur. Indeed:

“Each road safety issue in a given country exists in a space defined by the economic, institutional, social and cultural factors which influence it. The factors include both broad and
specific influences. The road safety space varies from one road safety issue to another, and from country to country, although some factors may be shared across road safety issues or across countries" (King, 2005: 97).

Figure 1: The Road Safety Space

The logical process for a Transferability Study is therefore based on the following steps:

- Use the “road safety space” concept to identify the factors belonging to the domains which can affect the safety issue in hand.
- Select which are the effective measures likely to be transferred among those available from the origin context.
- Use the “road safety space” concept to identify the factors which made the transferable measures successful in the origin context.
- Assess whether, according to the target context, the measures to be transferred are likely to be successful as they were in the origin case study or need to be adjusted to the new local situation; the option that they may be of no use (with or without amendments) may be contemplated.
2.2. Considerations about transferability

The level of transferability of a given measure depends on many aspects, belonging to the three domains previously described (e.g. institution, society, availability of funding). However, examples of good practice gone bad, once transferred, abound because it can be difficult to take into due account such factors contemporarily. Recurring reasons for such misinterpretation are:

- poor safety policies do not steer in direction of consolidated assessment of transferability procedures, resulting thus into a simple transfer of recommended good practices with no assessment at all;
- some measures, being already successfully transferred elsewhere, prevent decision makers from elaborating further local evaluation;
- in many cases transferability deals only with single measures and therefore considerations on transferability under the technical and economic points of view prevail on the assessment of the community acceptance and awareness; in some cases, for some measures transferability assessment seems to be even unnecessary.

The first two issues can be explained because in not "mature" contexts transferability of technologically-advanced measures is often saluted for its potential of progress, but the reality is that being such contexts often compelled to play the role of mere recipients of technologies not locally-developed, they have poor control over them (on the contrary, developed Countries are able both to design and control safety measures). Needless to say, this is an “implant” of measures / know-how and not a transfer, and as long as such an implant process will be reiterated, there will be no end to the dependency on developed countries technologies, which can partly explain some criticisms about the from-west-to-east transferability process itself (Mohan and Tiwari, 1998).

The third factor usually affects pure-technological measures, which because of their complexity should call for more careful assessments; for instance transferring Intelligent Transport System (ITS) measures is usually judged just as matter of technological feasibility and economical affordability. Indeed, since what the mission ITS are designed for is to prevent dangerous human actions, that can cause crashes at the earliest possible stage, it is taken for granted that end-users will unconditionally accept them. This is typical of developed countries, where local decision makers “copy and paste” safety technical measures as they expect their communities to be educated enough to acknowledge the need for them.

From the issues above it is possible to single out some principles which can help clarifying the “object” of transferability.

Any single measure can be theoretically transferred from one place to another, provided to be affordable and technically/legally feasible in the receptor context; but outcomes can be very unpredictable. This leads to three general principles:

1) Any measure is theoretically transferable, but what makes it potentially transferable is the full availability of technical data about its performance, implementation costs, enforcement of regulatory drivers / barriers and above all information about the level of acceptance among the end-users, which enable decision makers to assess whether the measure has been successful or not. For this reason the Transferability Audit, should be divided into two categories: the economic-institutional goals and the social ones.

2) Provided to have enough information about the success of a given measure, such a measure can be eligible to be transferred only if consistent with the “Road Safety Space” of the receptor context, which moves the focus on the importance of consistency.
3) It is necessary not only to transfer single measures but the concepts behind them, i.e. the political visions supporting them, which means exporting not only technical know-how but also consensus building and (if necessary) fundraising techniques, along with procedures for the long-term assessment of the transferred measures.

The Road Safety Space

Hence, such three principles lead to the importance of thinking about transferability not in terms of single, successful, road safety measures to implant somewhere, but in terms of visions or concepts for road safety whose practical translation is the implementation of packages of multitask measures. Such an approach has been shared since long time by the ADB - Asian Development Bank (ADB, 1998), which issued the Road Safety Guidelines for the Asian and Pacific Region, recommending direct actions to adopt, according to the following 14 topic areas.

- Coordination and Management of Road Safety
- Road Accident Data Systems
- Road Safety Funding and the Role of the Insurance Industry
- Safe Planning and Design of Roads
- Improvement of Hazardous Locations
- Road Safety Education of Children
- Driver Training and Testing
- Road Safety Publicity and Campaigns
- Vehicle Safety Standards
- Traffic Legislation
- Traffic Police and Law Enforcement
• Emergency Assistance to Road Accident Victims
• Road Safety Research
• Road Accident Costing

For each area, ADB presents specific aspects along with some good practice examples (from both Eastern and Western Countries) envisioning possible improvements consequent to the adoption of funding concepts and itemizing which are the priority actions needed. It is clear that the mentioned measures have been, more or less, already implemented in Europe or in the US but the emphasis is not on the single measure itself but on benefits that a cluster of them can provide the adopting community with.

Therefore, it is worth analyzing, starting from the taxonomy proposed by ADB, which are the most relevant road safety actions in Europe, less applied elsewhere but effective, and the related pros and cons of their transferability, with respect to the SaferBrain tasks.

Table 1 presents a sample of some of the most recurring safety concepts to be considered for the VRUs safety in India and Brazil.

Table 1: Most recurring safety concepts less used in target contexts

<table>
<thead>
<tr>
<th>Topic</th>
<th>Main actions / concepts</th>
<th>Lesson learned from Europe</th>
<th>Positive influence for SaferBrain case studies</th>
<th>Negative influence for SaferBrain case studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordination &amp; Management of Road Safety</td>
<td>Fostering national bodies in charge of creating general road safety policies</td>
<td>Creation of national visions for road safety endorsing choices and actions</td>
<td>Coherence of contents and comparability of results at national level</td>
<td>None</td>
</tr>
<tr>
<td>Road Accident Data Systems</td>
<td>Data recording</td>
<td>Importance of data standardization</td>
<td>Data standardization helps comparing results</td>
<td>None</td>
</tr>
<tr>
<td>Road Safety Funding &amp; Role of Insurance Industry</td>
<td>Fundraising for road safety</td>
<td>Road safety tax</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Safe Planning and Design of Roads</td>
<td>Traffic calming</td>
<td>Importance of planning a mix of measures, supported by enforcement, education, engineering and encouragement activities</td>
<td>Possibility to switch from the single countermeasure implementation to a packages of solutions to create safer environments</td>
<td>Traffic calming may not be used if not adapted to local traffic patterns and built environment features. ITS and DSS may not be accepted</td>
</tr>
<tr>
<td>Topic</td>
<td>Main actions / concepts</td>
<td>Lesson learned from Europe</td>
<td>Positive influence for SaferBraIn case studies</td>
<td>Negative influence for SaferBraIn case studies</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>------------------------</td>
<td>-------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Improvement of Hazardous Locations</td>
<td>Black spot analyses</td>
<td>Importance of area-wide assessment</td>
<td>Possibility to consider not just spot events but to run analyses at district level</td>
<td>None</td>
</tr>
<tr>
<td>Road Safety Education of Children</td>
<td>User need analyses (mental maps, walkability lists)</td>
<td>Design starting from user needs</td>
<td>Possibility to “customize” transferred safety concepts to the local “road safety space” features</td>
<td>In case of no check/participation with end users, acceptance could be very low</td>
</tr>
</tbody>
</table>

### 2.3. EC-funded projects on Transferability Studies – lessons to learn

The “Road Safety Space” concept is focused on the transferability of single measures or of packages of measures. This may be appropriate to contexts where road safety is already a consolidated practice (even though with flaws) and just one or more actions are needed to improve the safety level. In this case the “Road Safety Space”, due to its multidisciplinary approach, is a suitable tool to assess the effectiveness of measures and above all the feasibility of their implementation.

However, in some contexts with very low local safety levels, such concept may turn to be unsuitable since single measures / interventions would be too a poor response to meet the safety requirements and a more complex approach may be required, such as the introduction of comprehensive safety policies.

Thinking in terms of policies or Safety Concepts, rather than single measures, is a key element to promote effective safety measures, which moves the focus from the transferability of single measures to the transferability of a course of actions, guiding criteria, or procedures to create “road-safe” environments.

Examples of transferability of road safety policies do not abound, and in many cases they deal with simple recommendations of best practice to transfer. The literature on transferability of transportation policies is richer, and consolidated results from transferability studies are available, although they mostly concern transfer of policies from/to developed countries.

Among the transferability studies on transportation policies, some relevant EC-funded research projects are worth further analysis:

- TRANSPLUS - TRANSport Planning, Land Use and Sustainability.
- LEDA - legal and regulatory measures for sustainable transport in cities.
- CIVITAS Initiative (METEOR, MIRACLES).

Such examples are coherent with the “Road Safety Space” concept, since they take in due consideration the legal and regulatory aspects, the available economic resources and the social issues as factors influencing the transferability process as a whole.
2.3.1. The TRANSPLUS approach

The core of the EC research project TRANSPLUS (http://www.transplus.net) was to assess how transportation and land use issues must be integrated to create exportable best practice. Main findings on transferability can be synthesized according to the following key-concepts:

- **Compatibility** – It is important to assess not only whether the policy tool itself is exportable to the target city, in terms of technical contents, goals, timeframe, etc. but also how it may be compatible to the target context; hence the need to look for comparable cities in terms of “relationships between institutions and territories”.

- **Scope** – Such relationships call for identification of the level of transferability, which can be considered in terms of:
  - **Horizontal transferability**, i.e. the translation of a tool at the same scale of generation and application across territorial boundaries. Possible combinations of translations are:
    - Translation from one city to another in the same metropolitan area or from one sub-national context to another in the same country.
    - Translation from city to another in the same region.
    - Translation from one city to another in the same sub-national context.
  In any case, horizontal translation of a policy means that a policy can be transferred from one institution / territory to another, without changing the scale of application.
  - **Vertical transferability** is the case when a given policy may be scaled up or down, according to different degrees. Possible combinations of transfers are:
    - Transfer from one city to one metropolitan area or sub-national to national level.
    - Transfer from one city to one regional level or regional to national level, etc.
    - Transfer from one city to sub-national level

The vertical transferability in the SaferBrain project can be seen as a kind of premium achievement; indeed up-scaling would entail that the safety policies / measures implemented in the demonstration cases have been successful and hence the lessons learned are worth exporting on a larger scale.

The transferability study according to the TRANSPLUS directions may present some positive and negative aspects. Among the former, the identification of the Transferability Scope (i.e. vertical and horizontal transferability concepts) is the most important one since it stresses the possibility to “stretch” and “move” the transferability focus in a very broad way. The assessment of the possibilities due to the so-called osmosis effect can be of some importance, since any positive outcomes the pilot projects may achieve can enlarge the transferability extent far beyond the SaferBrain lifetime. The poor flexibility of the 3-steps approach, on the contrary, may be difficult to adapt.

2.3.2. The LEDA approach

The final task of the LEDA project was to assess the transferability of a series of 20 “less well-known but effective measures” to some receptor cities in Europe, selected according to the project evaluator’s expertise. The concept was simpler than the TRANSPLUS one, since the transferability study was focused on the transfer of just single measures, namely under the legal and regulatory points of view. Each measure was eligible to be tested by more than one target city, if possible.

As a pre-requisite to the transferability study itself, a study of possible correlations between the two sets of Target / Origin Cities was developed by the LEDA participants. The profile of
Origin Cities was drawn by a questionnaire submitted to the LEDA participants. Questions were created to provide information about drivers and barriers for the transferability study strictly under the regulatory point of view and therefore in terms of:

- Urban structure.
- Legal framework.
- Political will.
- Public acceptance.
- Role of enforcement

For any answer, responses available were based on a 3-point Lickert Scale: A, B, C; each point corresponded to a score (-1, 0, 1), where 0 is meant as neutral, i.e. the midpoint.

Transferability scores can be divided also according to the relevance:

- **Low scorers**: those measures that require some form of restriction or perceived risk to be imposed above and beyond what is "typical". Consequently these measures are assessed as creating a problem from either the public acceptability or the political standpoint.

- **Medium scorers**: those measures that can typically be done under existing powers, but are not perceived as providing significant benefits either publicly or politically, or in respect of the City’s objectives.

- **High scorers**: those measures that can be implemented using existing powers, and which are relatively easily enforceable, and which are perceived to provide benefits for the City or to the public” (Macario and Marques, 2004: 24).

In general the evaluation process was rather time-consuming because of the calculations. Basically, positive aspects to consider are:

- the possibility to outline characteristics of the cities in the most flexible way and according to the most different goals;
- the provision of a method easily usable by decision makers (calculations can be easily made by spreadsheets);
- the possibility to have a kind of quantitative control of the transferability study;
- the avoidance of data search and desk research in general, since characteristics are determined according to the transferability study participants’ expertise.

At the same time, it is worth reminding that the LEDA focus was just on single measures and the application of such a method enlarged to policies may turn to be not that straightforward.

### 2.3.3. The CIVITAS approach

The CIVITAS approach differs from the above mentioned ones because it was aimed at providing a general methodology for transferability, that would be easily adaptable to different kinds of research projects and the related measures implementation process.

The methodology for the transferability study was based on simple steps according to an algorithm which takes into consideration some of the aspects already dealt in TRANSPLUS and LEDA.

The approach is based on the following 10 steps (Figure 2):

- **STEP 1** – Diagnostic of the problem
- **STEP 2** – Characterisation of the city
- **STEP 3** – Analysis of the city context and implications of problems identified
• STEP 4 – Look around for similar contexts
• STEP 5 – Selecting examples of source urban contexts
• STEP 6 – Identify measures with potential for transferring
• STEP 7 – Packaging and dimensioning the measures for transferring
• STEP 8 – Ex-ante assessment of measures to transfer
• STEP 9 – Identify need for adjustment
• STEP 10 - Implement measures and steer results

This is meant to steer a theoretical transferability process in which some measures / policies under implementation have their potential for transferring assessed, in light of some general goals of the transferability study itself and in consistency with the involved cities characteristics.

The sequence and the process above described is too complex and long to govern a transferability study like the SaferBrain one, the study being very different from that of CIVITAS. Moreover, measures, indicators and implementation programs were already...
decided within the CIVITAS framework, which facilitated and directed the whole transferability study. The sequence, however, is flexible enough to:

- be adapted to both horizontal and vertical transferability options;
- start the process either from target cities and looking for candidate origin cities or vice versa;
- jump some steps if needed (for instance step 8 can be skipped in case of poor resources or information to create the scenarios);
- use indicators coherent with the road safety space concept and useful to be considered in safety audit process.

2.4. Fostering the concept of Transferability: The 4E´s of Road Safety

In Emerging Economies the typical development of motorisation can be expected to follow a similar sequence as in the today’s “industrialised nations” which have left this emerging speed growth behind them (Figure 3). Many of these countries are members of the European Union. So the typical progression can be also assumed for Emerging Economies.

![Figure 3: Long term model (Elvik & Vaa, 2004) and extension: potential mitigations](image)

Part of an attempt to transfer the existing Traffic safety measures from EU to India and Brazil is the estimation of range of development in the time axis to get an approximate time horizon which represents a level that can be compared to the former European conditions.

As the wide motorisation of India and Brazil has just started and the population with absolute figures but also with weak factors is completely different, there are divergent tendencies to be expected. Traffic safety development can use elements of traffic safety countermeasures to mitigate these consequences. This could possibly help to pass the peak earlier and to start implementation at an earlier stage in Brazil and India. While traffic safety research in Europe has been conducted for a long time, the theoretical base may be used to be adopted for EE so that the results can be transferred depending if there is a demand.

To understand the system of “Road Traffic Safety”, an integrated concept shall be used to describe a theoretical optimal system that could be a long term development target.

Best practice is to prevent accidents and thus to improve road safety; for that all technical, economical, juristically and educational measures should be used. For this to happen it is necessary to use all technical, economical, legal and educational measures. Schlag (1997, c.f.) defined the basic “4 E’s” strategy as a strategy to prevent accidents.

- Engineering - technical measures e.g. road design or traffic optimisation
- Education - information and education
- Enforcement - legislation and control
• **Encouragement** - (economical) motivation, individual cost-benefit-consideration

The theory is focussed on measures within primary and secondary prevention, with the main focus on the 4 E’s. Tertiary prevention is concerned with feedback from post-accident experiences to improve both. Figure shows the classifications used in the car industry (Schwarz & Bergmann, 2009), including primary (active) prevention (before crash), secondary (passive) prevention (during crash - mitigation of aftermath) and tertiary (after crash) prevention (rescue and save).

Figure 4: Primary Prevention classification used in car industry (Schwarz and Bergmann, 2009)

**Primary Prevention**

Primary Prevention is the active prevention of accidents. It includes any aspect of safety which aim is to prevent a road accident from happening in the first place. For example, safe road design (e.g. self explaining roads, visibility at junctions), in-vehicle safety systems such as automatic emergency braking systems (e.g. Volvo City Safe) and also the education of road users to help prevent unsafe driving (e.g. speeding, drink-driving) and promote safe road use (e.g. at pedestrian crossings, safe cycling).

**Secondary prevention**

Secondary Prevention means the mitigation of the accident consequences (e.g. use of helmets, safe equipment, protections and technical equipment in cars such as airbags, safety belts). It also includes roadside protection devices such as crash barriers and breakaway posts.

The new development target is not only the safety of people inside the car but also towards VRUs safety. Best example is the future development of outside airbags or the “seeing car” that connect the protection of inhabitants and the VRU outside car using possibilities of active and passive security for all accident parties.

Pedestrian crash protection is now part of the EuroNCAP ratings for new cars, therefore vehicles are being designed to be more crash friendly to pedestrians, particularly in terms of bonnet design, to ensure a good EuroNCAP rating. Another example is the future development of outside airbags for VRU protection. Also, another future concept is the
“seeing car” that connect the protection of inhabitants and the VRU outside car with active and passive security for all accident parties, which covers primary as well as secondary prevention.

**Tertiary prevention**

After an accident has happened, the strategy to mitigate the consequences of injuries involves several possible factors. It starts with running a chain of every measure that can help. Tertiary prevention includes components such as First Aid organisations as a ready system that is active and can respond fast and as possible. Escape and rescue has developed with the use of emergency helicopters with central coordination in a medical emergency service networks for transport, hospitals, medicals and so on.

Tertiary prevention also includes the limitation or the possible compensation or balance with Therapy and Rehabilitation. Therapy and rehabilitation measures must be realised in public mind as a part of aftermath of accidents including social and financial factors. Awareness and information about of years or lifelong care of accident victims to minimise the negative effects and to optimize a positive outcome are important for a feedback to primary prevention and for estimation of real costs.

