TRANSFERABILITY OF EU METHODOLOGIES AND TOOLS FOR VULNERABLE ROAD USER SAFETY TO EMERGING ECONOMIES

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ABSTRACT

Despite the strong improvements in road safety registered in European countries during recent years, the situation in the Emerging Economies is getting dramatically worse, especially concerning the safety of Vulnerable Road Users. To increase the level of safety of Vulnerable Road Users in Emerging Economies, the project *SaferBraIn* (Innovative Guidelines and Tools for Vulnerable Road Users Safety in India and Brazil) has been developed within the framework of the 7th Framework Programme of the European Commission. The general aim is to develop innovative tools, guidelines, and recommendations adapted to the local conditions of India and Brazil.

SaferBraIn analyzes local requirements for safety of Vulnerable Road Users and the conditions for transferability of European experiences in Emerging Economies.

Based on the identification of safety requirements in India and Brazil, the conditions for transferability of European experiences were defined according to the following methodology:

- analysis of similarities and differences between Europe, India, and Brazil;
- identification of barriers to transferability from Europe to India and Brazil;
- definition of a transferability audit to check the applicability of measures from European countries to India and Brazil;
- in-depth evaluation of the cause-and-effect chain and determination of the underlying mechanisms.

Two main results were obtained: i) a specific database for the Transferability Audit and ii) a dedicated Curriculum for the Transferability Audit from Europe to India and Brazil.

Keywords: Emerging Economies, Vulnerable Road Users, Road Safety, Transferability.

INTRODUCTION

The efforts of the European Commission and all the Member States to reduce road fatalities in Europe have yielded significant results (the number of fatalities decreased by about 35 percent from 2001 to 2009 in EU27), even if the 2010 objective of reducing the number of deaths by half was not fully reached.

Walking and cycling are transport modes by which relatively unprotected road users interact with motorized traffic. This makes pedestrians and cyclists vulnerable, namely children and the elderly, who perform their activities mostly on foot, as well as youth who enjoy biking for recreation.

Of all traffic fatalities in EU Countries, the proportion of pedestrian fatalities is about 17 percent and that of cyclists is about six percent. The highest percentage of pedestrian fatalities occur among children younger than 10 years of age and adults aged 65 years or older. Cyclist fatalities have the highest share among children between 6 and 14 years of age.

Trends in fatalities among pedestrians and cyclists in Europe show that, since 1980, the numbers have decreased by about 65% and 55%, respectively. To put these figures into perspective, the number of fatalities among car drivers and their passengers only decreased by 35 percent (European Road Safety Observatory - ERSO, 2008).

Despite this significant improvement in European Countries, the situation in Emerging Economies is getting dramatically worse.

If we look at India, in 2006 the reported road traffic fatalities were nearly 106,000 with 84 percent attributed to male deaths and 16 percent to females, while the reported non-fatal road traffic injuries were approximately 453,000. Fatal accidents involving pedestrians and cyclists were respectively equal to 13% and 4% of the total. While India has only 62,000 registered vehicles per million inhabitants, the road traffic fatalities per registered vehicles is six times higher than in Europe.

In Brazil, in 2006, there were 35,155 road traffic fatalities reported and about 408,000 non-fatal road traffic injuries. Fatal accidents involved 28% of pedestrians and 5% of cyclists. Here the number of registered vehicles per million inhabitants is lower than in Europe (about 259,000) but the road traffic fatalities per registered vehicles is three times higher than in Europe.

These data show the gaps between India and Europe as well as Brazil and Europe and suggest that Europe could greatly improve Vulnerable Road Users (VRUs) Safety in these two Emerging Economies by transferring and adapting European findings to local applications.

In order to increase the level of safety of Vulnerable Road Users in Emerging Economies a research project (*SaferBraIn* – Innovative Guidelines and Tools for Vulnerable Road Users Safety in India and Brazil) was established. The project started in October 2009 and was developed in accordance with the FP7 of the European Commission.

SaferBraIn analyzes the main risk factors for V Vulnerable Road Users in Brazil and India and, based on European experiences and best practices, attempts to develop innovative methodologies and tools for planning, designing, and maintaining safe infrastructures in these Countries. The project also evaluates the transferability of these tools in order to modify them according to the experiences of local participants.