![Image of First Aid Vehicles](image)

**Figure 5: First Aid Vehicles (Mücke, 2007)**

One of the basic rules is to be able to give adequate medial analysis of accidents quickly starting right after arriving at the accident location and into this network administration using all mobile and information technologies. Such an on duty system needs centralized preparation, organisation and maintenance. So this describes the advanced before crash organisation as a complex life saving and mitigation of aftermaths system.
To shift the borderline between secondary and tertiary prevention to secondary is aimed by the direct after accident measures as well. Safe and rescue and medical help going hand in hand have an enormous potential to mitigate. In (Schlag et al., 2006) the improvement of Save Rescue and the emergency medicine is considered to make an essential influence to reduce fatalities.

**Composite strategy of 4E to prevent accidents**

This basic scheme shall be used to make a practicable description of active road safety measures. Using the understandable 4 E’s, the main scheme focuses on primary prevention, also including elements of secondary and tertiary prevention. In Scientific Advisory Board at the Federal Ministry of Transport, Building and Urban Development of Germany (Wissenschaftlicher Beirat beim BMVBS, 2010, c.f.) a complex building scheme, as a house to live in, was introduced, in the form of a house-style structure.

The transferability of European measures to the Emerging Economies should concern a description of the pillars and reasonable parts of the foundation with reference to the institutional roof. The English version with respect to international standards could be adapted as shown in Figure 7.
Figure 7: House of the “4E’s”, English version

With regard to technical measures of engineering, road design for VRUs will be introduced from a best practice list and checked by experts in India and in Brazil. This will result in a compressed common description compared to the others. Also the other E’s cannot be described completely within this summary of measures. It is necessary to see this model in a context of global initiatives such as First Global Ministerial Conference on Road Safety (WHO - World Health Organisation, 2009) to be compatible to the global context and to resume that also in the so called “higher developed” countries.

In this sample also countries that invest enormous amounts every day in infrastructure, for example Germany (the main transit country of Europe), suffer from problems in Road Traffic Safety that must be improved to realise the Vision Zero or Towards Zero in the coming years or decades. Acceptance and motivation are essential in all these operations, as well as the systematic measures to be developed, refined and adopted to this aim.

Development of Transport in EU and in the global world

There is a need of minimisation of motorised traffic if possible. The maximum use of public transport or rail for freight transport is important for a balance with other participants. Vision Zero has been declared to be a main target for the medium and long time development. In Europe it is expected to be realised in a foreseeable time.

The living standard in the European countries is based on a massive transportation to have everything, every time and everywhere available, which forms a market and makes the competition between all member states possible. Globalisation effects a further extensive growth of transport of goods from and into the EU. Just in time organisation of freight transport has the use of trucks intensified 24h every day and if possible using the road network as a warehouse of goods. This makes it difficult to compare figures of trucks in long term development to the past.

Even this omni-availability as the pattern of Europe, a global consumption behaviour causes necessity to adjust the historical grown transport schemes probably a counterpart or a
precondition for (local) Road Safety measures. Therefore limitation to the necessary transport amount, using environmental sustainable kinds of transport (effective use of existing transport infrastructure) must be balanced with the maximization of production and consumption. A part of individual transport consumption in urban areas in an environmental sustainable way: walking and bicycling combined with public transport as one component.

**Data about accidents and evaluation**

It is important to base the system of 4E’s on real data feedback about accidents and to improve their quality further. Quality is to have reports about the most of the accidents in a standardised scheme and, if possible, digital stored to make use of them by several parties. As a convention of the expert for Road Safety, should be defined which data can be retrieved and how to use them in the network of the stakeholders and how they shall support the decisions to be made to indentify conflict points or black spots and to improve them.

Many countries in the EU have a national accident database which is compiled from police report of slight, serious and fatal accidents across the country. For example, in the UK, there is the STATS19 accident data collection system\(^1\) which contains details of all incidents attended by the police and those they become aware of within 30 days which occur on any public road in which one or more person is killed or injured and involves one or more vehicle. Many of the EU country's accident data can also be found in the CARE\(^2\) accident database, which is a Community database where national accident data from EU member states is compiled to allow for analysis of many countries’ data at one time.

It is a standard in most European countries to identify types of accidents injury levels and property damages with special reports and to store them in a road map based system, preparing them for analyses with proper information reliable gathered from police. Of cause an underreporting can be expected for light accidents but the insurance companies insist to get official reports as a base or certified experts report that costs money. Injuries have to be in each case reported, in EU countries it is an indication for public prosecutor to be involved.

Basic precondition for getting proper information are common federal standards, as for example in Germany (UDV - Unfallforschung der Versicherer, 2011)\(^3\), that had been used on paper maps for several ten years or the new digital use that is used in 8 Federal states on base of a public private initiative (PTV, 2011).

Such a system is ideal for interaction on the several state levels of experts using the data (in Germany Road Authorities, Police and political decision preparation in accident commissions). These include several analysis and evaluation possibilities with special respect to VRU issues or with respect to fatalities of children and others, within an everyday growing knowledge base and open to all mandated to take care for public road safety.

\(^{1}\) http://www.stats19.org.uk/


\(^{3}\) IG-EUSka
Figure 8: Paper maps and use of databases (UDV - Unfallforschung der Versicherer, 2011)

Further data extension can be retrieved by special accident expert services (in-depth investigations), often provided by different organisations with a link to public interests. In the cities where the accident causes tend to be more complex, they have access to police and Rescue and safe network and take part with additional investigations. They can be found at several institutions powered by state initiatives, as existing research networks of universities, accident research of insurance company association, car producers association, technical supervision association and others. They all work together helping securing of evidence immediately after accident and share the data. The common vision to be part of professional's network with a responsibility to the society, using all the institutional and organisations power, speeds up the development enormously.

Figure 9: Accident research cars of Clinical of the University of Technology in Dresden (Schäfer, 2008)
Another example is the UK On The Spot (OTS) in-depth accident data collection study\textsuperscript{4}, funded by the UK Department for Transport and Highways Agency. As part of this project, in-depth accident data is collected by an expert team who travel out to the scene in a police car, typically arriving within 15 minutes of the crash occurring. Data regarding the road users involved, the vehicles (e.g. types, damage, defects), environmental conditions and the road layout are taken while the vehicles are still in situ and often while the road is still closed to traffic. This data is stored in an in-depth database which can be used for future analysis.

Based on these data, complex interdependencies can be analysed and categorised and the understanding is open not only to a single institution.

So, the 4E’s, brought together with the dimensions of Society/Culture, Institutions and Economy, form a space in which the improvement of road safety can be defined.

Having a look on this space with several focuses as a macro, meso or micro resolution to make the related decisions, allows to achieve evaluation scales in a suitable way. So evaluation is essential to estimate the possibility of implementation of new measures to be transferred. Considering the transfer of measures from a certain European level into units of the Emerging Economies shall be based on such a system considering strategic, system and operation interfaces.

\textsuperscript{4} On The Spot (OTS) in-depth accident data collection study
http://www.dft.gov.uk/rmd/project.asp?intProjectID=11702
3. Theoretical Model of 4E´s

3.1. Engineering

3.1.1. Road design

Design, construction and maintenance of traffic infrastructure with respect to VRUs is an essential part of Road Safety improvement. The basic issue is the speed adoption to location as well as advanced road design configurations in potential conflict areas with different kinds of transport.

For VRUs, speed difference is the main danger to be taken into consideration. The higher the speed of motorised vehicles is, the greater the risks are. Higher speeds on arterial roads requires the separation of different traffic types. In urban areas the basic level and the resulting design elements should adopt appearance and accessibility to the targeted level of VRU’s safety.

Visibility is an important criterion in areas where priority is given to VRUs, to make possible braking in conflict situation. Awareness of high level VRU usage has to be provided and is essential for the coexistence of motorised and non-motorised traffic. This does not necessarily mean expanding the space provided, but consideration should be given to adaptive design for motorised traffic, to give information about the need to adapt Behaviour to VRUs.

Therefore, comprehensive and more sophisticated design in urban areas is necessary to cover the needs of VRUs, while having acceptable conditions for other road users. The clear guidelines with predominant technical contents for design are only used for mainly motorised traffic on arterial roads and cannot be adapted to urban systems. They are space oriented and a greater diversity of technical features, especially for VRUs, is required. The integration of public transport and VRUs, combined with individual transport, build up three components in the urban road space. The wide expertise in Europe with renaissance of public transport with more trams and buses on the road makes this scheme complex but successful.

A typical European example is the UK’s position on standards and guidelines for safe road design. On major arterial roads (motorways and other major routes maintained by the UK Highways Agency), the Design Manual for Roads and Bridges - DMRB (Department for Transport, 2011) is used (Highways Agency, 1992).

The standards in the DMRB are generally mandatory. On urban and minor rural roads (roads maintained by the local roads authorities), DMRB is not mandatory, but most authorities develop their own guidance based on DMRB to maintain the safe design and maintenance of their roads. More recently, Manual for Streets 1 and 2 have been developed by the UK Department for Transport and Chartered Institute of Highways and Transportation (CIHT, 2010) to provide more relevant guidance to local roads authorities for developing better and safer local streets (Department for Transport, 2007) (CIHT, 2010).

These two documents are guidance (i.e. not mandatory). However, due to the litigious society we now live in, local roads authorities have to be able to prove they have ensured the safety of all road user types during the design and maintenance process, to avoid legal action if an accident occurs on their roads. Also, with the introduction of the Road Death Investigation Manual in 2007 (ACPOS, 2009), local roads authorities can also be criminally prosecuted (e.g. manslaughter) if it is thought that poor road design or maintenance was a major factor in the death of a road user in an accident on their road. Therefore most local

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5 Design Manual for Roads and Bridges. http://www.standardsforhighways.co.uk/dmrb/

roads authorities will follow the guidance provided in these documents and also carry out road safety audits in the design process.

Germany has introduced a completely updated guideline generation that focuses on Road Users (FGSV, 2008)\textsuperscript{7} in an integrated network for all kinds of transport modes, also integrating road safety audit (FGSV, 2002)\textsuperscript{8} with respect to urban roads (FGSV - Forschungsgesellschaft für Straßen- und Verkehrswesen, 2007)\textsuperscript{9}.

The balance of integrating individual motorised transport in areas with high VRUs share is always dependent on the availability of superior traffic planning which takes into consideration the demand of VRUs. Traffic planning is the basic for all design steps to consider the demand and the possibilities of the available space.

The Self Explaining Road (SER) concept (Theeuwes and Godthelp, 1995) (SPACE, 2010) (Hartkopf and Weber, 2005) is a more typical adaptation in rural road environments that explains with its appearance the other requests of urban life and the necessity to adapt traffic behaviour into this space. This includes the different functions of roads in the network. A main (arterial) road with main connecting functions to big cities in the neighbourhood crossing urban areas with main motorised traffic as their connection function is dominant. If the traffic density is heavy, overlaying local urban functions in the crossed city, may be minor compared to connective needs. This typical conflict situation for VRUs can make a split of parts of the motorized traffic.

Road-focussed network adaptation alone is not sufficient. In several European countries an integral network design involves also considering public transport, cycling and pedestrian needs. The quality needs for Germany are described in the Guidelines for integrated network planning (FGSV, 2008)\textsuperscript{10} (Gerlach, 2009) as a basis for all planning and design of infrastructure, including all kinds of transport modes, detailing minimum service requirements for public transport for bicycle and pedestrian networks. For example, the demand for rural cycling is to have both short efficient routes as well as additional scenic bicycle routes. This comprehensive, integrated network model for all kinds of traffic in rural and in urban areas in a common guideline, integrating the links within the EU, is a new step ahead. It is expected that everything has to be based on an integrated traffic planning including existing and time horizon prognoses of future network improvements.

The needs of VRUs should be included in the design of the roads from the beginning. Regulations to change the use of a road infrastructure without changes in road design will not solve problems in the long run, but can be considered as a preliminary possibility. So road design is an integrated process and includes traffic planning on macroscopic, mesoscopic and microscopic levels which are always simultaneous with land-use planning to define possible features according to available traffic space.

In the following step, after impact analysis, improvements generating feedback have to be assigned and iteratively adopted to planning the design of space and facilities for VRUs, public transport and individual motorized transport. The speed of motorised road users always matters in this process as a basic risk figure in an accident. 50 km/h is regulated as a standard speed in Europe in urban areas. In (Wissenschaftlicher Beirat beim BMVBS, 2010) the German Ministry of Transport is advised to make the main urban roads with 50 km/h an exception and set urban areas 30 km/h as a standard level.

In the UK, 20 mph (32 km/h) limits are becoming increasingly prevalent in urban areas, particularly in residential areas and outside schools, but also in town centres. The UK

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\textsuperscript{7} RIN – Richtlinie für integrierte Netzgestaltung
\textsuperscript{8} Empfehlungen für das Sicherheitsaudit auf Straßen (ESAS)
\textsuperscript{9} RAST 06
\textsuperscript{10} RIN – Richtlinie für integrierte Netzgestaltung
Department for Transport has published guidance for local roads authorities for setting speed limits, including 20 mph zones (Department for Transport, 2006)\textsuperscript{11}.

Another practice is to reduce regulation to cultivate more responsibility and to have a partnership between attendees with different levels. For example, the Shared Space philosophy is widely accepted in countries such as Sweden, Netherlands, UK (all who took part in the Sunflower project – Koornstra et al., 2002) and others, but not so in Germany or Switzerland which tend to avoid juristic uncertainty, leaving out regulations in traffic space.

This is officially stated in publications e.g. of German Insurance Federation (BSVI - Bundesvereinigung der Strassenbau- und Verkehringenieure e.V., 2010).

Nevertheless the movement to more responsibility while having an also physical protection for VRUs is in development in residential areas with considerable regulation level as well. The Urban Roads Guidelines (e.g. German RAST (FGSV - Forschungsgesellschaft für Straßen- und Verkehrswesen, 2007)\textsuperscript{12}) puts the priority of VRUs in the foreground and does not prioritise only the capacity of cars traffic flow. A medium solution exists, and shared space projects are under research in Germany, Switzerland and Austria as well, which are used to operate similar road guidelines.

In the UK, Manual for Streets was published in 2007 (Department for Transport, 2011) and provides guidance to improve the quality and safety of local streets, particularly residential streets, and to consider the needs of all road users, but particularly VRUs (pedestrians and cyclists) and public transport.

Following on from Manual for Streets, Manual for Streets 2 was published in 2010 (CIHT, 2010) which contains the same principles as Manual for Streets (Department for Transport, 2007), but is focussed on widening the application of these principles to beyond residential streets (e.g. town centres and arterial routes between residential roads and town centres).

Although they do consider the needs of the VRUs, these documents do not always fully favour the VRUs in expense to the motorised vehicle and Manual for Streets 2 outlines a number of street types which can be relevant to the site(s) being evaluated (e.g. multifunctional streets, relief roads, boulevards, arterial routes, high streets, interchanges, rural lanes, village centres). The documents also detail the design and implementation process that should be undertaken, including community involvement, the stages of improvement, quality audit, safety audit and maintenance issues.

Road design guidelines can also include guidance for reducing the severity of injuries if accidents do occur, although these are mainly aimed at motorised vehicle occupant injuries rather than VRU injuries. For example, road safety barriers (Highways Agency, 2006) and passively safe signs and posts (Passive Safety UK, 2010). However, pedestrian barriers can also contribute to reduced injury severity by protecting the VRUs from errant vehicles entering the footway, particularly at pedestrian crossings and road junctions (British Standards Institute, 1995).

An important component to make regulations for the competing demands in traffic also delivers a useful contribution for the protection of VRUs. The intelligent traffic system generation extends the possibilities for a logical use and can help to reduce land-use as well as to optimise existing infrastructure use to avoid their extension.

The safety initiative of the EU ((eSafety Initiative, 2006), (EU Commission, 2008)) established a framework for the necessary developments. One lesson learned is that fixed traffic lights which don’t adapt to the traffic conditions, constitute less acceptance for both

\begin{footnotesize}
\begin{itemize}
  \item \textsuperscript{11} Requirement for Road Restraint Systems http://www.standardsforhighways.co.uk/dmrb/vol2/section2/td1906.pdf
  \item \textsuperscript{12} Richtlinie für die Anlage von Stadtstraßen (RASSt 06)
\end{itemize}
\end{footnotesize}
motorised and non-motorised road users (i.e. they are more likely to ignore the traffic lights, speed towards traffic lights or cross at other locations).

Therefore acceptance of the red traffic light sequence, capacity for motorised users and quality of use for cyclists and pedestrians must be achieved by moving towards more intelligent traffic light control systems. There can be a wide range of cooperative telematic systems used. However, the essential part is the improvement of information systems additional to those that are visible by the human eye, to avoid accidents through active identification of conflicts with other road users and assist the road user in their journeys.

3.1.2. Vehicle and equipment

In the last decades a wide spectrum of so called active and passive road safety measures have been developed. Particularly the car manufacturers are setting the pace in improving not only the safety of vehicle occupants but also the protection of road users outside the car (i.e. VRUs). The competitive situation between global companies makes it possible to integrate these efforts to EE, if they are not limited by regulating legislative and registration procedures. The global players in the car industry pay attention to VRU safety as it is requested by the clients, and technical developments for other purposes give advanced possibilities to do this as well. It can be expected that the integration of VRU interests will develop alongside new driver assistance systems that control cars with their inside and with their outside effects. The ability to adapt speeds depending on the outside situation and probably also in order to reduce the fuel consumption, with lighter cars, are other relevant aspects.

In the TRACE Project a categorised listing of possible active and passive safety measures can be found (TRACE, 2007).13

Active Road Safety (measures) contribution

Active safety includes measures to prevent accidents, such as antilock brake (ABS), four wheel drive and brake systems. They have been introduced several years ago and optimise the road surface – tyre – load transmission. But there are other active factors that can be assumed to be based on the weight of the car. New assistance systems for critical situations should be combined with the operation of the car. They can support the driver with active assistance features in many ways, but even these many possibilities have to be prioritised. Here technical engineering and perception and the possible individual information retrieval and reactions have to be balanced and to be adopted.

In Figure a simple feedback control system as a model of relations between driver, vehicle and road is shown. It remarks in an abstract way points of intervention to approve the active safety measure.

One of the targets of driver’s assistance is to increase the amount of time for the driver to react in possible conflict situations and to enhance the visibility. There are also simple feedback features (e.g. lane assistance or adapting lighting) but also more complex information (e.g. about cars around their own position - car2car communication - or the situation with the road around - car2infrastructure communication - see Figure ).

In the near future there will also be systems which help the VRUs to be more visible by enhanced technical perception for the driver (i.e. pedestrian and bicycle detection systems). Other applications are road database information about critical bends or intersections coming up ahead, which can be shown in the front windsreen in a projection (head-up displays), as well as information about critical local traffic and weather conditions. This additional information must be balanced with drawing the attention of the driver off the road itself, which can be critical even in urban situations.