It has been demonstrated (ERSO, 2008) that, under European conditions, the measures which can significantly reduce the number of accidents involving pedestrians and cyclists and/or decrease the severity of resulting injuries relate to:

- The traffic system itself, such as the separation of motorized traffic from non-motorized traffic, area-wide speed reduction, and the provision of walking and cycling networks.
- Proper design of pedestrian and cyclist facilities.
- Improvement of visibility of pedestrians and cyclists.
- Vehicle design, in particular crash-friendly car protection on trucks.
- The use of protective devices such as bicycle helmets.
- Education and training of pedestrians and cyclists as well as drivers.

The implementation of effective countermeasures and the achievement of higher safety levels for Vulnerable Road Users in Emerging Economies requires a significant improvement in local analysis, planning, and design capabilities. However, the approaches that are successful under EU conditions will not necessarily be equally successful in other areas. Differences in local infrastructure, training, vehicle fleet, and mobility patterns can all degrade the effectiveness of otherwise successful countermeasures.

In conjunction with *SaferBraIn,* this paper analyzes conditions for transferability of European experiences in Emerging Economies.

The comparative analysis of Europe, India, and Brazil has been studied in terms of Vulnerable Road Users needs, infrastructure design, land-use configuration, and road safety management procedures.

The barriers (e.g. social, legal, and economic) to transferability of methodologies, measures, and tools from Europe to India and Brazil have been identified, and a generalized Transferability Audit (TA) has been defined and used to check the applicability and acceptability of available road safety measures, guidelines and tools from European Countries to India and Brazil.

Organization of paper

This paper is comprised of three sections. The first section presents a background overview on transferability issues, used as basis to develop the method adopted in *SaferBraIn*. The second section outlines the development of the method: starting with prerequisites for transferability, the general algorithm developed, along with details on the methodology in finding problems applying road safety measures[1]. The third section presents results on the assessment of European road safety measures created using the method developed. Finally, conclusions and projected future developments are presented.

BACKGROUND

Generally speaking, transferability means the quality of being transferable or exchangeable, which, for road safety problems, refers to the possibility to implement in a given context measures or practices successfully adopted elsewhere.

[1] The term “measure” is used throughout the paper in reference to road safety measures, guidelines and tools.

Successful stories of transferability are represented by two well-known safety concepts pioneered, since the 1980s, in some Countries (France, the United Kingdom, the Netherlands, etc.) and currently widely applied across Europe. The first relates with infrastructure planning and design to promote Vulnerable Road Users mobility. The second relates with Road Safety Audit and Inspection (RSA&I) procedures. For the former, after years of best practices, a variety of comprehensive manuals, guidelines, and standards for safe infrastructure planning and design are now available in many European Countries. Alterations to alignment or geometric features, as chicane or carriage narrowing, compact and mini roundabouts, are, for instance, the most common solutions to traffic calming problems, the shared approach being the enforcement of standards to reduce speed on the road, especially in urban areas. Some European Countries such as Italy, Spain, and Denmark also have detailed standards for cycle tracks. These standards are conceptually very similar to those for road design; they derive the geometric features from the design speed.

Road Safety Audit and Inspection is of great interest, because it is mutually transferred among several Countries, even outside of Europe. Road Safety Audit and Inspection is a standard procedure described in a set of guidelines with checklists and issued in many national manuals (New Zealand, the United Kingdom, Australia, Denmark, USA, Norway, France and Italy). A common feature of such handbooks is the provision of checklists for every stage of the project and for road safety inspections, but only two Countries have implemented guidelines for Road Safety Audits of projects dedicated specifically to Vulnerable Road Users: USA (Nabors et al, 2007) and the UK (HD 42/05, 2005). The first provides guidelines for every road element; the second, in addition, highlights the differences among the various Vulnerable Road Users: pedestrians, mobility and visually impaired users, cyclists and equestrians. With these characteristics, both manuals are more suitable for urban projects than the other generic Road Safety Audit guidelines. In general, Road Safety Audit is considered an efficient and recommended tool for the improvement of road safety, within a comprehensive safety management system.

So far, transferability can be defined as a process in which the feasibility of implanting measures from an origin city/area to a receptor city/area is assessed. Thus the transferability 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 and Marques, 2004: 6).

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

- the institutional domain (i.e. the totality of legal, regulatory, and standardization tools which authorize 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 (i.e. the cultural status which makes a community aware of the need to adopt a given measure and willing to accept it).

Each factor can affect the others, can have both a local (case study, pilot study, urban area) and a general (state, national) influence, and may involve more study areas than those usually involved (i.e. psychology, anthropology, public health, security, etc.).

Such three factors should be, whenever possible, translated into indicators. It is very difficult to frame them within a univocal and comprehensive approach, especially if the focus is to perform the transferability assessment relying solely on quantitative indicators.

So far, many experiences have provided a wide palette of concepts for the transferability process, depending on different goals, contexts of application, measures and policies to transfer, users involved, etc.

It is clear that the more in-depth the analysis of the three main factors, the easier it is to identify drivers and barriers to support the transfer feasibility. The impossibility in dealing with the three factors according to a unique, quantitative point of view prompted King (2005) to address the problem by the elaboration of an innovative concept: the Road Safety Space. This concept is intended as a kind of "environment" where, theoretically, a TA can take place and where all the mutual influences among the three above-mentioned factors occur (see Figure 1). 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).

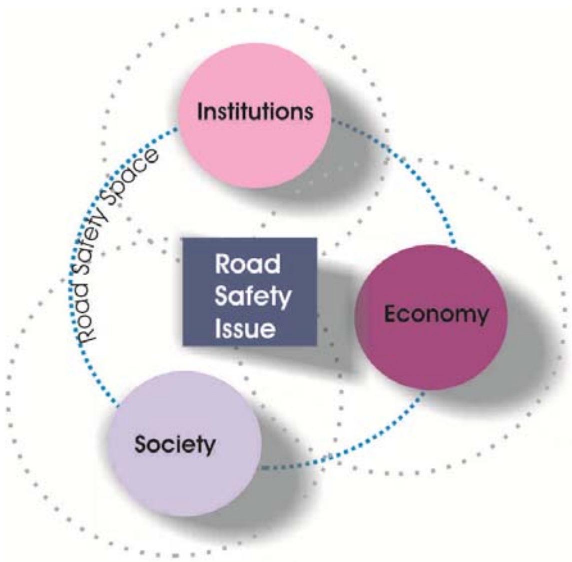


Figure 1 - The Road Safety Space

A typical example of this concept could be the introduction of traffic calming devices to improve safety at intersections; improving conflict areas by traffic calming solutions will entail a Road Safety Space whereby economic, regulatory and cultural issues, which impact the final effectiveness, can be considered.

The success of a TA and the reliability of its outcome depend on: a) the comprehension of the Road Safety Space itself and b) an assessment of how such an introduction process can be operated.

The logical process should therefore be based on the following steps:

- Using the Road Safety Space concept to identify the factors belonging to the three factors (Institution, Society, Funding) which can affect the safety issue at hand.

- Selecting which are the effective measures likely to be transferred among those available from the origin context.
- Using the Road Safety Space concept to identify the factors which made the transferable measures successful in the origin context.
- Assessing whether, according to the target context, the measures to be transferred are likely to be as 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.

The Road Safety Space concept is focused on the transferability of single measures or packages of measures and may be appropriate in contexts where road safety is already a consolidated practice (even with "flaws") and minor actions are needed to improve the safety level.

Examples of transferability of road safety policies do not abound in the literature, and in many cases they deal with simple recommendations of best practices to transfer, very often regardless their cost effectiveness, being the economic efforts behind such practices very different from place to place; this may also explain the success of some conventional but very qualitative evaluation analyses of the safety measures effectiveness, including costs, largely used, for instance, in Europe as the PIARC (2009) one.

On the other hand, the literature on transferability of transport policies is rather rich, and consolidated results from Transferability Audits are widely available - although they mostly concern transfer of policies from/to contexts in advanced economies.

Among the Transferability Audits on transport policies, some relevant EC-funded research projects, which provide recurring structures and implemented models useful for the transferability of comprehensive policies to improve road safety, are worthy of mention. These include:

- TRANSPLUS - Transport Planning, Land Use, and Sustainability
- LEDA - legal and regulatory measures for sustainable transport in cities
- CIVITAS Initiatives, a cluster of projects, two of which appeared to be relevant in terms of transferability issues:
  - METEOR - Monitoring and Evaluation of Transport and Energy-Oriented Radical strategies for clean urban transport
  - MIRACLES – Multi Initiative for Rationalized Accessibility and Clean Liveable Environments.

TRANSPLUS defines the identification of the Transferability Scope, i.e. vertical and horizontal transferability concepts, stressing the possibility to "stretch" the transferability focus broadly, as vertical transferability implies the possibility of zooming a given measure in or out, while horizontal transferability means the opportunity to move such a measure without changing scale (Macario and Marques, 2004).