Other vehicle developments support the visibility of vehicles to each other and adapt the lighting to improve own visibility. Most important is driving behaviour in critical situations and the individual constitution of the driver. The monitoring of individual condition of drivers that depends on other factors and can be checked with several methods. (Appelt et al., 2010) used active Gazetracking system with a high frequency pupil measurements and detection in real 3D Models with feedback about recognition patterns, to monitor where the eyes are looking and percept contents when conducting driving tasks.

Communicating possible conflicts on the road ahead by vision or addition of information about these possible conflicts is most important. Feedback (through noise or vibration) about the current situation makes it possible for the driver to adapt their direction or speed.

The EC funded TeleFOT project is also investigating using nomadic devices in-vehicle Field Operation Trials’s to investigate driver behaviour (TeleFOT, 2011).

These technical assistance devices are, to a certain degree, bound to cars and their typical equipment and can be adapted to trucks, buses and trams. Some of the features have also enforcing power as tires and brakes supervision systems, time report books, or are educating and also actively influence drivers with noisy signals or stopping vehicles if safety-related defects are detected.
Also for two wheelers a considerable range of these instruments are supposedly usable. Antilock Braking Systems (ABS) or Electronic Stabilising Programmes (ESP) can be adapted, and active measures can include permanent lights to improve their own visibility. However, these can get overcompensated if the same is used by cars as well. So further main active possibilities can be seen with tires that use available road grip and a future possible driving assistance with car similarly communication features to other partners and infrastructure.

Even the driver assistance systems can be problematic if they impact on the autonomy of driver. Several functions, such as systems for automatic light adaption, braking, acceleration, emergency brake assistance will have potential of contributing to lower the risk of VRU if the juristically part can be determined for their use which concerns the responsibility of producers as well. Autonomous decision chains just before a crash are a first part of the long term development. Here the integration of mitigation of VRU risks could be involved.

Vulnerable road users can contribute by improving their visibility by use of reflecting materials, use of lights in darkness and behaving with good road sense. Public transport includes VRUs as possible clients with indirect infrastructure – vehicle connections as traffic light protection.

Passive Road Safety (measures) contribution

Mitigation of effects of accidents in a passive way starts with car basic features, such as the speed of the vehicles on impact, the s-shape of car fronts, and including possibilities to protect VRUs from cars (for example, the expected development of external airbags – TNO, 2011).

The risk of injuries or fatalities for VRUs can only be solved in a partnership on development with car makers trying to reduce damage and injuries in car crashes. The reduction of injury
risk inside a car is a success story and the result of long term evolution. Fixed positions of car inhabitants (e.g. safety bells, seats, headrests combined with airbag systems, deformability of the survival space, deformable crash section of the car body that absorb the crash forces while distorting) maximises the effects controlled by special sensors and emergency logics. This is expected to be adopted while recognizing VRUs before crash.

A new balance and weighting of certification of technical features with both active and passive measures is a necessary precondition in Europe. Euro NCAP (Euro NCAP, 2011) provides methodology and the necessary approval know-how for certification of new safety features but national regulations outside Europe can vary from this.

The passive safety of VRUs outside the vehicle can be improved by wearing helmets and protectors, which in some countries is encouraged, at least for bicyclists (Bicycle Helmet Research Foundation, 2011). These injury mitigating measures cannot substitute effective and real test conditions in crash simulations. Crash test dummies are to be improved and to be used as control figures for simulation with biomechanical simulations that test the complex scenarios of VRU – vehicle accidents. The new development of the airbags situated outside the front shape of the car body to avoid injuries could be very important for VRU safety in the future.

Improving their research and development in the field of engineering, the car industry has developed autonomous driver assistance systems for crash situations, although legal problems have to be clarified before the use of this technique. E-Cars, E-Cycles will assign their own traffic safety problems, including maybe the chemical content protection or the acoustic perceptibility which is much more important for VRUs than for those people in the car (Wissenschaftlicher Beirat beim BMVBS, 2010). A scope of traffic safety measures by vehicle manufacturers has to be accredited on an international level which makes a further harmonisation of technical standards eligible. To have more realistic results an improvement of crash test situations, crash test conditions and crash test dummies is required. Also tendencies to use simulations with digital bio mechanical dummies are under preparation to have a complex variety of possible impacts in the test components.

3.2. Education

Vulnerable road users have the highest risk and have to be considered in a special way by all kinds of traffic safety. For example the main targets for the coming years of the German Traffic Safety Programmes¹⁴ (DVR - Deutscher Verkehrssicherheitsrat, 2010) are:

- Complete improvement of the traffic climate to reduce aggression.
- Protection of VRUs.
- Reduction of accident risks involving younger drivers.
- Reduction of danger from heavy trucks.
- Improvement of traffic safety on rural roads.
- Introduction of new developments on environmental sustainability and adaption of infrastructure to new requests.

The strategies have to be communicated as a public relations and public communication exercise to the road users. The conventional way to do this is by big campaigns, which can include television and advertising in public spaces. This is changing, especially as far as the younger generation or certain special parts of the society are concerned. An important medium now is the internet with high quality websites such as social networks like Youtube and Facebook or related to special platforms and communication channels for disabled

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¹⁴ Ministry of Transport, Deutscher Verkehrssicherheitsrat, Deutsche Verkehrswacht
people, migrants or residents’ groups, sport clubs, car or cycle clubs and organisations, and others. Organisations with a large integration in society can contribute to national or federal level public relations campaigns, providing common or tailor-made messages.

Shock messages have become a part of strategies referring to death as a possible result of incorrect traffic behaviour (THINK!, 2011), as well as positive messages and use of painting books (see Figure ). A systematic analysis of possible media and its effectiveness is essential in advance.

Figure 13: Road Safety painting book for kids (Deutsche Post DHL, 2010)

When considering educational campaigns it is important to be able to assess how effect current and previous campaigns have been. The EU project Campaigns and Awareness-raising Strategies in Traffic Safety (CAST, 2009) developed an evaluation tool for road safety campaigns (Boulanger et al., 2009). This details the campaign attributes that will have the most determinative implications for an evaluation study (Boulanger et al., 2007). These attributes are: scope (national vs. local), target group (general vs. specific), objectives (to change behaviour, attitudes, perceived norms, knowledge etc.), and supportive activities (media only vs. integrated campaign).

It is discussed that campaigners should also take into account some factors given or determined outside the campaign such as: the budget (more specifically the evaluation budget), stakeholders of the evaluation (e.g., sponsors), and a-priori information (in-depth assessment of the road safety problem, marketing studies of the target group).

Measures that can be collected in order to assess the impact of a road safety campaign are listed as: self-report measures, observed behaviour and accident statistics. The project then describes how the results should be written up in a detailed and structured report, and then consult this (and similar) reports before starting a new campaign.

In the UK the Department of Transport (Department for Transport, 2004) has also published guidelines for evaluating road safety education interventions. This is designed to support evaluators so that they can decide if a campaign has been successful or not, and the

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15 Guidelines for evaluating road safety education interventions
http://www.dft.gov.uk/pgr/roadsafety/laguidance/educationinterventions/
reasons why, so that these can be used or avoided in future campaigns. The results can also be used to inform policy makers, detail strengths and weaknesses with the current policies, and help decide if future funding should be made available to the campaigns or others. The process of evaluating interventions also usually involves the people involved and affected by the campaign, giving them the chance to give feedback and feel more involved in the decision making process, which could encourage greater compliance.

Mobility and traffic safety education should start from the youngest children, following them through school and on into jobs or further education. Driving motorised vehicles is certificated with driving licenses and should be prolonged with lifelong learning. It may be necessary to focus on aspects of getting older and/or losing physical abilities, as reaction times when driving can drop. The awareness of traffic safety problems is the first step, and in Europe is a part of education provided by official and voluntary organisations.

**Figure 14: German Schülerlotse / school crossing guard (HNA.de, 2010)**

Human error is said to be responsible for 70 to 80% of accidents in general" (Rasmussen 1997, quoted by Stigson 2009: 2). In (DVR - Deutscher Verkehrssicherheitsrat, 2011) is considered that in more than 90% main accident reasons are human mistakes and non-adapted behaviour. Dangerous behaviour patterns themself or combined with bad conditions of infrastructure and means of transportation. The public awareness of traffic safety problems has increased and within society the awareness of traffic safety measures has been established.

From the point of view of fatalities reported in Germany the most dangerous roads in the EU are rural roads, the most dangerous age adolescence, and the highest risk occurs to two wheelers. But children and the increasing role of older road users has to be taken into account. Disabled people may have specific physical and cognitive abilities which require a special focus, as well as inexperienced adolescents.

Table below gives details about the age of a child and the different types of traffic education programmes that operate in Germany. The right integration in school as a mobility education and cultivation of social transport behaviour and the contents to be provided to the age groups are subject of research works of teachers. (Limbourg, 2004) shows children Traffic and mobility education as a development over decades in Germany with updated contents related to ecology and sustainability.
Table 2: Continuous Traffic Education at different ages in Germany (Schlag et al., 2006)

<table>
<thead>
<tr>
<th>Age / Constitution</th>
<th>Activity / Traffic Education Programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kindergarten / Preschool</td>
<td>Practice of Basic Behaviour, Programme “Children and Traffic”</td>
</tr>
<tr>
<td>School start</td>
<td>Planning of way to school / Safety on way to school</td>
</tr>
<tr>
<td>Basic school</td>
<td>Traffic education in general studies</td>
</tr>
<tr>
<td>3rd/4th School year</td>
<td>Bicycle training</td>
</tr>
<tr>
<td>Primary / secondary school</td>
<td>Facultative interdisciplinary Traffic education</td>
</tr>
<tr>
<td>Secondary school</td>
<td>Motorized two-wheeler training</td>
</tr>
<tr>
<td>Young adults</td>
<td>Driving school</td>
</tr>
</tbody>
</table>

Other countries have their own programmes: within the UK the Bikeability scheme (Department for Transport, 2011)\(^\text{16}\) operates at 3 levels (level one for younger primary school children, level 2 for 10/11 year olds, and level 3 for children in secondary school), giving information and training on riding bicycles on the road. They also run courses for adults.

Often voluntary organisations contribute to official policy. For example, in Germany the Deutsche Verkehrswacht (German Traffic Watch) has 70,000 members who are active in advising federal, local and communal structures, performing a lot of activities and training programmes, while learning and updating their own knowledge. Members include people from all parts of society, from parents and children, to pensioners and all kinds of professions.

Information about long term rehabilitation after accidents, the physical, psychological aspects even with VRU is also an important message being established in the public mind. Road traffic safety public relations work is also done on other institutional levels, such as German Insurance Federation (UDV, 2011), car manufactures, bicycle and bicycle equipment producers, children clothes producers that understand road safety as a positive argument for people to choose their products or simply understand their responsibility within the society.

A very important part is the education and collaboration of the professionals in this field, such as:

- Police, teachers.
- Private road safety organisation representatives.
- Public transport organisations.
- Road safety public relations experts.
- VRU representative organisations.
- Companies and authorities in the field of:
  - Road design.
  - Road construction, road equipment.

\(^\text{16}\) Bikeability - Cycling Proficiency for the 21th century
- Road maintenance.
- First Aid, emergency hospitals, rehabilitation clinics.

Only an iterative process of feedback between all stakeholders results in road safety improvement. These structures are diverse, but the communication between them is essential. A good example is the organisation of Road Guidelines development in Germany that involves all the professional experts in FGSV - Research Association for Roads and Traffic (FGSV - Forschungsgesellschaft für Straßen- und Verkehrswesen, 2007)17 or BSVI – Federal Union of Road Planning and Traffic Engineers (BSVI - Bundesvereinigung der Strassenbau- und Verkehringenieure, 2010). This is an organisation dealing with infrastructure design, construction and maintenance and reflecting current development with education and training programmes on-site for those involved. The introduction and voluntary implementation of Recommendations on Road Safety Audit (FGSV - Forschungsgesellschaft für Straßen- und Verkehrswesen, 2002)18 and the curriculum for the education of certified Road Safety Auditors (MAZS, 2009) have taken place with integration of all players. Software based road safety analysis is also investigated scientifically with much effort (Brannolte et al., 2009).

In the UK road safety audits are mandatory for all trunk roads and voluntary for minor roads, however most local councils do undertake audits as a matter of course for all road developments and re-developments.

Road Safety Audits assess the development through the whole design process and give input to each design step as a precondition to get approval, and only after that to go ahead and build the road. The process can be extended until inspection before finalising construction and opening the roads to traffic use. Even though the federal level or communal organisations are free to take care of the recommendations this has to be considered as a growing model even for urban areas. National initiatives can be based on international efforts analysis and effects. Development with federal, local and community representative experts can be effective in a communicating the process of implementation. This is a form of education as well.

It can be assumed that education is close to communication and public relations. It is essential to gather positive and negative feedback from people who are not obliged to undertake education or training. Driver training, situation training in special training areas or with simulation programmes which include both motorised and non-motorised producers are further possibilities.

For example in Germany schools check bicycles and conduct bicycle road safety training programmes before the start of a new school year, including education films and test the safety equipment in field as well as crash simulation in field. The driving license enables (young) drivers to take part in motorised transport actively. Even when figures shows that even the first 7 years of driving experience provide problems which are above overage compared to the share of the population they are thought crucial for the establishment of transport behaviour. Theory and practice are parts of the training before the final exam. New chances are given in Germany by driving licenses for underage adolescences (from 17 years) in order to drive accompanied by parents or relatives who can influence safe traffic behaviour in the first driving year (BF17 - Führerschein mit 17). Positive learning for both sides can be expected. There is discussion about having a lifetime driving license, with suggestion that physical checks be made even if there are no records of unusual behaviour, as the person ages, this would require a change in rules. The update conditions for driving licenses could be similar to tram and bus drivers. These drivers are being checked regularly (starting at a certain reasonable age). Intervention may be necessary since reaction times

17 Richtlinie für die Anlage von Stadtstraßen (RAS St 06)
18 Empfehlungen für das Sicherheitsaudit von Straßen (ESAS)
and recognition abilities can be expected to decrease as people get older. This may be a source of conflict between constitutional rights for individuals as a subject of public convention. The Institute of Advanced Motorists in the UK (IAM, 2011) offers training and advice (including tests) for drivers of cars (tests since 1956) and motorcycles (since 1976) as well as bicycle riders, enabling education and training to be further developed in interest people through adulthood. However, this is purely optional and whilst to date 400,000 people have taken advanced tests with a pass rate of 75% (IAM, 2011) it is not known how many people are aware of such training and opportunities.

Another problem is the misuse of alcohol, medicine and narcotics which influences driver abilities. Education can focus on these problems as well. In order to increase awareness of the effects of alcohol on perception and awareness, drunk simulation glasses (Figure ) can be used to show adolescents and adults the change of recognition when drunk and can be combined with transport situation simulations. Educational efforts can possibly set a goal for new generations to abstain from alcohol while driving or to organise at least one in a group to stay sober and drive the others home (Polizeipräsidium Mittelhessen, 2011).

![Figure 15: Drunk Simulation Glasses (Rauschbrillen, 2011)](image)

3.2.1. Public Relation

Public Relation campaigns follow rules close to advertisement using similar elements. Traffic Safety campaigns represent societies interests; they are often introduced by institutions having high serious prestige. Different cultural aspects have to be taken into consideration to be effective.

There is the "Tales of the Road" website and campaign (since 2009) (Department for Transport, 2009)¹⁹, aimed at 6-11 year olds in the UK. This includes online games, information packs, animations and videos to encourage children to make safe decisions when near roads.

In the UK there is the long-established THINK campaign (THINK!, 2011), which is aimed at providing advice and information on road safety for all users, including drivers, children, teenagers, pedestrians, cyclists and motorcyclists. Educational materials that are available include guidance on planning and delivering effective road safety education, teaching ideas, video and audio clips, worksheets and interactive activities, and information for parents. Materials are appropriate and designed for: 3-5 year olds, 5-7 year olds, 7-11 year old, 11-16

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¹⁹ Tales of the Road. http://talesoftheroad.direct.gov.uk/
year olds and out-of-school groups. Also, Kerbcraft is a practical child pedestrian training scheme which is designed to teach pedestrian skills to 5 to 7 year olds, by means of practical road-side training rather than teaching in the classroom. It is built around teaching three skills: choosing safe places and routes; crossing safely at parked cars and crossing safely near junctions and these skills are taught over the course of a number of roadside sessions (Thomson & al., 2008).

In 2010 a campaign was run in the UK by Coca Cola, including advertisements on national television, encouraging people to chose a "designated driver" for evenings out (Coca Cola, 2010). This campaign followed previous seasonal campaigns in the UK to discourage drink-driving.

![Figure 16: Example of Road Safety Campaign in Germany (Vollpracht, 2006)](image1)

![Figure 17: Example of Road Safety Campaign in Germany (DVR, 2010)](image2)

### 3.3. Enforcement

The best engineering methods and ideas can be made useless if nobody follows the regulation framework which they are made for. Even the feedback generated by enforcement, both negative and positive, influences behaviour and pushes or penetrates changes. Enforcement includes the following fields:
1) Legislation and related establishment of rules, guidelines, regulations, recommendations – it has strong relation to national and even federal bodies and several levels of validity;

2) Supervision, control, monitoring and analyses of relation according to 1;

3) Negative feedback – sanctions and punishment with a variety of levies, penalties, trials with several also additional constraints for education, psychological tests, prison;

4) Positive feedback which is the subject for further development and bounded to strict active prevention by authorities and touches encouragement (see 3.4) with motivation or incentives to understand that road safety matters to all road users.

The variety of possible and necessary rules must be observed within the cultural behaviour in of the whole society. Adoption of legislation is a target to realise necessary change for improved road safety, with a regenerating system being established, combined with education and encouragement.

The European Transport Safety Council (ETSC - European Traffic Safety Council, 1999) estimates that the potential reduction in accidents due to improved enforcement could be 59%. In (ESCAPE, 2003) one can find a figure of 76% possible accident prevention for Sweden if ignored rules were enforced. Enforcement is a basic issue that starts together with education in childhood, probably in the family. Any scheme to achieve sustainable enforcement is going to be a special research field which has a subject of transport and psychology. The presence of authorities should establish a supervisory deterrence with their high presence, high availability in conflict areas and conflict situations to make the road user sure to expect sanctions if they are not following rules, and promote social behaviour in traffic. On the one hand, on a scale of vulnerability the weakest participants must be protected, but at the same time the traffic needs of stronger participants that has to be balanced.