The LEDA project assesses the transferability of a series of 20 "less well-known but effective measures" to some receptor cities in Europe, selected according to the project evaluators' expertise (Langsaam Verkeer, 1999). The concept is simpler than the TRANSPLUS one, since the Transferability Audit focused on the transfer of just single measures, namely under the legal and regulatory points of view. Positive aspects to consider are: a) the possibility to outline characteristics of the cities flexibly and according to the most unique goals; b) the provision of a utilitarian method easily adaptable by participants; c) the possibility to have a kind of quantitative control of the Transferability Audit; d) the avoidance of data search and desk research in general, since characteristics are determined according to the Transferability Audit participants' expertise. The LEDA focus was just on single measures, and the application of such a method to broader policies may not be that straightforward.

The CIVITAS approach provides a general methodology for transferability, easily adaptable to different kinds of research projects and the related measures' implementation process. The methodology - developed during the METEOR project with the aim to provide decision-makers with a univocal process to assess whether or not some mobility measures could be transferred from CIVITAS cities (including those of MIRACLES) to other European urban areas - was based on a ten-steps algorithm which takes into consideration some of the aspects already dealt with in TRANSPLUS and LEDA (Macario and Marques, 2004). The transferability methodology was further revised, still within CIVITAS, during the "GUARD" project (Hall et al., 2008) and successfully applied to other CIVITAS case studies (CIVITAS MOBILIS, 2009).

TRANSFERABILITY AUDIT METHOD

The Transferability Audit developed in SaferBraIn has been based, then, on the models developed in the above-mentioned EC-funded research projects, and was changed from the sequence and process developed within METEOR and according to the outcomes from MIRACLES (Musso and Corazza, 2006). Such an approach is too complex and long to govern a Transferability Audit like that of SaferBraIn, the scope of the latter 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 Audit process. Such a sequence, however, appeared to be flexible enough to be adapted to:

1) both horizontal and vertical transferability options,
2) start the process either from target cities and look for candidate origin cities or vice versa, and
3) use indicators coherent with the Road Safety Space concept.

The prerequisites for transferability

Before starting the transferability process, it was necessary to find solutions to the following matters, in order to have useful indications for the SaferBraIn Transferability Audit:

- If transferability is aimed at exporting successful measures, how can "success" be defined?
- Once assessed, the characteristics which contributed to the success of a given measure in the origin city, must be evaluated on their importance in the target city as well, or in other words whether they may be as decisive in the new context as they were in the origin one.
- Implementing mobility measures requires a deep knowledge not only of the environments where the measure is implemented, but also of the quality and quantity of data and information available to support the Transferability Audit.

As to 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 gamut of safety topics, from transportation, to health, to economy, etc.). Logically, values from such indicators can be used also to determine measurable criteria for success (i.e. as a kind of threshold values for transferability) to meet some agreed transferability requirements (or goals). For example, a given safety policy which contributed to decrease the accident rates in a given area can be assessed as successful only if such decrease meet the n-% value as a threshold, required by the Transferability Audit.

Similar considerations can be made about the second issue. In this case as well, it is necessary to quantitatively assess the importance of the key drivers (e.g. according to the experts' knowledge) which could be done by rating them. Matching relevance for any driver in both origin and target contexts could be a good marker for successful transferability.

The last issue is not only a problem of availability of data but above all of their reliability. Quantitative information and directly monitoring the effects of a given implemented measure are not always available and even when available, they cannot be trusted as unique elements to determine whether the measure is exportable or not, since the conditions for transferability might not match. Consequently, to start a Transferability Audit it is important to have a study session in which available data and information are scanned and assessed as to whether they may be usable to support the Transferability Audit. Such assessment should be made by consultations. Such phase should occur both at a political level in the target context, to have key players aware of the starting level of the Transferability Audit, and at a technical level, to have transferability planners aware of what is still missing to perform a Transferability Audit and how such gap(s) can affect the transferability results.

Generic algorithm for Transferability

Basing on the above described prerequisites, the general structure for the Transferability Audit of *SaferBraIn* has been developed according to the sequence below (see Figure 2).