Also for enforcement we can find technical components from engineering, such as supervising cameras for point and section speed control, and red light controls to protect VRU from potential injury. But the social components and the acceptance of speed limitation is much more complex, and punishment will be always discrete single cases. If violation of the rules can be technically reported instantly, the juristically fixation may be later as driver of cars and two wheelers have to be identified. The technical equipment must be on a very high reliability level and certified to be approved in trials.

Therefore there are requirements to close the gaps in existing legislation to make enforcement possible. This may be felt as a limitation of tolerance in special situations and for individual rights. It has to be understood that technical limits can not reflect a deficit in behaviour at first glance. Legal proceedings occurring some months after committing the illegal behaviour do not make the necessary impression. Elements to make people aware of the direct connection between enforcement of legislation control and monitoring possibilities are becoming advanced and more effective. Whether and how these data shall be used needs a political decision. In order to enforce laws at critical points of road safety major activities are needed to record the stronger motorised road user and high speed bicyclist:

- Acceptance of speed regulations (e.g. speed control at conflict points, section or while driving, speed cameras to automatically record and issue fines to those breaking the limit).
- Alcohol and drugs (e.g. control of alcohol especially with conflict potential).
- Red light (e.g. combined with speed cameras).
- Telephone without hands-free kit (e.g. individual controls, observing cameras).
- Truck travel time control (e.g. travel time reporting systems).
• Technical vehicle control (e.g., frequently control and certification of each vehicle, obligation to remedy defects, deregistration of vehicles in bad condition).

Several countries record certain penalties in registries (for example Germany has a national minus point registry, and in the UK drivers can have points added to their licence for offences) that is reported depending on time spent and is a basis to legally try repeat offenders in order to enforce them with stronger penalties, for example a loss of driving license, or participation in special courses for drink and drive alcohol mis-users (BMVBS - Bundesministerium für Verkehr, Bau und Stadtentwicklung, 2010)\textsuperscript{20}.

In the UK there is a maximum allowable number of points a person can accrue on their driving licence, after which the licence is taken away and the person is banned from driving for a set period.

3.4. Encouragement

To lower barriers in society while encouraging road users towards more safety has several aspects and is embedded and connected with the other E’s in a special way: to make use of them at an appropriate level and to accept the rules which form the base for them. This includes simulation and variation of the individual cost-benefit-consideration of road users. Attracting someone with social and economical benefits seems to be predictable if one can find out incentives to prevent unsafe transport behaviour. Encouragement can also be aimed at different people: at road users themselves to encourage them to adopt safe behaviours and practices, and also at national and local level to encourage decision-makers to instigate policies and practices that improve safety.

Traditional schemes will work with some generations but a change to give a choice with “push-pull-publicity” is a step forward to more social and ecological responsibility and to feel that complying is to the individual’s advantage (Schade and Schlag, 2004).

National Governments may offer road safety grants or other incentives to encourage local authorities to improve road safety in their area. Lobby groups and advisory committees can work at all levels to offer advice and guidance to policy makers, from the national level, for example the Parliamentary Advisory Council for Transport Safety in the UK (PACTS, 2011) which advises the government on air, rail and road safety issues. Other similar groups in the UK include Roadsafe (Roadsafe, 2011) and BRAKE (Brake, 2011). Charities such as these aim to increase public awareness with their own road safety campaigns as well as lobbying decision makers as required.

Encouragement of individual road users can include aspects such as (in the UK and in Germany) insurance companies offering lower premiums to people with no accident history, and reduced premiums after a given number of years with no claims made. Vehicle safety can be influenced by special safety standards, and safer cars / cars with additional safety features could be offered lower insurance premiums One example is Volkswagen insurance subsidiary VVD that offer discount if road safety equipment package of the Volkswagen Group standards is purchased with a car. So the costs for additional technical features are balanced by a 3-4 years discount.

The Association of Chief Police Officers in Scotland (ACPOS, 2009) has developed its own framework based on the 4Es for improving the policing of Scotland’s roads. From the encouragement perspective they discuss that alternatives to legislation can have greater public approval, and the need to publicise campaigns and actions being undertaken to increase road safety.

In traffic, especially on roads, a problem with cost structures and a lack of clearly understood cost-benefit-chains identification can be expected. Even costs in the field of environmental

\textsuperscript{20} Bußgeldkatalog
influences or benefits in time and other factors of society favour have to be balanced and to be taken into consideration for neutral cost-benefit estimation. In practice it must be simple to make people choose road safety. This combination is basically to be supported by main stakeholders of goods with safety content and profiteers, beneficiaries and responsible in traffic (Wissenschaftlicher Beirat beim BMVBS, 2010). In main groups they are described with:

1) Road Users - decide about success of enforcement and compliance, acceptance, adaptation of transport behaviour, attendance to pay for road safety products should be assisted in a proper way.

2) State or country (cooperation of some of them) state responsibility - is a safety oriented legislation, basic research and the road infrastructure itself with appropriate information and telematic equipments; state power to obtain and invest taxes in road safety makes its influence crucial.

3) Industry - research and development for safety technologies in all fields concerning road safety and introduction to the market are preconditions for active and passive road safety.

4) Insurance system - is in daily business with aftermaths of accidents and their compensation follow ups. New insurance strategies stimulate minimisation of the accident claims.

In terms of the environmental and sustainable impact of road vehicles, this can be linked in to road safety. If people can be encouraged to walk, cycle, use public transport or car-share schemes instead of their private cars, this will reduce the number of motorised vehicles on the roads, which will increase safety as well as be good for the environment. For vehicle users a lot of Pay-as-you-drive (PAYD) measures are being developed.

VRU can benefit by using public transport systems directly by walking and cycling. However, this requires proper infrastructure, with public transport being cheaper and readily available to encourage people to see that using it is a benefit to them, as well as recognising that reducing environmental impacts is an advantage for everyone.

3.5. Conclusion

The 4E´s are a basic theoretical model that categorise the scope of possible measures to improve road safety with primary and secondary prevention.

The 4E´s are not mutually exclusive. Engineering developments that are not enforced will have no impact on safety. Education of road users needs to be linked to successful enforcement so that a minimum of active punishment is needed. The categories must be overlapping. This overlapping and the interaction between the 4E´s has the potential to adapt to the changing needs of road users (see Figure ). So an analysis of the existing situation informs the adaptation needed for practices to be successfully transferred. Challenges to transferability should be described in a problem score estimation, indicating a need for engineering measures to be accompanied by the other E´s.
It is necessary to get the system calibrated as a generic balance by the real accidents or research about a potential danger. The accidents that can be considered are those that are properly recorded. Underreporting of problems can be improved by appropriate enforcement and education. The better the quality of reports the better the feedback and outcome to improve the system. Accident reports also provide a good possibility to compare whether the before and after situation has been changed.

It is essential to understand why the accidents occurred and it is therefore essential to get detailed information about the reasons and the circumstances of accidents in standard categories. The experts and protagonists in this interdependent system must be integrated in an education and motivation network with a common vision to improve road safety. This allows more information to be available for adaptation of measures specific local needs.

Implementation of the 4E’s costs money, but has the potential to save money in the long term if a society accepts the importance of transport safety, and reduces the costs incurred by road traffic accidents. Ten years of research into the socio-economic costs due to road traffic accidents in Germany (BASt, 2010) found that for the year 2008, the Federal Highway Research Institute calculated the costs of road accidents to be as follows (Table 1).

### Table 3: Standard cost rates per person and per accident for Germany 2008 (BASt, 2010)

<table>
<thead>
<tr>
<th>Cost rate for injuries and fatalities per person</th>
<th>Costs in Euro</th>
</tr>
</thead>
<tbody>
<tr>
<td>fatality</td>
<td>1,035,165</td>
</tr>
<tr>
<td>heavy injury</td>
<td>110,506</td>
</tr>
<tr>
<td>light injury</td>
<td>4,403</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost rate for property damages per accident</th>
<th>Costs in Euro</th>
</tr>
</thead>
<tbody>
<tr>
<td>accident with fatalities</td>
<td>40,242</td>
</tr>
<tr>
<td>accident with heavy injuries</td>
<td>19,436</td>
</tr>
</tbody>
</table>
Personal injuries and property damage in road accidents in Germany caused socio-economic costs of (more than) 31 billion Euro. Personal injuries made up 45% of this figure, property damage 55%. For Germany, as a main European transit region, the annual costs of road accidents are more than 30 Billion € (see Table 4).

### Table 4: Development of accident costs in Germany for personal injuries and property damages 2005 - 2008 (Bill Euro) (BAST, 2010)

<table>
<thead>
<tr>
<th>Year</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs personal injuries</td>
<td>15.23</td>
<td>14.73</td>
<td>14.88</td>
<td>14.04</td>
</tr>
<tr>
<td>including fatalities</td>
<td>5.46</td>
<td>5.16</td>
<td>5.08</td>
<td>4.64</td>
</tr>
<tr>
<td>heavy injuries</td>
<td>8.15</td>
<td>7.98</td>
<td>8.16</td>
<td>7.83</td>
</tr>
<tr>
<td>light injuries</td>
<td>1.62</td>
<td>1.59</td>
<td>1.64</td>
<td>1.57</td>
</tr>
<tr>
<td>Costs property damages</td>
<td>16.25</td>
<td>16.22</td>
<td>17.09</td>
<td>16.96</td>
</tr>
<tr>
<td>National economy damages</td>
<td>31.48</td>
<td>30.95</td>
<td>31.97</td>
<td>31</td>
</tr>
</tbody>
</table>

Reducing such costs by aiming zero fatalities and reduced injuries to VRU can only be achieved with a systematic work and long-term vision. The amount of accidents in the EU, Brazil or India requires efficient use of possible instruments within the local context, to a local optimum. This is why ensuring transferability of approaches and instruments is key.
4. Cultural Model and Human Factors

Culture is more often a source of conflict than of synergy. Cultural differences are a nuisance at best and often a disaster.

Geert Hofstede

4.1. Introduction

When working on a project, one should reflect on the possible external factors that may influence the research scope, the research process and the feasibility of outcomes. As already mentioned, each road safety issue in a respective country exists in a space defined by the economic, institutional, social and cultural factors which influence it.

For SaferBraIn specifically, attention should be paid to the cultural differences, as a comparison and cooperation between Brazil, India and Europe lie at the core of the project. Effective communication with people of different cultures is especially challenging. Cultures provide people with ways of thinking, ways of seeing, hearing, and interpreting the world. Thus the same words can mean different things to people from different cultures, even when they talk the "same" language. When the languages are different, and translation has to be used to communicate, the potential for misunderstandings increases. The study of cross-cultural communication is fast becoming a global research area.

To assume that solutions or approaches that have proven to be effective in one culture will automatically have the same results in another would be more than naive. Any single engineering measure can be theoretically transferred from one country to another, but outcomes can be very unpredictable. One may claim that culture – be it national or organisational – will always influence a project between two parties and that it would lead too far to always take this into consideration in projects. It is here argued however that the parties cooperating in the SaferBraIn project are representatives of cultures that could potentially be so different that not recognising these differences could eventually lead to poor or unfeasible outcomes.

To evaluate the transferability, and in this case also cultural influence, on the results different approaches are possible. The widely spread try-and-error approach with following iteration process seems to be unacceptable in case of SaferBraIn. On the one hand there are only limited possibilities within one pilot project, on the other hand no equal bidirectional interrelation can be expected between the safety measures and cultural issues. It means that the results of a Transferability Audit cannot directly influence cultural matters. On the contrary, cultural issues affect the transferability and have therefore to precede any transferability analysis.

Hence, the main objective of this chapter is the evaluation of the existing research results of cultural dimensions for European countries, Brazil and India as well as of the research for metropolitan areas of São Paulo and Delhi, which was done for this particular project by the local partners. The main targets are to ascertain cultural differences of the countries participating in SaferBraIn project and to define how they can influence the transferability of Road Safety measures.

Taking into consideration that a majority of accidents occurs due to human factors, an extra chapter will be dedicated to this issue. User state and behaviour may impact on road safety. Therefore a model of Human Functional Failure which was developed for car drivers is introduced as a possible basis for an analogue model for VRUs.

4.2. Cultural and social background for Brazil and India

For cooperation between different countries the awareness of their cultural background is essential. Table 5 represents the main general characteristics of India and Brazil.
Table 5: Basic information about India and Brazil

<table>
<thead>
<tr>
<th></th>
<th>India</th>
<th>Brazil</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Population in 2010</strong></td>
<td>1 150 000 000(^{21})</td>
<td>200 000 000</td>
</tr>
<tr>
<td><strong>Population density</strong></td>
<td>360,34 per sq km</td>
<td>22,72 per sq km</td>
</tr>
<tr>
<td><strong>Languages</strong></td>
<td>Hindi/English + 14 official languages, ca. 400 languages</td>
<td>Portuguese, 236 catalogued languages</td>
</tr>
<tr>
<td><strong>Literacy rate</strong></td>
<td>64.84%</td>
<td>95%</td>
</tr>
<tr>
<td><strong>Main religions</strong></td>
<td>Hinduism, Buddhism, Islam, Sikhism</td>
<td>Catholicism, Protestantism</td>
</tr>
<tr>
<td><strong>Social aspects</strong></td>
<td>Castes system</td>
<td>High income concentration; strong concept of class and status</td>
</tr>
<tr>
<td><strong>Cultural differences</strong></td>
<td>Collectivistic culture, but business is very personal; patriotism; fatalism; long time oriented</td>
<td>Family-oriented; religion as the essential part; subjective feelings dictate the solutions; extremely close proximity</td>
</tr>
</tbody>
</table>

The population of both countries is very diverge, whereas Europe in terms of the European Union counts about 501.103.425 inhabitants (Eurostat, 2011). The population density is extremely high-contrasted though it is well known that the population density in Brazilian cities is very concentrated. Concerning the official language(s) we have a special situation in India with the equal acceptance of English to the national Hindi language. This allows better information exchange between the international community and India. All Indian legislative documents and most of the materials about transport and Road Safety issues are available in English. The situation is different in Brazil. Even when the majority of educated people can speak or at least understand English, only few official documents or specific information about transport topics can be found in English. This fact makes the transferability of the European content – in this case the Transferability of Road Safety Measures – difficult.

The awareness of Road Safety measures and traffic regulations also depends on the level of education. Taking into consideration that the official literacy rate in India is 64.84% (Know India, 2001), the authorities of India should cooperate in order to improve the literacy rate and to create alternative methods of providing information and education in terms of Road Safety for illiterates. There should be efforts done similar to existing refresher training for heavy vehicle drivers in India. Since a significant number of them are illiterate, an attempt is being made to prepare and standardise audio-visual training material for the training.

Speaking about India and Brazil, religion should be concerned as one of the major characteristics in the daily lives. Brazil is the largest of the Roman Catholic countries of the world. Officially there is no state or official religion in Brazil. In practice, there is only limited separation between the church and the state. Most government officials avoid taking positions or actions that would offend the Church officials. Catholicism in Brazil and Hinduism in India are dominant and practiced by over 80% of the population. In India, religion is a way

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\(^{21}\) This is the estimated population of India in 2010 according to the preliminary results of the Census of India 2011 (India Population, 2010).
of life. It is an integral part of the entire Indian tradition. For the majority of Indians, religion permeates every aspect of life, from common-place daily chores to education and politics. Two of the world’s great religions – Buddhism and Hinduism – were born in India. Also for safety issues the influence of religion in these countries can be assumed. One example is the use of helmets in India. Section 129 of Motor Vehicles Act, 1988 (India Parliament, 1988) makes it compulsory on the part of all two-wheeler riders and pillion riders to wear a protective head gear conforming to relevant Indian standards. The law however makes certain exceptions for persons who cannot use helmets on account of the religious reason of having to wear turbans. In this case religion takes priority over safety.

![Figure 19: Wearing turban on motorcycle in India](image)

The social system of Brazil and especially of India is very different from the European system. The caste system dominates the society in India being a kind of religious social standing system which divides the population in higher and lower groups. Also in the modern society of India the caste system remains deeply entrenched and is still widespread, especially in rural India. Brazil inherited a highly stratified society from the colonial system and from slavery. The legacy of sharp socio-economic stratification is reflected in Brazil's highly skewed income distribution, among the world's worst. Socio-economic inequality involves subtle forms of residential, educational, and workplace discrimination, in such ways that members of different socio-economic layers tend to live, work, and circulate in different settings. The well-to-do live in attractive neighbourhoods, usually centrally located, go to private schools, drive or ride in cars, and shop at malls. The urban poor live in favelas or distant housing projects, take long bus trips to work, go to public schools or drop out, and shop at smaller supermarkets or local shops. These hierarchical differences of course influence educational level and traffic behaviour of the respective social levels and as a result their safety. Concluding it can be assumed that pedestrians both in Brazil and India are considered as low-class road users.

4.3. Cultural Model in SaferBrain

4.3.1. Cultural Models and Cultural Dimensions (Hofstede)

Cultural studies are not a unified theory but a diverse field of study encompassing many different approaches, methods and academic perspectives. As in any academic discipline, cultural studies academics frequently debate among themselves. Cross-cultural communication, as in many scholarly fields, is a combination of many other fields. These fields include anthropology, cultural studies, psychology and communication.

There exists no uniform evaluation system or model of cultural aspects to date. However, the variety of the available models much more illustrates how multifaceted the approach can be. Nevertheless, there are some common dimensions for the most cultural models such as
concept of time and space, equal (or non-equal) rights of men and women and position of the individual in the society. The most popular cultural models come primarily from the English-speaking researches: Hall (1989), Hofstede (1991), Oksaar (1988). Wierzbicka is famous for her work in semantics, pragmatics, and cross-cultural linguistics and has established the idea of so called *Universal Human Concepts* and their realisation in the language (Wierzbicka, 1992).

Looking for an appropriate basis cultural model for this research a short comparison of the most known models needs to be done. The differences begin at the definition of culture or even at avoiding any definition, at the objectiveness level (e.g. amount and homogeneity of the interviewed persons) as well as at use of different cultural dimensions. Table 6 contains a comparison between three most popular cultural models of Hofstede, Hall and Gesteland though the latter should be concerned more as a collection of a life experience in how to behave in business with success worldwide.