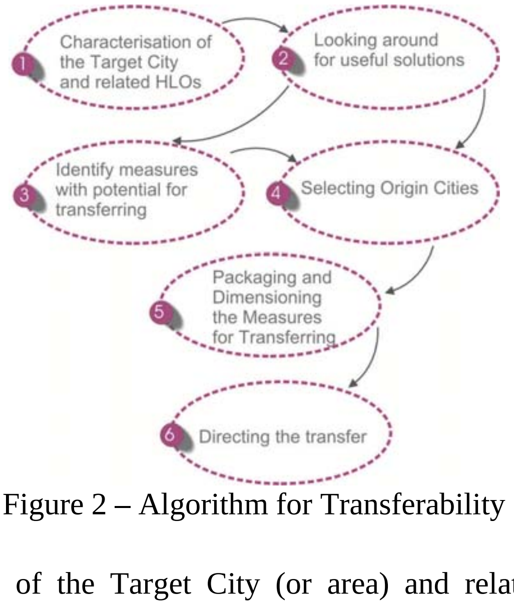


Figure 2 – Algorithm for Transferability

STEP 1 – Characterization of the Target City (or area) and related High Level Objectives (HLOs). This is the characterization of the target contexts, according to the Road Space Safety concept, which requires the description of the contexts under the three main factors (i.e. regulatory, economic, and social indicators). Safety problems emerging from this picture should be codified into a series of High Level Objectives. The goals of this step are to obtain a good snapshot of the contexts in hand and to have a priority list of High Level Objectives to pursue.

Such prioritization can result from calculations (Macario and Marques, 2004) or from questionnaires submitted to all the involved experts (the importance of qualitative recommendations is great, since many studies on transferability are largely based on consultations; see for instance Buchanan, 2003).

STEP 2 - Looking around for useful solutions. This consists of providing a list of efficient safety measures (already successfully adopted), which grouped together form comprehensive safety policies coherent with the contexts of application and hence with High Level Objectives. The selection of solutions must be consistent with the technical and economical affordability of the target contexts and their tendency towards some category of measures rather than others. For this reason consultancies should be created to develop shared decisions and solutions.

STEP 3 - Identifying measures with potential for transferring. This step consists of selecting the measures coherent with the characterization of the target/origin cities and the local High Level Objectives. The measures must be monitored by the selected indicators.

STEP 4 - Selecting origin cities - outlines, when looking for exportable successful measures (STEP 2 and 3), where they have been implemented (origin cities) and if such origin contexts are close to the target ones (STEP 1). A characterization of the origin cities similar to the target ones is necessary, in order to have comparable results.

STEP 5 - Packaging and dimensioning the measures for transferring - aggregates the measures according to directions provided, at target cities level, during STEP 2.

STEP 6 - Directing the transfer (creating the Transferability Audit) - consists, once decided what and how to transfer to the target contexts, of providing criteria to carry out the transfer process (timelines, level of involvement of users in the process, resources to be utilized in the process, etc.). Included also is the creation of do-something/do-nothing scenarios to estimate the level of efficiency of the selected safety measures and hence to have a set of useful ex ante/ex post indicators, once the measures are implemented.

Weighing the role of human factors and road user behavioral issues

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

As a result, tasks involving the individuation of objectives for the Transferability Audit in the target cities (STEP 1), adoptable solutions (STEP 2), and their packaging (STEP 5) can be simple if considered under the regulatory, technical and/or economical points of view, since related local constraints, barriers, and drivers to support the implementation of packages of measures are easy to individuate and assess. For instance, costly solutions can be as easily discarded as those that require specifications, rules or laws currently not in force in the target contexts and for which no short-term changes are planned. The same cannot be said when such tasks include human factors and road user behavioral 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 Transferability Audit, in which the evaluation of regulatory, technical and economical issues becomes a general prerequisite for the transferability of measures (a kind of go/no-go step), but the real transfer feasibility is assessed through proper knowledge of the role human and behavioral factors may play in the acceptance of the safety measures.

This kind of approach (see Figure 3) means that, whatever the package of measures or safety concepts to transfer, the Transferability Audit should deal both with technical and behavioral domains (the former meaning the “Economic” and “Institution” factors of the Road Safety Space concept, and the latter the “Social” factor). Technical solutions to transferability can have direct relationships with economic and institutional issues, but they cannot markedly affect the local social patterns, *per se*. On the contrary, how people perceive and assess the proposed technical solutions to transfer is important for their final acceptance and proper use. The behavioral domain, which reflects the cultural and social acceptance of the proposed solutions due to stated human and behavioral factors, may strongly influence key participants and planners in their final assessments. Indeed, the awareness that “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 understanding better the end-users’ attitudes towards safety problems, investigating aspects of their behavioral patterns due to specific needs, level of awareness and acceptance, and expectations.

Thus the High Level Objectives (i.e. objectives to be defined during STEP 1) should be divided into two categories: economic-institutional goals and social goals. 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.

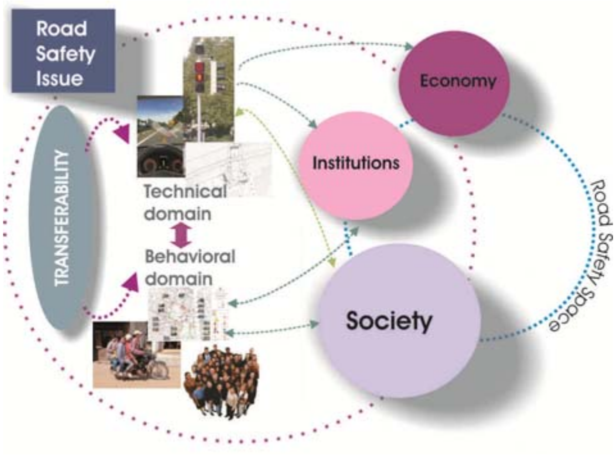


Figure 3 - Adaptation of the TA with respect to the human and behavioral factors

Methodology to finding problems in applying Road Safety Measures

As previously described, 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 unique the cultural scenario between origin and receptor contexts, the more difficult the adjustment of safety concepts to the real needs of the latter will be.

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 significant periods (allowing thus a longer term 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 STEP 1 of the Transferability Audit (Characterization of the target city 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 weighed in order to have a final list of barriers to the implementation of a given safety concept.

The proposed search methodology is based on a simple three-step procedure described in Figure 4:

- STEP A – Collecting road safety concepts to transfer (the lesson from Europe).
- STEP B – Creating a problems priority matrix.
- STEP C – Assessing the matrix outcomes.

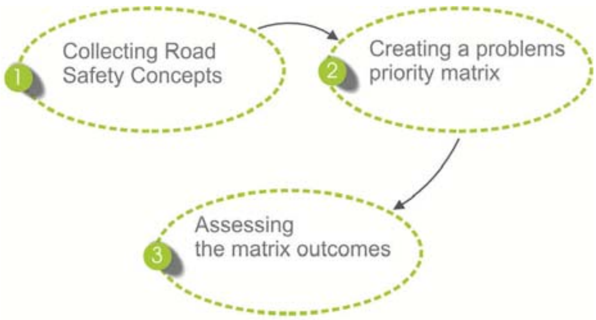


Figure 4 - The search methodology algorithm

The concept supporting such an algorithm (see Figure 5) stems from an Artificial Neural Network (ANN)-based algorithm developed by the EC-funded project TRACE (2007) to model some accident configurations, which has been adapted in light of the lessons outlined by the Road Safety Space.

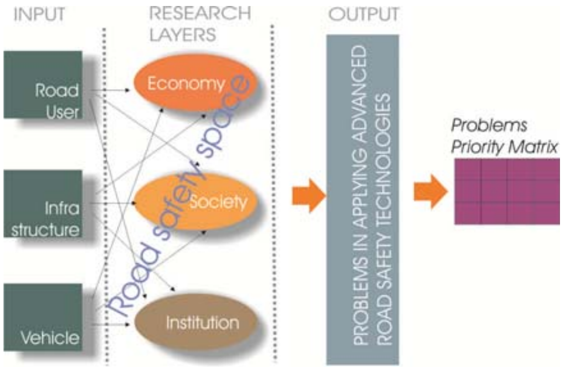


Figure 5 - Supporting concept of methodology algorithm

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, Economy and Institution) as research layers which describe the receptor context.

Most of the road safety measures, usually implemented in developed areas, have already been (more or less) transferred to Emerging Economies, even though not systematically and without a proper assessment of the achieved results, which implies the need for 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 identify both possible problems due to their implementation in other contexts and insurmountable barriers which can hinder the whole transferability process.

STEP 1 - Collecting road safety concepts - organizes the road safety concepts according to a structure which can facilitate the analysis of problems they can cause. This can be done by classifying the road safety concepts-inputs according to the three main components of the road safety system: road users, infrastructure, and vehicles. In other words, the task is to organize a taxonomy of road safety concepts, dividing them by main component affected.