**Table 6: Comparison of Cultural Models (Astapenko, 2008: 92)**

<table>
<thead>
<tr>
<th>Research basis</th>
<th>Hofstede</th>
<th>Hall/Hall</th>
<th>Gesteland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviews with IBM employees from 50 countries</td>
<td>Personal 30 years’ experience with intercultural communication as well as 180 interviewees (inhomogeneous) from 3 countries: USA, Western Germany and France</td>
<td>Personal 26 years’ experience being manager abroad as well as conversations with business travellers at airports, bars etc.</td>
<td></td>
</tr>
<tr>
<td>Cultural dimensions</td>
<td>5 dimensions: *power distance, collectivism vs. individualism, feminity vs. masculinity, uncertainty avoidance, long-term vs. short-time orientation</td>
<td>4 dimensions: *time: monochron vs. polychron, context: high vs. low, message speed: fast vs. slow messages, space: high vs. low territoriality</td>
<td>5 dimensions: *relationship vs. deal/faceted culture, *low vs. high context culture, *focal vs. inf. or unstructured culture, *polychronic vs. monochronic culture, *expressive vs. reserved culture</td>
</tr>
</tbody>
</table>

This comparison demonstrates the lack of homogeneity of the research basis. While the amount of the interviews done by Hall is relatively high, he surveys only three countries. Gesteland on his hand does his research without any statistics using his own experience. Comparing to this the cultural model of Hofstede is more representative and homogeneous. He worked on interviews of IBM-employees in over 50 countries who therefore work in the same sector in comparable positions and have a similar social status.

It is obviously that every cultural model has to be approached with great caution and an uncritical reading of cultural dimensions can lead to false conclusions. But even if Hofstede’s conceptualization of culture has attracted some criticism he is though one of the most renowned and most cited experts. The continuity of his researches can be observed over decades and the approach of his scientific school is still being applied and improved. Moreover, his research approach establishes a connection to the active prevention measures mentioned in Chapter 2. As his classification system will be used to make a comparison of the involved regions later in this chapter, it adds to the consistency of this report to explain his definition.

Hofstede defines culture as “*the collective programming of the mind that distinguishes the members of one group or category of people from others*” (Hofstede et al., 2010: 6). Investigating culture is an attempt to catch general trends among a large group of people on a very general level. Therefore, the findings in this report should not be applied on an individual level, as this may lead to miscommunication or even stigmatisation. There are different levels of culture (national, regional, ethnic, religious, gender, social class or even organisational level) but regarding Transferability of Road Safety measures the national level was suggested to be the subject for further research. Strictly speaking, the concept of a common culture applies to societies, not to nations.
Based on elaborate research from 1967 to 1973, Hofstede developed a model that tries to capture "culture" through scores on four values, so-called cultural dimensions (given below). Later researches added further dimensions which cannot be fully evaluated here due to other focuses in this project. The complete description of the cultural dimensions can be found on the website (Hofstede, 2011). The four main dimensions according to Hofstede are:

- **Power Distance Index (PDI):** the extent to which the less powerful members of organizations and institutions (like the family) accept and expect that power is distributed unequally.

- **Individualism (IDV):** the degree to which individuals are integrated into groups.

- **Masculinity (MAS):** refers to the distribution of roles and values between the genders. The women in feminine countries have the same modest, caring values as the men; in the masculine countries they are somewhat assertive and competitive, but not as much as the men, so that these countries show a gap between men's values and women's values.

- **Uncertainty Avoidance Index (UAI):** a society's tolerance for uncertainty and ambiguity.

Based on the values for these dimensions of the 19 European countries for which cultural dimension scores are available, an average European score was calculated. After a comparison between Europe, India and Brazil based on the official study data from Hofstede the research for metropolitan areas of São Paulo and Delhi which was done for this particular project by the local partners using the questionnaire of Hofstede is being presented. On the basis of its results the project partners awareness of the cultural differences and similarities between Brazil, India and Europe should be sharpened in order to consider them during the transfer of European Safety measures to Emerging Economies. This allows to avoid misunderstandings and to exclude from the beginning those measures which cannot be transferred due to cultural reasons.

### 4.3.2. Comparison of Cultural Dimensions of Europe, Brazil and India

A first issue that arises when comparing the regions that are cooperating in SaferBraIn is the difference in analysis levels: how should one compare the cultures of two countries (India and Brazil) with the culture of a continent (Europe)? Having some insight in the European states cultures, it is safe to say that significant differences can be noted between the European member states. Therefore an average European score was calculated based on a mathematical analysis of Hofstede’s cultural dimension scores. Even if there are in some cases crucial differences between European countries like Italy and Germany, Spain and Sweden, this average score allows comparing the cultures of Europe, India and Brazil.

The next figure presents the scores on the four dimensions for these three regions. It must be stressed at this stage that it is not the authors’ intention to make hard statements about cultures. As was indicated before, Hofstede’s research can only be used to describe general trends in the average culture of a country. This should under no circumstances be translated to an individual level.
Figure 20: Comparison of Europe-India-Brazil on Hofstede’s 4 cultural dimensions

Figure 20 indicates that the power distance is relatively large in India and Brazil, compared to Europe. This could mean that individuals in these two countries operate in a more hierarchical system. Following Hofstede’s definition, hierarchy in India and Brazil is not only accepted, it is also expected. It may be interesting to keep this in mind when analyzing the corresponding traffic systems and when designing pilots to be implemented in these two countries. Especially concerning the enforcement of safety measures, the strong power orientation influences its exercising. It is known that Brazil and India already have many road facilities and road safety measures but they are not proper used by population. Due to that stronger enforcement measures are needed to improve the acceptance of new technologies and facilities.

One can also notice that Europe appears to have a more individualist culture than India and Brazil. This tendency toward individualism can be found in several Western countries. The United States of America for example, have a score of 91 on Hofstede’s scale. Individualist cultures rely more on media and less on their social networks. Different surveys demonstrate that in an individualist culture employees are expected to act at their own responsibility and organise their work gathering their own interests with those of their employers. In a collectivist culture an employee is a part of a group and has to act according to its interest. This should be considered cooperating in pilot projects for SaferBraIn. Moreover, collectivist cultures tend to have higher power distance that individualist ones. So a strong hierarchy and acceptance of higher positioned partners can be presupposed working with India and Brazil.

Considering vulnerable road users a health-care survey mentioned by Hofstede showed that individualist and collectivist cultures differently deal with disability. A special part of the survey was dedicated to disabled children. “In the individualist communities […], people with disabilities tended to remain cheerful and optimistic, to resent dependency and being helped, and to plan for a future life as normal as possible. In the collectivist communities […], there would be more expression of grief, shame, and pessimism; family members would be asked for advice and assistance, and they would make the main decisions about the person’s future” (Hofstede, 2010: 116). Translating this finding to the SaferBraIn project, it can be supposed that collectivist cultures like India and Brazil would not have sophisticated facilities for disabled VRUs and these persons would not be well integrated in the society. This could be therefore a useful part of the safety measures’ transfer though the awareness of local partners cannot be assumed.
The scores on the *masculinity* dimension show the smallest differences between the investigated regions. The scores are about 50-60 which can be interpreted as a quite balanced value between masculinity and femininity in the compared countries. However, one can notice that Europe has the highest score. A thorough look at Hofstede’s full definition for this dimension could interpret it as follows: Europe has a more assertive culture overall than India and Brazil, while India and Brazil have a slightly more modest culture. In relation to this report, it may be important to safeguard these cultures’ higher need for modesty. Even if the masculinity dimensions scores are very different within Europe, the average score demonstrates the predominant masculine character. In masculine societies there is a feeling that conflicts should be resolved by a “good fight”, where challenge, earnings, recognition, and advancement are important, whereas in feminine cultures there is a preference for resolving conflicts by compromise and negotiation focused on relationships. Since the score’s difference for surveyed countries are minimal, this dimension cannot evoke critical misunderstandings within SaferBraIn project.

Finally, the level of *Uncertainty Avoidance (UA)* shows strong differences between the three regions. Though, UA is not the same as risk avoidance and these two concepts should not be mixed. Risk is focused on something specific and refers on a known and expected event. Avoiding risk we prevent something what we can foresee and not what is completely unpredictable. Hence, it would be incorrect to conclude that showing a relatively low level of UA, a potentially higher sense for risk taking can be assumed for India.

Cultures with high *Uncertainty Avoidance Index (UAI)* like Brazil or to a lesser extent Europe shun ambiguous situations and try to prevent them with more laws, rules, and regulations. Brazil has more law schools than all countries in the world together. There are 1,240 higher education courses for the training of lawyers in the country while the rest of the planet comes to about 1,100 universities (CNJ, 2010). Cultures with low UAI like India believe that many problems can be solved without formal rules and that the latter should be established only in case of absolute necessity. Paradoxically in countries with weak UA where rules are less scared they are often better followed. Translating these findings to the needs of SaferBraIn even when European experts can expect hindered possibilities for Road Safety measures enforcement due to low legacy level in India they can presuppose their better acceptance. On the contrary in Brazil it is assumed that every measure would first need a legal regulation. However, in countries with strong UA laws can fulfil a need for security even when they are not followed.

Another finding done by Hofstede that is relevant for SaferBraIn shows an interesting correlation between the strength of UA and the maximum speeds allowed in the country. “The relationship is positive: stronger uncertainty avoidance means faster driving. Faster driving, other things being equal, means more fatal accidents, thus more risk. However, this is a familiar risk, which uncertainty-avoiding cultures do not mind running. Their emotionality provides them with a sense of stress, of urgency, which in turn leads to wanting to drive faster. The higher speed limits in stronger uncertainty-avoidance countries show, in fact, a priority of saving time over saving lives” (Hofstede, 2010: 198).

### 4.3.3. Cultural Research for metropolitan areas in Brazil and India

Brazil and India are countries of contrasts concerning climate, geography, income distribution, and educational level of its people. Because of the diversity we cannot consider that knowing the country’s culture we also know cultural dimensions of its metropolitan areas. For this reason the Hofstede’s theory of Cultural Dimensions using the interviews based on his questionnaire was applied in São Paulo city and Delhi – the big metropolises which can be compared in their extension and live rhythm and in which the use of western experience can be assumed.

Local partners (IMR for Brazil and A+S for India) have initiated interviews of about 200 people each in São Paulo and Delhi to have representative scores for these metropolitan areas. Of course, analogue researches can be done for every region or city where the
transfer of safety measures is planned. The detailed information to the results of these researches can be found in Annexes 6 and 7. Though, the difficulties with the questionnaire are worth to be shortly mentioned at this point. Although questionnaires in local languages (Portuguese and Hindi) were used, the interviewees in India could not always interpret question unambiguously. It was established especially dealing with lower and lower middle class that a certain level of education is affordable for the answers. Many easy understandable issues from the European point of view needed to be explained. In contrary, the upper-class representatives preferred to use the English version of the questionnaire.

The main outcomes of the research are the differences between Individualism (IDV) and Uncertainty Avoidance (UAI) scores. For Brazil also the Masculinity (MAS) score features diverse scores. Power Distance Index (PDI) remains very similar in Brazil and India for both country average and metropolitan area (Figure 21).

![Figure 21: Comparison PDI incl. São Paulo and Delhi](image)

As mentioned before countries with high PDI tend to have well-built hierarchical relations within the society and need strong enforcement. Concerning wearing of helmets to protect two-wheelers, Error! Reference source not found. should be studied. Following the law, the motorcycle driver is wearing a helmet. At the same time more vulnerable passengers (two children and the lady) are not protected. Hence, only the stronger member of the family, having more power, is protected.

![Figure 22: Using helmet on motorcycle in India](image)

IDV (Figure 23) shows very high divergence between the country average and metropolitan area in both Brazil and India. Though, the development goes in both countries in opposite directions. While the inhabitants of São Paulo turn out to be extremely individualistic the population in Delhi tends to more collectivism.
Figure 23: Comparison IDV incl. São Paulo and Delhi

With reference to the assumption in Chapter 4.3.2 according the interrelation between the individualism score and the treating of disabled following examples can be used due to motivate this assumption. Delhi roads are equipped with convenient, wide footpaths. Though, the level of most kerbs on Delhi roads is inconveniently high (Figure 24). This prompts pedestrians to walk along the roadside especially when they have physical problems in climbing high steps.

Figure 24: High kerbs in India

However, in modern projects like the Rapid Bus Corridor (RBC) in Delhi a segregated and safe corridor for pedestrians and non-motorized transport is provided. Also for the VRU with disabilities special facilities like dropped kerbs, low floor buses or platform-bus adjustment are provided. In the City of São Paulo, where the individuality score is very high, dropped kerbs and tactile pavements are applied on most major junctions in the consolidated part of the road system (Figure 25).
Another example for extremely low IDV in Delhi is the unspoken rule to never cross the street alone. They always wait to gather a group of some persons and cross the street in a crowd feeling safer as a part of a group and providing counterweight to motorised traffic (Figure 26).

Traffic rules require motorists to stop once a pedestrian steps on the zebra crossing. Practically this rule is not being followed, and crossing busy roads at zebra crossings is as dangerous for pedestrians as elsewhere. Pedestrians cross roads either in larger groups or whenever opportunity occurs.

Concerning Masculinity score the research shows that São Paulo has a very high MAS (Figure 27), even higher that the European average. Therefore a conclusion can be drawn that the society of São Paulo is more oriented on financial recognition, earning and challenges. Possessing a big and expensive car means to be more powerful and respected. For this reason VRU have to subordinate whether crossing the street or waiting for a car blocking the footpath while garage or property. However, when a pedestrian shows his power by stepping to the road and focusing directly and self-confident on the driver he will be accepted and the car will let him cross the street.
Figure 27: Comparison MAS incl. São Paulo and Delhi

In Delhi even having an expensive do not automatically means to be more powerful. These cars can be scratched and damaged the same way as a simple rickshaw. Even animals are seen as the most vulnerable road users and are equal to others. These facts are related to the very low IDV which means that this society is relationship-oriented and tries to solve conflicts by compromise.

Similar to IDV the tendency of the score for UAI develops in the opposite direction between the country average and metropolitan area (Figure 28). In Brazil it is drastically decreasing for São Paulo, in India it is slightly increasing for Delhi. It can be therefore concluded that in São Paulo new safety measures being to a certain degree always ambiguous would be easier accepted. On the contrary, in Delhi more enforcement and education measures would be needed to promote acceptance of new safety measures.

Figure 28: Comparison UAI incl. São Paulo and Delhi

To sum up the research has identified several crucial differences between the countries’ scores and the scores for metropolitan areas. It is important to consider it when talking about transferability of road safety measures or working on pilot projects.

4.4. Human Factors Issues in Road Safety

Human factors are known to be implicated in the majority of accidents. According to Sabey and Taylor (1980) human error is a factor in almost 95% of accidents.

Petridou and Moustaki (2000) suggest that behavioural factors collectively represent the principal cause of three out of five traffic accidents and contribute to the causation of most of the remaining. They distinguish between a number of different types of behavioural factors according to the duration of their effect on the road user:
• those that reduce capability on a long-term basis (for example, inexperience, ageing and other health issues);

• those that reduce capability on a short-term basis (for example, alcohol impairment, fatigue, psychological stress or temporary distraction);

• those that promote risk taking behaviour (speeding, disregard of traffic, failure to use protective systems).

In low income countries, a number of other factors may contribute to the accident problem, including the failure to design motorised vehicles which are less hostile to vulnerable road users (Roberts et al., 2002) high proportion of non-motorised traffic and the presence of locally designed para-transit vehicles (Mohan, 2002).

This Chapter examines the human factors and road user behaviour issues which may affect the efficient transfer of road safety methodologies, measures and tools from Europe to Brazil and India. A particular emphasis is placed on measures to improve safety for vulnerable road users, as this is the main area of concern for the SaferBraIn project.

4.4.1. User State

Health problems and ageing

A number of studies have assessed the impact on driver state of various medical conditions, with the incidences of health problems which have road-user safety implications likely to vary between different countries. In addition, it is likely that screening for and treatment of the health conditions mentioned would also vary.

Linked to the question of health, is that of ageing. According to (Brace et al., 2006) changes related to the ageing process (such as reduced bone density) make older people more at risk than other road users of sustaining a serious or fatal injury once involved in an accident.

The specific changes which occur as part of the ageing process which may impact on road safety include (Hakamies-Blomqvist et al., 2004):

• Stiff joints and weak muscles making it difficult to turn to look;

• Deterioration in eye sight and hearing, loss of peripheral vision and medical problems such as glaucoma and cataracts;

• Dulling of reflexes and reduced attention span, leading to increased reaction times and difficulty processing information;

• Memory loss;

• Disorientation;

• Poor or decreased judgement;

• Loss of initiative;

• Increased use of medication.

Maintaining safe mobility for older people has been shown to be linked to other physical and mental health outcomes (Brace et al., 2006), so it is essential that the implementation of road safety measures is not undertaken without consideration being given to the age profile of the population.

Fatigue

Fatigue affects individuals in a number of ways. It is associated with a reduction in alertness, longer reaction times, memory problems, poorer psychometric coordination, and less efficient information processing.
Alcohol Impairment

Alcohol is well documented factor in accidents, affecting drivers in a number of ways in the short term. Approaches to enforcing the existing drink-drive limits also vary; in some countries (including the majority of European countries) random breath-testing is allowed, whereas in others the police can only test drivers for the presence of alcohol where they have reason to suspect it. Similarly, attitudes to alcohol consumption and legislation controlling sales vary significantly, even between European countries, and could be expected to do so to an ever greater extent between countries with more widely differing social, cultural and behavioural characteristics.

4.4.2. Behaviour

Distraction

As the number of electronic devices and vehicle technologies increase in the driving environment the human machine interface grows in complexity. These devices can lead to distractions for all road users by reducing the attention and concentration given to the task in hand. The technologies can relate to both the driving task (e.g. satellite navigation) and unrelated (e.g. phones, mp3 players). The later is also an issue with pedestrians and cyclists, who may use mp3 players and as a result cannot hear their surroundings (Young et al, 2003).

Distraction from the road environment can result from a number of factors; information overload by too many road signs, misleading information by incorrect signage or ineffective, missing signage and roadside features not related to driving (shops or previous accidents) (AA, 2009).

Other factors which can lead to the distraction of the road user whether it is a driver or a vulnerable road user include internal distraction, mental load or distractions due to companions or passengers (ROSPA, 2007).

There appears to be very few studies regarding pedestrian distraction (e.g. crossing the road while using mp3 players), often because it is difficult to deduce at crash scenes whether pedestrian distraction has played a contributing role in a collision. However, this is still an issue to be considered, as the use of music players and mobile phones by pedestrians while walking along the street is widespread.

Risk taking - Failure to use protective systems

Protective systems include cycle helmets. Use of protective headwear for motorcyclists and cyclists is not an uncontroversial measure, as some studies suggest their impact on safety has not been established (Macpherson et al. 2002). Moreover, the effectiveness of legislation on increasing rates is also open to debate (LeBlanc et al. 2002). As with seat belts, enforcement is likely to be an important determinant of the effectiveness of legislation.

Risk taking – Failure to use designated areas

In terms of using the street itself, identified issues included;

- Walking on the street (road) edge, even where a pavement (sidewalk) is available
- Walking in the road, not facing the oncoming traffic.

Khan et al. (1999) suggests a number of possible explanations for these behaviours, including encroachments on the pavements which blocked an average of 67% of the available space. These encroachments included parked vehicles, advertising, street vendors and cafes.

In addition Evans and Norman (1998) also found that pedestrians are more likely to engage in risky behaviour when it is perceived as being the easiest thing to do.
Lack of provision of crossing facilities means pedestrians do not form the habit of looking for them when deciding where to cross (Khan et al. 1999). Where pedestrian provision has been made it may be arduous and poorly designed, so pedestrians may choose not to use it (Khan et al. 1999)

In real world accident, studies such as the UK On The Spot (OTS) accident research project a number of common accident scenarios or more specifically the actions and behaviour of pedestrians during the accident have been identified. Factors which can lead to conflicts between vehicles and pedestrians include restricted visibility between the vehicle and pedestrians, pedestrians emerging from behind obstacles such as parked vehicles or vegetation, reduced visibility due issues with lighting or the pedestrian wearing dark clothing. Unexpected pedestrian behaviour such as running out into the road or walking along the carriageway where no pedestrian facilities are provided.

Common behavioural issues observed in pedestrian accidents include the incorrect use of pedestrian facilities, pedestrians running into the carriageway without looking correctly or the pedestrian not crossing at designated areas but taking the shortest route following pedestrian desire lines.

Common reasons for not using a pedestrian crossing correctly include:

- not crossing within the designated area;
- being on the wrong side of the pedestrian barriers;
- crossing on a red light for pedestrian traffic (green light for vehicular traffic).

Common scenarios leading to conflicts between pedal cyclist and vehicles identified in real world studies can be split into two distinct groups: actions by the pedal cyclist and actions by the vehicle driver.

Actions by the pedal cyclist can include pedal cyclists travelling along the footway. The cyclist does not perceive any risk towards other traffic and is in collision with vehicles turning into or out of minor roads. The pedal cyclist enters the carriageway from the footway without looking or giving any consideration for other modes of transport, this may include a gradient for the pedal cyclist and as a result a higher speed of entry to the carriageway.

Actions by the vehicle which can include a vehicle overtaking the pedal cyclist and turning in front of the pedal cyclist into a minor road, which results in a conflict and a collision. Other scenarios include vehicle sight obstructions, where the pedal cyclist is obscured in the vehicles blind spot when the vehicle is starting a manoeuvre or a lane changing manoeuvre.

4.4.3. Model for Evaluating the Role of Human Factors for Transferability of VRU Safety Measures

The Human Functional Failure (HFF) methodology was developed by the EC funded project TRACE (TRaffic Accident Causation in Europe) to address the issue of ‘human error’ in road accidents. This ‘error’ was conceptualised as a failure of human function. It enables the identification of factors that contribute to crashes and how the resultant human functional failures occur (Figure 29).

Although the methodology was developed to evaluate failures (i.e. errors) experienced by drivers in road accidents, it could also be used as a basis for a model to evaluate the behaviour of other road user types (e.g. pedestrians, cyclists). It also has the potential to be used to evaluate not just road accidents, but also the effects of road user behaviour on the safe and correct usage of road safety measures.

22 The UK On-the-Spot accident research project
http://www.dft.gov.uk/rmd/project.asp?intProjectID=11702
The aim of the HFF methodology is to be able to clearly define the types of functional failures that humans experience in road collisions. It defines five main stages that the road user goes through when undertaking the driving task (perception, diagnosis, prognosis, decision-making and taking action) and defines the types of functional failures that can occur at each stage. Whilst the model is designed for the driving task, it is applicable to the tasks that other road users undertake, for example when crossing the road, walking or cycling alongside motorised vehicles, and so on.

4.5. Conclusions

The goal of this Chapter about the potential cultural differences between India, Brazil and Europe is to raise awareness on the possible implications of these differences on the focus of SaferBrain partners but also of any stakeholders dealing with transferability of European experience to EE. It is beyond SaferBrain scope to make a full analysis of the effects of cultural differences on the local traffic systems. An additional research could meet this goal. Nevertheless the awareness of the existence of differences however may add to the value of the final outcomes of this project. The analysis of cultural circumstances is the first step when talking about Transferability.

As has been established, human factors are known to be factors in a majority of accidents. Their study has identified a number of relevant issues which affect accident involvement, and which must be considered when assessing the transferability of road safety expertise and knowledge between different countries. There will be variations between different countries which must be taken into account when determining road safety priorities, designing and implementing programmes, and assessing outcomes.
Connecting the results of cultural research with the model introduced in Chapter 2, it is obvious that 4 E´s have always to be considered in the respective cultural context. This fact can be schematically illustrated as follows (Figure 30).

![Figure 30: 4E´s in cultural context](image)

It can be assumed that the weight of every “E” can vary within a culture. As mentioned before in India with its high Power Distance Index there is a high need but also acceptance of enforcement measures whereas encouragement is more a matter of developed countries like EU countries. Also educational measures would contribute to more safety and acceptance of transferred safety measures. In countries with high Uncertainty Avoidance Index like Brazil education plays an essential role. This allows to make people – whether drivers or VRU – aware of ambiguous situations and measures. Accordingly an abstract weight of the 4 E´s can be shown (Figure 31).

![Figure 31: Weighting of 4 E´s in cultural context](image)

In the next step, while evaluating positive and negative effects of VRU Road Safety measures, the role of 4 E’s in the cultural context have to be weighted. According to the results of this evaluation a more exactly weighting can be extracted and quantitative interpreted. It is in any case advised to keep the aforementioned cultural differences in mind, as awareness of their existence in itself may be a first step in delivering realistic and feasible results.
5. Transferability Audit

5.1. Layout of the Transferability Audit

A matrix of 4E’s (Engineering, Education, Encouragement and Enforcement), and its combination with CSIE (Culture/Society, Institutions and Economy) gives a comprehensive possibility for creating a model for Transferability Audit (TA) combined with the ranking from evaluation levels (Macroscopic, Mesoscopic and Microscopic). As the model is supposed as a complete description of Road Safety dimensions it has to be adapted to the special interests of VRUs.

The target is to transfer measures for establishing a better road safety which are categorized by the 4 E’s; the road safety space shall be described according to the Figure 3 below.

![Figure 3: General scheme of TA](image)

So the essential to get a transferability outcome would be to establish a 5th “E” in the model which means “Evaluation” as the key to transferability assessment.

Each of the 4E’s has several contents that are more or less important depending on the level of resolution. For example, decision makers on governmental level would prefer to have another - probably a macro-scale - perspective to the model than an engineer preparing a project, who would try to transfer the measures in a micro-level with more basic facts. Each of these levels can be expected to have an adequate interdependency with the CSIE.

A pyramidal scheme like that in Figure should be used.
Figure 33: Pyramid of Road safety measures and the evaluation resolution

The EU safety concepts and measures for VRUs shall be evaluated and audited to which degree they are transferable. To make a systematic approach a connection to transfer shall be established for:

- macroscopic – strategic interface
- mesoscopic – system interface
- microscopic – operation interface

In order to find out these interfaces between EU and EE the evaluation level should be adaptable.

**Macroscopic Evaluation - strategic interface**

To respect the environment of the analysis it is necessary to have a kind of zoom to a certain level in mind, though different zooms and resolutions are possible. For example a long term development in a historical context of culture, society, institutions, connected with economical and transport conditions has to be considered as a macro zoom.

It is necessary to keep also the time axis in mind as well as the speeds of development and changes to figure out similar stages in EU and Emerging Economics like Brazil and India and to consider common and different roots. To find out the facts for a transport related comparison in a certain level the methodology of language – culture, technique adaptation is necessary. It has to be investigated which concepts and descriptions belong together.

In case of SaferBrain the strategic macro consideration was based on the methodology of cultural dimensions of Hofstede. This allows the use of this model for universal issues and not only in transport context. Using Hofstede with his dimensions of:

- Power Distance
• Individualism vs. Collectivism
• Masculinity vs. Femininity
• Uncertainty Avoidance

It is essential to understand how far the categories of 4E’s can be weighted within a cultural, social, institutional and economy’s context and how basic mistakes in adaptation and transfer strategy can be avoided. The macroscopic step (i.e. Chapter 3) helps to consider cultural influences on the pyramid and the evaluation scheme.

**Mesoscopic evaluation - system interface**

The zoom to the mesoscopic level enables to conclude whether the medium system interface – in our case the transport and especially the field of VRUs – is comparable in both EU and EE or whether strong disparities are to be considered. In this case, the reversible adaptation of both development levels has to be fair balanced in order on the one hand to adapt the outcoming European requirements to the local available data or on the other hand to try to change local circumstances in order to install a European measure in the EE, which is obviously a more critical issue. Availability of similar system data and methodology and their adaptation is an essential result of mesoscopic TA evaluation. So the mesoscopic level provides an adaption of scheme of 4E’s and CSIE in preparation and adaptation of the matrix contents as well as a clarification of the contents and first challenge check.

**Microscopic evaluation - operation interface**

The microscopic level provides the operation interface of special technical measures of the 4E’s. The real vote of the users will give a response while (not) using the proposed solutions and to research on the practicable level. Adapted 4E /CSIE combination and data use are being checked in this step in the matrix.

Figure shows how the pyramid model could be used in practice. In this example a user defined evaluation level between meso and micro resolution analyses the Road Safety Space within a horizontal section.
5.2. Adaptation of the model to an Audit

The TA developed in SaferBrain is based on the lessons learned with the models developed in the EC-funded research projects mentioned in Chapter 2.3. Anyway such an approach is too complex and long to govern a TA needed for SaferBrain, being the scope of the latter very different from that of such EC-funded projects.

Moreover, measures, indicators and implementation programs were already decided within the CIVITAS framework, which facilitated and directed the whole TA.

The sequence, however, appeared to be flexible enough to be adapted to:

1) both horizontal and vertical transferability options;
2) addition of 3rd dimension of evaluation resolution;
3) use indicators coherent with the Road Safety Space concept for evaluate measures which should be categorised in 4E’s and weighted with CSIE in a 6 steps concept with challenges to be made for transfer or adaption and transfer

5.2.1. The pre-requisites for transferability

Before starting the transferability process, it is necessary to provide solutions to the following matters, so to have useful indications for the SaferBrain TA:

- Being transferability aimed at exporting successful measures, how “success” can be defined?
- Once assessed the success of a given measure in the origin place, it is necessary to evaluate its importance in the target place as well, or in other words whether they may be as decisive in the new context as they have already in the origin one.
- Implementing mobility measures requires a deep knowledge not only of the environments described in the CSIE, but also of the quality and quantity of data and information available to support the TA.

For what concerns the definition of success, the lesson learned stresses the need to use indicators to assess measures efficiency, according to some evaluation categories (which could run the whole scale of safety topics. Coherently, values from such indicators can be used also to determine measurable criteria for success to meet some agreed transferability requirements (or goals).

Similar considerations can be done about the second issue. Also in this case, it is necessary to quantitatively assess the importance in a certain evaluation resolution (e.g. according to the experts’ knowledge) which could be done by rating them.

The last issue is not only a problem of availability of data but above all of their reliability. Indeed, quantitative information or data directly monitoring the effects of a given implemented measure are not always available and even when available they cannot be trusted as unique element to decide whether the measure is exportable or not, since the conditions for transferability may not match. As a consequence, to start a TA it is important to have a study session in which available data and information are scanned and assessed whether they may usable to support the TA with experts of EU and EE. Such assessment should be made by consultations. In this project it should make sure to be comparable in both EE Units. Such phase should occur with decision makers aware of the starting level of the TA, and at a technical level, to have transferability planners aware of what still misses to perform a TA and how such gap(s) can affect the transferability results. The practical way is to propose a transferability matrix and to explain, access and select a structure understandable for both sides.
5.2.2. Generic algorithm for Transferability

Basing on the above described pre-requisites, the general structure for the TA of SaferBrain has been developed according to the sequence below (see Figure)

![Figure 35: 6-steps algorithm for TA](image)

5.2.3. Weighting up the role of human factors and road user behavioural issues

The suggested algorithm is based on the assumption of managing the whole process within the conceptual frame of the Road Safety Space (Figure 1, section 2.1), which means that for any of the six steps planned, equal consideration must be paid to cultural, social, technical and economical issues.

As a consequence, tasks concerning the individuation of objectives for the TA in the target unit (STEP 1), adoptable solutions (STEP 2) and their packaging (STEP 5) can be rather simple if considered under the regulatory, technical and/or economical points of view, since related local constraints, barriers and drivers to support the implant of packages of measures are easy to individuate and assess. For instance, too expensive solutions can be easily discarded as those that require specifications, rules or laws currently not in force in the target contexts and for which no changes are planned by short-term horizons.

Not the same can be said when such tasks come to consider human factors and road user behavioural issues, which call for a more in-depth assessment to ascertain whether they may hinder the transfer of road safety measures from one context to another.

Such an awareness requires an enlarged vision to support the TA, in which the evaluation of regulatory, technical and economical issues becomes a general pre-requisite for the transferability of measures (a kind of go/no-go step), but the real transfer feasibility is assessed through the proper knowledge of the role human and behavioural factors may play in the acceptance of the safety measures.

This kind of approach (see Figure) means that, whatever the package of measures or safety concepts to transfer, the TA should deal both with technical and behavioural domains (meaning the former the "Economic" and "Institution" factors of the Road Safety Space concept and the latter the "Social/Cultural" factors). Technical solutions to transfer can have direct relationships with economic and institutional issues, whereas per se cannot markedly
affect the local cultural and social patterns. On the contrary, how people perceive and assess the proposed technical solutions to transfer is important for their final acceptance and proper use. The behavioural domain, which reflects the cultural and social acceptance of the proposed solutions due to stated human and behavioural factors, may strongly influence decision makers and planners in their final assessments. Indeed the awareness that the “human error is responsible for 70 to 80% of accidents in general” (Rasmussen 1997, quoted by Stigson 2009: 2) suggests that major emphasis in the transferability assessment should be placed in better understanding the end-users attitude towards safety problems, investigating aspects as their behavioural patterns due to specific needs, level of awareness and acceptance, expectations.

Thus the so-called High Level Objectives (HLO) (i.e. objectives to be defined during STEP 1) should be divided into two categories: economic-institutional goals and the cultural-social ones. The fulfilment of the former will represent an accomplishment of the “technical” exportability of the safety measures and of their efficiency under the operative point of view. The achievement of the latter will represent the full acceptance of such measures by the target users.

Figure 36: Adaptation of the TA in respect to the human and behavioural factors

5.2.4. Methodology to find problems in applying Road Safety Measures

As described above, transferring a safety concept from one place to another raises a number of issues related not only to the physical differences that may occur between origin and receptor contexts, but also to the quality of the transferring process itself. The more different is the cultural scenario between origin and receptor contexts, the more difficult will be the adjustment of safety concepts to the real needs of the latter.

It is important, therefore, to individuate which could be the main recurring problems in transferring safety concepts from areas where they have been applied for ages (allowing
thus a long-time fine-tuning process, as in Europe) to others where they could be innovative but ineffective, due to a poor knowledge of the local context.

Detecting and understanding problems, typical of the receptor context, is also a pre-condition to the definition of the goals the importing safety concepts are required to meet, which is the core of the STEP 1 of the TA (*Target and related High Level Objectives for transferability*).

The most suitable tool to individuate such problems is a search methodology in which assumptions and inferences drawn from the Road Safety Space concept are coordinated to develop a simplified algorithm, in which problems can be easily identified and weighted so to have a final list of barriers to the implementation of a given safety concept.

The proposed search methodology is based on simple a 3-steps procedure described in Figure:

- **STEP A** – Collecting road safety concepts to transfer (lessons from Europe).
- **STEP B** – Creating a problems priority matrix of possible measures categorised in 4E’s sections.
- **STEP C** – Assessing the matrix outcomes.

![Figure 37: The search methodology algorithm](image)

The basic task is to assess whether a given road safety concept may be perceived as a problem within one (or more) of the assessment area(s) provided by the *Road Safety Space* (i.e. Society/Culture, Economy and Institution) as research layers which describe the receptor context.

Any of the road safety measures usually implemented in developed areas have been already (more or less) transferred in Emerging Economies, even though not systematically and without a proper assessment of the achieved results, which implies the need of more systematic analyses of safety problems. To switch from “one-off” or “on-the-spot” approaches it is necessary to translate transferable road safety concepts into inputs to find out both possible problems due to their implementation in other contexts and not surmountable barriers which can hindrance the whole transferability process.

**STEP A - Collecting road safety concepts** - consists in organizing the road safety concepts according to a structure which can facilitate the analysis of problems they can cause. This can be done classifying the road safety concepts-inputs according to the three main components of the road safety system: road users, infrastructure and vehicle. In other words, the task is to organize a taxonomy of road safety concepts, dividing them per main component affected.
Being the scope of SaferBraIn to improve safety of Vulnerable Road Users, safety concepts concerning infrastructure and users are likely to prevail on those ones concerning safety devices for vehicles, even though these cannot be discarded a priori. Since the task is apparently straightforward, but time-consuming when it comes to constitute univocal items of the list (a safety concept may affect more than one road safety system component), it is useful to subdivide each item into single measures which will constitute the rows of the Problems Priority Matrix (PPM) to be created in STEP B.

**STEP B - Creating a Problems Priority Matrix (PPM)** - consists in defining links among the list of road safety concepts categorised into 4 E's-inputs and the 4 Road Safety Space assessment factors

1) Engineering (concerning mainly infrastructure, vehicles and the mainly road user related).

2) Education.

3) Enforcement.

4) Encouragement.

as arising problems which could hinder the implementation of a given safety improvement. The best tool to analyse such links is an “influence matrix”, in which relationships among rows and columns are scored and weighted, so to have a proper knowledge of the most/least challenging measures. Such an influence matrix has been translated into a Problems Priority Matrix (an example is reported in Figure ) where rows represent safety concepts-inputs and columns the four Road Safety Space factors (Society/Culture, Economy and Institution).

To fill the matrix in it is necessary to answer the question “Would be this Vulnerable Road Users safety measure a problem for:

- Society/Culture
- Institutions
- Economy?”

By providing:

- a score according to a 1-5 Lickert Scale, being 1 the least challenging and 5 the most challenging, multiplied per
- a weight for the category of road users / modes mostly affected, according to the following values: 4 car drivers, 3 two-wheelers, 2 cyclists, 1 pedestrians.

It is also possible to assess 0 = neutral if the measure does not represent a problem or affect any category of road users in particular.

Scores and weights are to be provided according to the respondent’s expertise on the sites features and pattern where the measures should be designed and implemented. For example:

Row $j$ (1 to $n$):

Column $i$ (1 to $m$)

with $s = $ assigned score and $w = $ assigned weight.

As a result, the lowest are the total scores per rows, the least challenging are the measures to be implemented (this also means that the most benefited are the non motorised users).
The lowest are the total scores per columns, the least affected are the related Road Safety Space components (society/culture – institution – economy).