The scope of *SaferBraIn* being to improve safety of Vulnerable Road Users, safety concepts concerning infrastructure and users are likely to prevail over 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 2 - Creating a Problems Priority Matrix - defines links among the list of road safety concepts-inputs and the three Road Safety Space assessment factors as arising problems which could hinder the implementation of a given safety improvement. The best tool to analyze such links is an “influence matrix,” in which relationships among rows and columns are scored and weighted, so as to have a proper knowledge of the most and least challenging measures. Such an influence matrix has been translated into a Problems Priority Matrix (an example is shown in Figure 6) where rows represent safety concepts-inputs and columns the three Road Safety Space factors (i.e. Society, Economy, and Institution).

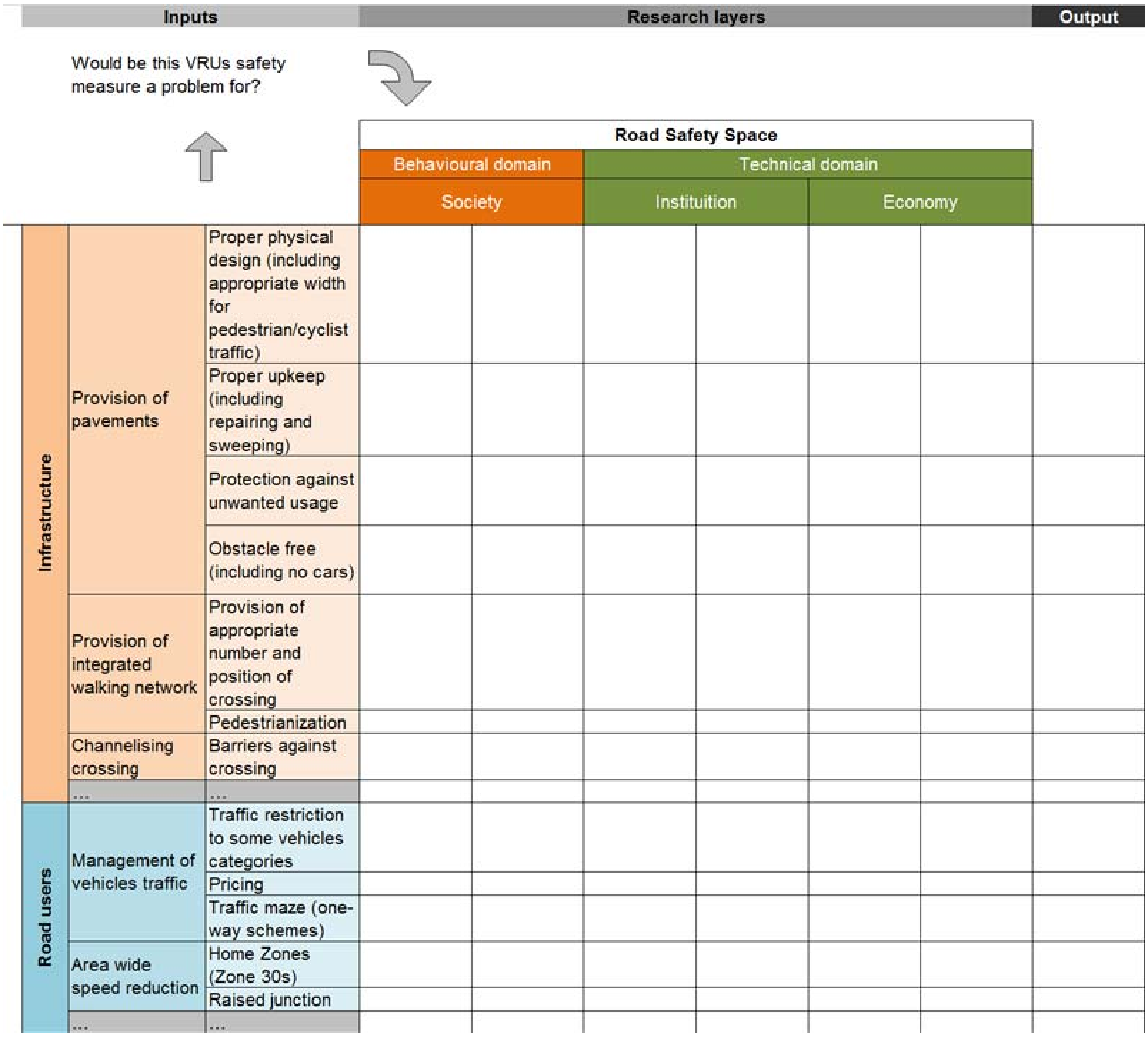


Figure 6 – Example of the Problems Priority Matrix

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

a) Society
b) Institutions
c) Economy

by providing:

- a score according to a 1-5 Lickert Scale, 1 being the least challenging and 5 the most challenging, multiplied by
- 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 respondents' expertise on the sites, features, and pattern where the measures should be designed and implemented.