On the contrary, highest scores reveal measures which, even though theoretically transferable, are very likely to be unsuitable to the cases in hand and hence to discard.

The list of inputs (rows) can be as long as the more comprehensive catalogue of safety concepts is desired to be; as a consequence, the three road safety factors may be divided into a number of sub-components consistent with the level of details requested for the rows.

In the PPM:

- **Culture** has less dimensions in the here discussed short terms and therefore can be unified to one column. Resuming the separate Hofstede Society/Culture assessment can be divided into subcomponents “People” (meaning the relevance of acceptance and awareness among the people especially for restrictive measures) and “Environment” (meaning the possibility to change the built environment in order to accommodate the proposed solutions).
- **Institution** can be divided into “Availability of regulation / specification” and “Political commitment”.
- **Economy** can be divided into “Design, implementation and maintenance costs affordability” and “Technical skill availability”.

More categories (especially for behavioural analyses) can be added or the proposed ones can be changed.

**Step C – Assessing the matrix outcomes** - allows to assess and comment the final scores and to provide for a list of problems arisen from the PPM (Figure 38).

![Figure 38: Example of the Problems Priority Matrix (PPM)](image)

### 5.2.5. Database for TA using checklists and automated tools

The focus of the Transferability Study is two-pronged: on the one hand, it is required to assess what can be actually transferred and on the other to find a tool which may make such an assessment process univocal and easy. The development of a Problems Priority Matrix – PPM, as described above, meets both requirements:

- **PPM** is a tool in which any assessments on any measure to be potentially transferred is based on the ascertainment that it must be compliant with the comprehensive Road Safety Space concept;
- being PPM organized according to a checklist in which responders (according to their skills and expertise) have to assess such a compliance by providing a score and a weight for each measure listed, it is easy to use and results are simple to calculate.

As a consequence, the design of the PPM means dealing with its formal structure, or layout, and content, or core. There are many variables which affect both and call for specific
features, due to the gist of the selected measures, which can be common to both the India and Brazil case studies or specific of just one case study.

How the PPM works
As said, PPM is a checklist, originally designed according to a spreadsheet in order to allow respondents to fill it, by providing scores and weights for each item listed in the rows. A “macro” function in the spreadsheet allows calculations of sums per each row and column, so to have final scores.

The spreadsheet can be downloaded from the project website: [www.saferbrain.eu](http://www.saferbrain.eu).

The core
The original spreadsheet design makes PPM flexible enough to accommodate similar or different rows, add more, write the text in any language (even though for the sake of comparability, English has been chosen), according to any case studies needs; to be reminded that, the content of each row corresponds to a safety concept/measure selected by the case studies partners.

The layout
From the assumptions stated above it is clear that, for what concerns the task of designing its layout, PPM rather than a simple form, has been designed as a kind of univocal worksheet containing the appropriate amount of boxes or cells, whose main features can meet the requirements resumed as follows:

- Adaptability to store data on a regular basis, as long as respondents provide feedbacks.
- Easiness to enter data.
- Familiar frame to facilitate the data entry task to respondents.
- Possibility of further data management (for instance, in the case of safety audits).

Opportunities for further developments
From the issues above described, it is clear that most of the efforts in the design of the PPM have been on providing a layout compatible with the Road Safety Space concept and flexible enough to easily contain a large number of data.

Such a tool, even though completed for what concerns its final layout and format, is however liable to be updated and revised, according to any further development due to any change that may occur in the case studies.

5.3. Practical Realisation of the TA process in Brazil and India
The methodology of TA was introduced to the local stakeholders and discussed both the structure of possible measures and the combination with CSIE contents with quantification in the PPM. So the evaluation levels in one matrix were decided to be practicable instead of having three matrices representing a macro, meso or micro level.

Contribution to Macro evaluation
The dimensions of the CSIE were explained and researched locally with interviews and their importance to understand the expected interdependencies and feedback given to PPM. A further feedback to the macro-level is the interpretation of the summarized categories of 4E’s and CSIE in the PPM in test evaluation and was also considered with final configuration and the weight in the safety concepts level.

A point of discussion within the team was the structure of CSIE in the team. One problem was the recognition of typical patterns of CSIE to fill in the PPM. An alternatively simplified subdivision of CSIE into Society/Culture, Institutions and Economy not subdivided with an
adaptation score between 1...10 and remarks to explain the votes was proposed (see Figure 39).

**Figure 39: Alternative CSIE structure and problem score quantification**

**Contribution to Meso evaluation**

A description of road safety measures dedicated to PPM (test PPM) for TA was developed in workshops in Brazil including experts for evaluation as a pre-analysis. Both Road safety concepts and **Road Safety Space** factors have been discussed and pre-weighted extensively and if necessary adapted. The CSIE was structured with more differentiations and following the scheme with a weight factor for affected road users (Figure 40).

**Figure 40: Final CSIE structure and problem score quantification in PPM**

The description of the Brazilian procedure shall be exemplary. The evaluation of measures considered the transferability study programmed on the SaferBrain project considers the positive and negative effects that can influence the transferability of the measures, accepting that they can be potentially effective on the road if properly understood by road users and adequately applied by road designers. The evaluation also tries to judge to what degree the measures will be relevant (tackling important problems) and effective (reducing accidents that are meant to be reduced) in the context of Emerging Economies.

This study of potential transferability was organised and conducted by local teams of the SaferBrain project in Brazil and India, given the methodology developed in the first phase of WP2 and the initial list of measures set out there. Starting from this general guideline, local teams had the freedom to rearrange and complement the list of measures and to carry-out the data collection task in their preferred approach.

In Brazil, as an example, after designing specific data forms for each measure, one leading expert was interviewed in a more thoughtful way and subsequent seminars expanded the consultation to a larger audience (finally, 7 professionals attended the seminars and were organized in 3 groups, each one led by an experienced professional with larger reputation in road design and accident analysis). After gathering the information, quotations were analysed and a synthesis of the answers were inputted in the tables to be presented here (see example in Table 7, Figure 41 and Annex 2).

**Table 7: Pre-analysis of road safety measures transferability in Brazil**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Culture/Society</th>
<th>Institution</th>
<th>Economy</th>
<th>Problems</th>
<th>Weight</th>
<th>Final Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sidewalks / Footways</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Description</strong>: increase the use of facilities to easy pedestrian sidewalks along roads and walkways or footways off-roads</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Current Practice</strong>: In Brazil, these measures are widely known but their application is limited. In some</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
cities, as São Paulo, there is a legal requirement to build sidewalks flat to pedestrians but, at large, it is overlooked by developers (that usually have the responsibility for provision and maintenance of sidewalks). In general, the quality of sidewalks along main roads is better in affluent areas of the city and deficient in other areas. The situation along minor roads is even more varied. Exclusive/segregated ways (footpaths or walkways), including pedestrian streets or areas, are usual in commercial regions of the larger cities. The public safety would be a major concern on their wider applicability.

<table>
<thead>
<tr>
<th>Potential for Transferability:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Negative Effects</strong></td>
<td><strong>Positive Effects</strong></td>
</tr>
<tr>
<td><strong>Regulatory</strong></td>
<td><strong>Regulatory</strong></td>
</tr>
<tr>
<td>A: Rules are inadequate</td>
<td>A: A rule for building and maintenance of sidewalk exist</td>
</tr>
<tr>
<td>B: The actual law defines the owner as responsible for building and maintaining the sidewalk</td>
<td>B: Guarantee of quality of preservation and construction</td>
</tr>
<tr>
<td>C: ---</td>
<td>D: NBR accessibility already exist</td>
</tr>
<tr>
<td><strong>Technical</strong></td>
<td><strong>Technical</strong></td>
</tr>
<tr>
<td>A: It's necessary to establish standards for dimensions, ramps, floor, etc.</td>
<td>A: ---</td>
</tr>
<tr>
<td>B: Floor choosing inadequate for the public power</td>
<td>B: Standardization of construction, universalizing the walk</td>
</tr>
<tr>
<td>C: Great conflict between track width and sidewalk. Difficulties with high sills and grid of road</td>
<td>C: Guarantee free circulation along the road for all the pedestrians</td>
</tr>
<tr>
<td><strong>Economic</strong></td>
<td><strong>Economic</strong></td>
</tr>
<tr>
<td>A: Cost relatively high, to adequate the existing sidewalks</td>
<td>A: Low cost</td>
</tr>
<tr>
<td>B: Necessity of public funds. Increase of IPTU value</td>
<td>B: Reduction of health spending for accidents of walking on the sidewalk</td>
</tr>
<tr>
<td>C: Cost of realisation</td>
<td>C: Reasonable costs compared to benefits for pedestrians</td>
</tr>
<tr>
<td><strong>Behavioural</strong></td>
<td><strong>Behavioural</strong></td>
</tr>
<tr>
<td>A: No oversight</td>
<td>A: Presence of inadequate sidewalks induces pedestrians walking on the road</td>
</tr>
<tr>
<td>B: Resistance of population due to potential increase of taxes</td>
<td>B: Enusre walking on the sidewalk.</td>
</tr>
<tr>
<td>C: Irregular sidewalk stunts its use</td>
<td>C: Enables full use of sidewalks</td>
</tr>
</tbody>
</table>

This procedure tries to warrant that the quotations are a balanced view of local experts and professionals, not the opinion of a particular one. However, despite the effort made to reach a wider audience, the professionals that attended to the seminar came from companies or
developed their carriers in the State of São Paulo (even the City of São Paulo) and this previous experience can have some influence on the common view built from them.

Overall, the procedure tried to fill four independent evaluations that were used to prepare the synthesis found in the following charts: 1 for the leading expert, 3 from for groups of professionals (1 from the CET/Sp; 1 from engineering consultancy, 1 from academic experts).

The leading expert was the Eng. Adauto Martinez Filho. Professionals from CET/Sp were Arq. Nancy Schneider and Arq. Maria Ermelina Brosch Malatesta. Professionals from Consultancy were Eng. Airton Mergulhão (VETEC Engenharia Ltda.) and Eng. Luis Carlos Trentin (Planservi Engenharia Ltda). Professionals from academic positions were Eng. João Cucci Neto (Universidade Presbiteriana Mackenzie; also Traffic Analyst at CET/Sp), Eng. Andréa Ribeiro (MSc student at EPUSP) and Eng. Ivo Chuquer Jr. (MSc student at EPUSP; also Traffic Agent at CET/Sp).

Table 8 shows the result of the local assessment in India.

### Table 8: Assessment in India

<table>
<thead>
<tr>
<th>Safety Concept: Provision of pavements</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure: Proper upkeep of sidewalks (including repairing and sweeping)</td>
<td></td>
</tr>
<tr>
<td>People</td>
<td>Maintenance of established sidewalks is necessary. There should be regular cleaning of it by responsible municipality at low-flow hours.</td>
</tr>
<tr>
<td>Environment</td>
<td>There is no major environmental problem.</td>
</tr>
<tr>
<td>Regulation</td>
<td>In India, in many big and medium cities, the facility is available. There should be proper sidewalks at every potential place in these cities. There is need to be extend this facility to small villages. Maintenance should be done at regular intervals as well as on demand.</td>
</tr>
<tr>
<td>Political Commitment</td>
<td>There should be high level of political commitment.</td>
</tr>
<tr>
<td>Design, Implementation, Maintenance Costs Affordability</td>
<td></td>
</tr>
<tr>
<td>Technical skill availability</td>
<td>Yes.</td>
</tr>
<tr>
<td>Problem Score</td>
<td></td>
</tr>
</tbody>
</table>
The proposed PPM was completed with education, enforcement and encouragement issues. The intention was to represent appropriate amount of measures in each 4E’s field for the...
PPM. Furthermore the sub-structures as mentioned in Chapter 5.2.3 were realised for further assessment possibilities.

In the field of Road Safety Space it was concluded to make the cultural weighting together with society since a test with PPM led to misunderstandings due to lack of awareness of cultural issues by engineers. Ideally, culture and society have to be separated. Furthermore the decision was taken to have the same PPM structure for Brazil and India to keep the result comparable.

Total scores were discussed with local experts first as a problem score range from 1 to 10. Afterwards it was more refined 1 to 5 and weighted to affected road users / modes: pedestrians =1, bicycles= 2, two wheelers= 3, cars =4. The refined method was voted for by the project partners.

The last step in TA was to fill in the PPM with the local partners after introducing the changes compared to the test PPM within local meetings and workshops that included also introduction of results, their discussion and in a further step adaptation. The results of these evaluations are shown in Annexes 4 and 5.

**Use of the PPM**

Being designed to collect data and information about the transferability of safety concepts/measures, PPM is targeted to a very large panel of stakeholders and users; indeed, as each PPM respondent is asked to provide answers according to his/her expertise and skill for what concerns a given safety concepts/measures in terms of technical, social and regulatory consequences, any individual who may play a role in the decisional process (from the strictly decision-making, to the technical design, to the economical assessment levels) may qualify for becoming a respondent.

PPM is also usable by end-users, provided they are familiar with the technical terminology used to describe the listed safety concepts/measures; but, should end-users have difficulties in understanding such a “jargon”, the PPM user-friendly layout allows to re-formulate the text of each row (corresponding to each safety concept/measure selected) and add pictures, when appropriate, to facilitate the comprehension.

**5.4. Results of the TA**

The PPMs of Brazil and India have the same contents of 4E’s / CSIE. TA results make at first sight different impressions of problem scores. The problem score level (Figure 42) foreseen in India is in general lower than in Brazil. This was recognised in the test PPM and discussed until which degree it depends on different audit teams.
5.4.1. **Comparison Road Safety Space factors Brazil India**

While Brazil shows a dominant problem score with “Society/Culture” and “Institution”, “Economy” problem score is low. On the contrary in India, “Economy” problem score is close to 50% of the total problem scoring, whilst “Society/Culture” and “Institutions” are balanced (Figure 43).

---

**Table:**

<table>
<thead>
<tr>
<th></th>
<th>Average problem score</th>
<th>Minimum problem score</th>
<th>Maximum problem score</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>39</td>
<td>23</td>
<td>66</td>
</tr>
<tr>
<td>Average</td>
<td>43</td>
<td>14.5</td>
<td>85</td>
</tr>
<tr>
<td>Brazil</td>
<td>47</td>
<td>6</td>
<td>104</td>
</tr>
</tbody>
</table>

---

**Figure 42:** Average problem scores in Brazil and India

These figures show that India has more balanced maximum and minimum scores, whereas Brazil tends to have bigger deviations from minimum to maximum.
As mentioned before Culture and Society were decided to become unified as first test questionnaire with PPM showed a lack of knowledge to differentiate between them without additional training about this components. This unification can have an impact on the results with low scores. Nevertheless, as there were no experiences about the practical handling this appeared to be compromising and necessary in order to avoid confusions.

The showed figures describe the situation in Brazil and India that is being changing. Keeping the potentials of such a change to a more balanced situation in mind, one should not forget the strong influences of cultures and be aware that a concept adaptation - not the implantation - with hard and soft 4E’s components are in some cases precondition of the safety concepts acceptability in the targeted recipients entity. It also indicates that concepts have to be seen in the time axis of the development before becoming transferable.

5.4.2. 4E’s measures comparison for Brazil and India

Also in a common 4E’s comparison significant differences of the problem scores have been found (Figure 44). In Brazil doubts can be resumed concerning Encouragement whereas Engineering and Education seem to be transferable. Inspecting that on a more culture-oriented resolution Engineering was declared to be clear, as technical staff knows European and North American Road Safety concepts. Mobility Education campaigns and education curricula are familiar and training centres exist. Here the combination of Education with other factors as obligatory curricula is new. Enforcement is also close to EU and North American traditions, innovative elements of this are interesting but have to be legalised and realised.
In India no big disparities between for 4E’s can be seen, the only interesting fact is the little low of Encouragement, considered to be a democratic principle of affluent societies, which has up to now not been introduced intensively and could be interesting for the future. Both weightings can be understood with cultural background and the current state of the art in Road Safety.

First of all, cultural reasons can provide explanation to this weight distribution. The balanced scores in India can be caused by a high level of tolerance in Indian culture trying to find a compromise which is a typical sign of a culture with low Masculinity score (MAS). On the contrary, São Paulo where the evaluations were done tends to have a high Individualist score (IDV) which can lead to a high encouragement awareness and even necessity. Both Brazil and India show high enforcement scores due to high Power Distance Index (PDI) which means strong hierarchical relations and power acceptance.

The balanced situation in India can be also interpreted that India is aware of its road safety problems in the current situation. The methodology of the 4E’s is known excluding encouragement and is part of a public discussion about road safety.

Sections 5.4.3 to 5.4.10 show the TA results (overall problem score) for India and Brazil for each of the 4 E’s in turn.
## 5.4.3. TA results Brazil engineering

<table>
<thead>
<tr>
<th>safety concept components</th>
<th>measures</th>
<th>Problems Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation Design/Redesign</td>
<td>Black Spot Analysis, with Attention to VRUs</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Road Safety Audit/Road Safety Inspection / Other Preventive Reviews, with Attention to VRUs</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Data Record, Storage, Process for Indicators, with Attention to VRUs</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Data dissemination activities, with attention to VRUs</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Integrating Land Use and Network and traffic Planning, with Attention to VRUs</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Information / Consultation / Participation processes for the Safety of VRUs</td>
<td>16</td>
</tr>
<tr>
<td>Provision of pavements</td>
<td>Sidewalks appropriate design (LOS-based)</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Proper upkeep (including repairing and sweeping)</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Protection against unwanted usage (pollards)</td>
<td>40</td>
</tr>
<tr>
<td>Provision of integrated walking network</td>
<td>Provision of appropriate number and position of crossing (zebra crossings basic provision)</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Pedestrianization</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Foot and cyclebridges</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Underpasses</td>
<td>23</td>
</tr>
<tr>
<td>Channelising crossing</td>
<td>Barriers against crossing</td>
<td>8</td>
</tr>
<tr>
<td>Shortening uncontrolled crossings</td>
<td>Provision of refuges</td>
<td>24</td>
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<tr>
<td></td>
<td>Provision of median opening</td>
<td>16</td>
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<tr>
<td></td>
<td>Pavement extension (build-out)</td>
<td>16</td>
</tr>
<tr>
<td>Automated demand-responsive crossings</td>
<td>Pelican crossings</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Toucan crossings</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Electronically-sensed signalised crossing (Puffin)</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Detector for pedestrian waiting</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Countdown for pedestrians</td>
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</tr>
<tr>
<td>Walking friendly surface</td>
<td>Differentiated paving/contrasted surfaces</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Dropped kerbs</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Tactile paving (special tiles for visually challenged users)</td>
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</tr>
<tr>
<td></td>
<td>Anti-slippery surfaces</td>
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<td>Making signing/markings more noticeable</td>
<td>Location, size and reflectivity of signs/markings</td>
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<td>Legibility of signs/markings</td>
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<td>Avoidance of accumulated signs, aids</td>
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<td>Colouring of road surfaces</td>
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<tr>
<td></td>
<td>Advanced Stop Lines for cyclists at signals</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Road Lighting for VRU Safety</td>
<td>48</td>
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<tr>
<td></td>
<td>Vehicle Activated Sign (VAS) for VRU Safety</td>
<td>76</td>
</tr>
<tr>
<td>Traffic calming</td>
<td>Speed Humps / Speed Cushions / Other Devices based on Vertical Deflection</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Speed Tables and raised intersections</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Chicane / Priority Narrowing / Other Devices based on Horizontal Deflection</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Conversion of intersections into roundabouts</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>Streetcoping</td>
<td>76</td>
</tr>
<tr>
<td>Reducing vehicles striking</td>
<td>Special tyres</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>Anti-locking brakes (ABS)</td>
<td>24</td>
</tr>
<tr>
<td>Softening impacts</td>
<td>Soft vehicles fronts</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>Side protection screen on lorries/other vehicles</td>
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<tr>
<td></td>
<td>Daytime running lights</td>
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<tr>
<td>Making vehicles more noticeable</td>
<td>Audible signals when vehicles drive backwards</td>
<td>24</td>
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<td></td>
<td>Side mirrors for bicycles</td>
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<td>Fluorescent/refective devices for bicycles</td>
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<td>96</td>
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### 5.4.4. TA results India engineering

<table>
<thead>
<tr>
<th>safety concept components</th>
<th>measures</th>
<th>Problems Score</th>
</tr>
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<tr>
<td>Preparation Design/Redesign</td>
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<td>34</td>
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<td></td>
<td>Road Safety Audit/ Road Safety Inspection / Other Preventive Reviews, with Attention to VRUs</td>
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<tr>
<td></td>
<td>Data Record, Storage, Process for Indicators, with Attention to VRUs</td>
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<tr>
<td></td>
<td>Data dissemination activities, with attention to VRUs</td>
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</tr>
<tr>
<td></td>
<td>Integrating Land Use and Network and traffic Planning, with Attention to VRUs</td>
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</tr>
<tr>
<td></td>
<td>Information / Consultation / Participation processes for the Safety of VRUs</td>
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<tr>
<td></td>
<td>Sidewalks appropriate design (LOS-based)</td>
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</tr>
<tr>
<td></td>
<td>Proper upkeep (including repairing and sweeping)</td>
<td>28</td>
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<tr>
<td></td>
<td>Protection against unwanted usage (bollards)</td>
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<tr>
<td>Provision of pavements</td>
<td>Provision of appropriate number and position of crossing (zebra crossings basic provision)</td>
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<td></td>
<td>Pedestrianization</td>
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</tr>
<tr>
<td></td>
<td>Foot and cyclebridges</td>
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<td>Underpass</td>
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<td>Provision of integrated walking network</td>
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<td>Toucan crossings</td>
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<tr>
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<td>Location, size and reflectivity of signs/markings</td>
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<tr>
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<td>Avoidance of accumulated signs, ads</td>
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<td></td>
<td>Colouring of road surfaces</td>
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<td>Advanced Stop Lines for cyclists at signals</td>
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<td>Road Lighting for VRU Safety</td>
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<td>Vehicle Activated Sign (VAS) for VRU Safety</td>
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5.4.5.  TA results Brazil education

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<tr>
<td>Marketing and PR / Public</td>
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</tr>
<tr>
<td>Communication</td>
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<tr>
<td></td>
<td>Orientation to special audience</td>
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</tr>
<tr>
<td>Conventional Education, Learning, Learning, Upbringing</td>
<td>Road Safety Teacher and Trainer curriculum</td>
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<tr>
<td></td>
<td>obligation of preschool children education and training</td>
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<tr>
<td></td>
<td>obligation of school education and training</td>
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</tr>
<tr>
<td></td>
<td>obligation/faculative children/adolescents school and apprenticeship education and training</td>
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<td></td>
<td>accompaniment of first driving year by relatives</td>
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<td>permanent upgraded education and qualification network of Road Safety experts</td>
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</table>

5.4.6.  TA results India education

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<td>obligation of preschool children education and training</td>
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<td></td>
<td>obligation of school education and training</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>obligation/faculative children/adolescents school and apprenticeship education and training</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>accompaniment of first driving year by relatives</td>
<td>31</td>
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<tr>
<td></td>
<td>facultative training for adults</td>
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<tr>
<td></td>
<td>facultative training for elder ages</td>
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</tr>
<tr>
<td></td>
<td>obligation of regular trainingschemes for all professional drivers</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>permanent upgraded education and qualification network of Road Safety experts</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>obligation/faculative offenders education</td>
<td>33</td>
</tr>
</tbody>
</table>
## 5.4.7. TA results Brazil enforcement

<table>
<thead>
<tr>
<th>Safety concept components</th>
<th>Measures</th>
<th>Problems Score</th>
</tr>
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<tbody>
<tr>
<td>Legislation</td>
<td>Long term financing of authorities and structures belonging to road safety VRU considered?</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Regulations and norms for road design, construction and maintenance - VRU proper included?</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Road Safety Audit and Inspections of real use in Projects for reconstruction and new roads - VRU proper included?</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>Regulations about accident data storage, investigation and feedback: concerned structures - VRU proper included?</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Financing regulations bound to road safety to all users and weighting of all interests VRU proper included?</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>List of offenses and related penalties and regulation of payment, trial and revision</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>Grant regulations for improving and closing existing road safety gaps VRU proper included?</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Common driving license standards and health preconditions</td>
<td>44</td>
</tr>
<tr>
<td>Monitoring and reporting</td>
<td>Accident data collection with refinement for VRU?</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Accident data: quality management, investigations and black spot analyses - VRU proper included?</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>System of traffic patrols</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>Calibrated cameras combined with traffic observation to find out reasons of black spots - VRU identification possible?</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Speed supervision isolated, section checks, trading</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>Intensified presence of police with reiteration or single strategy on points of identified need</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Monitoring after improvement measures to estimate effects and feedback</td>
<td>84</td>
</tr>
<tr>
<td>Punishment penalties</td>
<td>Subdivision of responsibilities to execution</td>
<td>24</td>
</tr>
<tr>
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<td>Official minus points offense registry to identify repeaters and to refer with new penalties with each addition as a part preliminary or total loss (must then suspend driving license)</td>
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<td>Execution or detection of traffic offenses in field to pay immediately or for afterwords inclusion, integration of witnesses, identification of offenders</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Transport trial and revision system with link to penal institutions</td>
<td>104</td>
</tr>
<tr>
<td></td>
<td>Possibility of obligation to execute public works and to benefit to charity organisations</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Deleting minus points in the registry for participation in a section of relevant education.</td>
<td>84</td>
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5.4.8. TA results India enforcement

<table>
<thead>
<tr>
<th>safety concept components</th>
<th>measures</th>
<th>Problems Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legislation</td>
<td>Long term financing of authorities and structures belonging to Road safety VRU considered?</td>
<td>38</td>
</tr>
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<td></td>
<td>Regulations and norms for Road design, construction and maintenance - VRU proper included?</td>
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<td></td>
<td>Road Safety Audit and Inspections of real use in Projects for reconstruction and new roads - VRU proper included?</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Regulations about accident data storage, investigation and feedback to concerned structures - VRU proper included?</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>Financing regulations bound to road safety to all users and weighting of all interests VRU -proper included?</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>List of offences and related penalties and regulation of payment, Trial and revision</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Grant regulations for improving and closing existing Road safety gaps VRU proper included?</td>
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</tr>
<tr>
<td></td>
<td>common driving licence standards and health preconditions</td>
<td>41</td>
</tr>
<tr>
<td>Monitoring and reporting</td>
<td>Accident data collection -with refinement for VRU?</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Accident data quality management, investigations and blackspot analyses VRU proper included?</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>System of traffic patrols</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>Calibrated cameras combined with traffic observation to find out reasons of black spots - VRU identification possible?</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Speed supervision isolated, section checks, testing</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>Intensified presence of police with retaliation or single strategy on points of identified need</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Monitoring after improvement measures to estimate effects and feedback</td>
<td>33</td>
</tr>
<tr>
<td>Punishment penalties</td>
<td>Subdivision of responsibilities to execution</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Official minus point/offence registry to identify repeaters and to refer with new penalties with each addition as a part of preliminary or total loss(most then repeated) of driving licence</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Execution of detection of traffic offenses in field to pay immediately or for afterwords links so, integration of witnesses, identification of offenders, legalisation of in field acknowledgement of indebtedness</td>
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</tr>
<tr>
<td></td>
<td>Transport trial and revision system with link to penal institutions</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>Possibility of obligation to execute public works and to benefit to charity organisations</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Deleting minus points in the registry for participation in a section of relevant education</td>
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### 5.4.9. TA results Brazil encouragement

<table>
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<tr>
<th>safety concept components</th>
<th>measures</th>
<th>Problems Score</th>
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<tbody>
<tr>
<td>Social incentives</td>
<td>Being part of a community with good social transport behaviour</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Being part of a community with good ecological transport behaviour</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Being part of a new (young) generation (children, adolescents)</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Breaking with overcoming traditions, being modern and up to date in older ages</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Understanding new Public transport systems, not being addictive from own car</td>
<td>104</td>
</tr>
<tr>
<td></td>
<td>Use of new mobility products as car sharing, bike renting, multiple transport cards</td>
<td>72</td>
</tr>
<tr>
<td>Economical incentives</td>
<td>Pay as you drive insurances, PAYD rewards</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>Bonus for participation in trainings on Road Safety</td>
<td>104</td>
</tr>
<tr>
<td></td>
<td>Private companies Incentives, Discounts for Buying Road Safety Products</td>
<td>104</td>
</tr>
<tr>
<td></td>
<td>State Subventions for research and development, introduction and production and sale of new Road Safety products</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Awards for development and use of new Road Safety technologies and Prices to University Researchers and Non Profit Organisations</td>
<td>56</td>
</tr>
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### 5.4.10. TA results India encouragement

<table>
<thead>
<tr>
<th>safety concept components</th>
<th>measures</th>
<th>Problems Score</th>
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<tbody>
<tr>
<td>Social incentives</td>
<td>Being part of a community with good social transport behaviour</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Being part of a community with good ecological transport behaviour</td>
<td>27</td>
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<td></td>
<td>Being part of a new (young) generation (children, adolescents)</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Breaking with overcoming traditions, being modern and up to date in older ages</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Understanding new Public transport systems, not being addictive from own car</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Use of new mobility products as car sharing, bike renting, multiple transport cards</td>
<td>30</td>
</tr>
<tr>
<td>Economical incentives</td>
<td>Pay as you drive insurances, PAYD rewards</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Bonus for participation in trainings on Road Safety</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Private companies Incentives, Discounts for Buying Road Safety Products</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>State Subventions for research and development, introduction and production and sale of new Road Safety products</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Awards for development and use of new Road Safety technologies and Prices to University Researchers and Non Profit Organisations</td>
<td>30</td>
</tr>
</tbody>
</table>

### 5.5. TA and PPM use conclusion

The proposed procedure is a flexible scheme to estimate problems for transferability of a described safety category, a safety concept or a single safety measure into a Road Safety Space with different CSIE. The use for Transferability Audit within the VRUs context is a first step. A use for other Road Safety issues can be expected to be successful as the system seems to be adaptable enough. The use of the Problem Priority Matrix is helpful to handle the necessary data efficiently.

The combination of data store in the TA steps and the possibility to visualize the results referring to the steps helps to find out the necessary vote for or against a concept and a measure. Based on this mix of qualitative and quantitative criteria achieved by evaluating it can be expected that measures can be estimated on their transferability.

It has always to be considered that the successful transfer requires the quality criteria:
1) Expert knowledge of each of the 4E’s and the CSIE. In case that one of these criteria is missing disparities appear with the source data or with wrong evaluation. The awareness of cultural environment is essential.

2) Assessment of existing concepts and measures delivers a problem score. The problem score for transfer in a unit is to be seen relatively to their concept and measures. It is no absolute figure.

3) A relatively high problem score is an indication to adapt a measure before try to transfer it. It may be useful to localize it by adapting to local demands. Before starting a localisation it is necessary to assess the data of Road Safety Space evaluation in detail and in several resolutions.

4) A CSIE balanced PPM result is considered to be feasible as it shows clear whether a measure is problematical or not. If there is a medium score and there are disparities inside the CSIE the success depends on a strategy to adapt to the critical components outcome.

5) Concept and measure management is a necessary step afterwards. It seems to be useful to consider that Road Safety concept should not only contain either a group of engineering measures or an enforcement package. The concept of transferring a measure in engineering should be bounded with measures from the other E’s

6) The TA is (if it is targeted to make the adaptation and transfer acceptable) a process that can be compared to reiterated algorithms. Therefore several iterations are useful to be planned.

7) The TA algorithm is based on existing experiences but has to be proved in further work and to be adapted if needed.
6. Conclusions with respect to Curriculum for Transferability Audit

The sequence of steps to explore the possibility of transferring know-how of VRUs Safety can be considered to be used systematically. It is necessary to focus on the “weak” qualification resources that should be available, as a sole technical transferability process cannot be expected to be successful.

The success of the process depends on an intercultural team making intercultural communication as an essential node point of the efforts. The “only presence” of engineers is not sufficient. Exploring new possibilities for transferring Road Safety concepts and measures need acceptance by the objected recipient from the beginning and an accompaniment of further experts. It should be a constitutional convention of the team to accept the differences and to be ready for an adaptation by the members themselves.

Starting Transferability Audit it is necessary to provide from the beginning exceptional amount of communication and motivation of all these experts to equalize a common basic knowledge of technical, cultural and language skills.

In the SaferBrain team for Transferability Audit development were included the key persons described in Table 9.

<table>
<thead>
<tr>
<th>Qualifications</th>
<th>Language skills</th>
<th>Cultural skills living and working more than 5 years in EE unit now based</th>
<th>Cultural skills living and working more than 5 years in EU/western unit in that time based</th>
<th>Further cultural residential experience more than 1 year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineer machine construction</td>
<td>German, Portuguese, English, Italian</td>
<td>Brazil</td>
<td>Germany</td>
<td>Spain, Italy</td>
</tr>
<tr>
<td>Social Anthropologist</td>
<td>German, Hindi, Marathi other Indian lang. Italian, English</td>
<td>India</td>
<td>Germany</td>
<td>U.K., Italy</td>
</tr>
<tr>
<td>Psychologist</td>
<td>Portuguese, English, Italian, Spanish</td>
<td>Brazil</td>
<td>Germany, USA</td>
<td>Several South America countries</td>
</tr>
<tr>
<td>Eng. Traffic and town planning</td>
<td>Mharati, Hindi, English</td>
<td>India</td>
<td>U.K.</td>
<td></td>
</tr>
<tr>
<td>Linguist</td>
<td>Russian, German, English, Italian</td>
<td>Germany</td>
<td>Russia, Belorus</td>
<td>USA</td>
</tr>
</tbody>
</table>

Standardized international English can be declared to be the common language. Finishing touches are quite difficult to find out without refined language. Though, the national language of EE has to be considered during TA in order to organise proper adaptation of measures also in terms of their translation. Public transport, bicycling and new features for pedestrians, legislation, advertisement and other contents needs communication with additional demand on language score. There are often new terms and phrases needed to be introduced and explained to experts and community.

The EU development can be seen in the time axis of Figure 3 on the right hand side. EE’s have started their development several years ago and are strong increasing. The wish to be motorised, to be protected in a car, to show social state that can be simply represented by bigger cars is possibly stronger. To realise unsocial behaviour in traffic (the stronger against the weaker) must be brought to mind which can work maybe only for following generations.
as well as the answer how much traffic makes a real improvement of the living conditions as a whole subject.

Technical knowledge in most of the EU countries is highly developed and can be very complex to be transferred directly as several long term decisions have to be made. Safety concepts that are targeted to be transferred should be understood in their development in the origin unit and be seen in the time axis where a recipient unit can be expected when adapting and transferring it. Each concept has a history that must be communicated. Even in EU, VRU way of thinking is a result of long experiences made before and from the pressure to improve live circumstances.

In the project the local pre-analysis workshops have been a platform to penetrate the problems, to understand each other, as well as to estimate the transferrable nucleus and to identify the EU local part to be adapted. Reiteration with permanent communication and meetings are a platform to bring different points of view closer together and to compensate different cultures of personal, verbal and written communication.

The know-how of the Road Safety concepts and measures to be transferred has its own variety. The EU represents different nations and traditions as the targeted EE units do as well. All parties of SaferBrain have a cohesion process within the units. The considerable spectrum even dealing with a new topic as VRU safety and transferability anticipating all activities through the lens of a real tests planned in SaferBrain is intensifying the efforts as real results have been expected. Terminology standards for the team must be shaped due to understanding content.

The steps to be made as shown in Figure 33 and a Curriculum of the TA process need integration of structures that can fulfil or at least understand the necessary tasks and consequences. Integration of institutions dealing every day with road safety on a practical level is the best partnership. Even pilots prepared by TA analyses should have a grip on reality when dealing with conception of a regular Road Safety concept and measure adaptation to a new cultural unit. Also legal and institutional issues after identification of transferability must be taken into consideration to estimate the chances of real transfer on a practical level.

To form a data sample based on the knowledge structure of important work contents, the following is recommended:

1) Cultural environment transferability consideration.
2) Sample and communication about Road Safety concepts and VRU measure configuration in EU and EE; identification of measure packages.
3) Integration of possible concepts in the 4E’s/CSIE Problem Priority Matrix.
4) Analysing problem score of transfer evaluating Macro-, Meso- and Micro-Level contributions in the transferability data pyramid.
5) Reiterating while communicating the results until a stable balance between both sides EU and EE unit is achieved.

As a consequence, it is recommended to proceed qualification structure before trying to transfer measures. The experience within TA for SaferBrain shows that the identification of problems and the improvement is supported by the qualitative-quantitative indicators of PPM analyses and even the visualised results give a useful help to make reiterations. It is considered that the TA helps to avoid heavy mistakes and indicates the amount of additional efforts for heavy challenging concepts and measures.
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The On-The-Spot accident research project http://www.ukots.org/


Annex 1 Infrastructural measures
Annex 2 Pre-analysis of roads safety measures transferability in Brazil
Annex 3 Pre-analysis of roads safety measures transferability in India
Annex 4 Problems Priority Matrix Brazil
Annex 5 Problems Priority Matrix India
Annex 6 Research on Cultural Dimensions for Brazil
Annex 7 Research on Cultural Dimensions for India