Total scores will be calculated as follows (see Equations 1 and 2):

- Row j (1 to n): $\sum_{i=1}^{n} w_i \cdot s_i$ (1)
- Column i (1 to m): $\sum_{j=1}^{m} w_j \cdot s_j$ (2)

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

As a result, the lowest are the total scores per row, the least challenging are the measures, and the most benefited are the non-motorized users. The lowest are the total scores per column, and the least affected are the related Road Safety Space components.

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

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

As an example, in the Problems Priority Matrix:

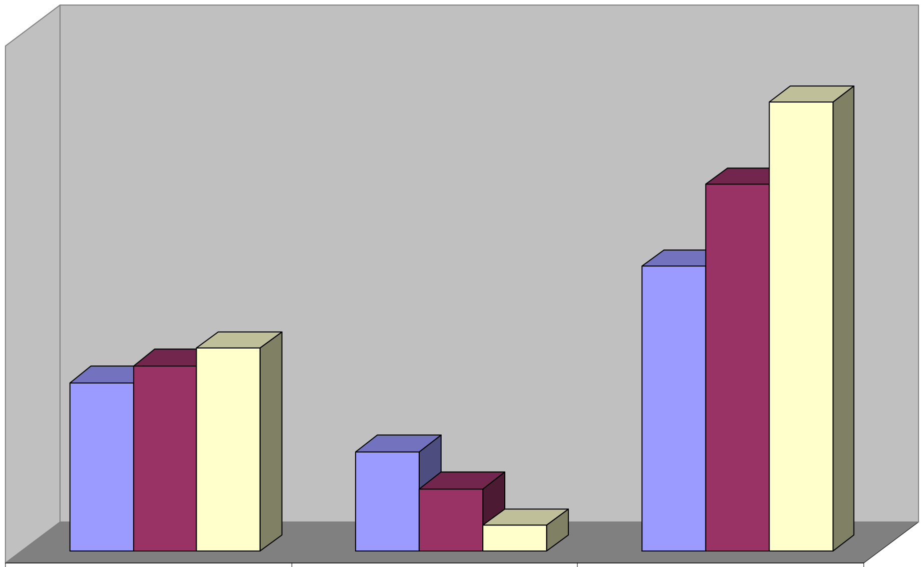
- Society can be divided into subcomponents "People" (meaning the relevance of acceptance and awareness among the people especially for restrictive measures) and "Environment" (meaning the possibility to change the built environment in order to accommodate the proposed solutions). The factor has thus been renamed to Society/Culture.
- 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 behavioral analyses) can be added or the proposed ones can be changed.

STEP 3 – Assessing the matrix outcomes - assesses and comments on the final scores and provides a list of problems arisen from the Problems Priority Matrix.

TRANSFERABILITY AUDIT OF ROAD SAFETY MEASURES

The methodology of Transferability Audit was introduced to local stakeholders in India and Brazil with the aim of assessing the exportability of road safety measures normally used in Europe. About 110 road safety measures, belonging to different categories, were analyzed, and a panel of stakeholders was required to fill in the Problems Priority Matrix matrix to provide results. As expected, differences, in terms of problem scores, did arise. The problem score level (Figure 7) foreseen in India is in general lower than in Brazil. Results show that India has more balanced maximum and minimum scores, whereas Brazil tends to have bigger deviations from minimum to maximum.



	Average problem score	Minimum problem score	Maximum problem score
India	39	23	66
Average	43	14,5	85
Brazil	47	6	104

Figure 7 – TA average problem scores in Brazil and India

Comparison Road Safety Space factors in Brazil and India

While Brazil shows a dominant problem score with “Society/Culture” and “Institution”, the “Economy” problem score is low. On the contrary, in India, the “Economy” problem score is close to 50% of the total problem scoring, while “Society/Culture” and “Institutions” are balanced (Figure 8).

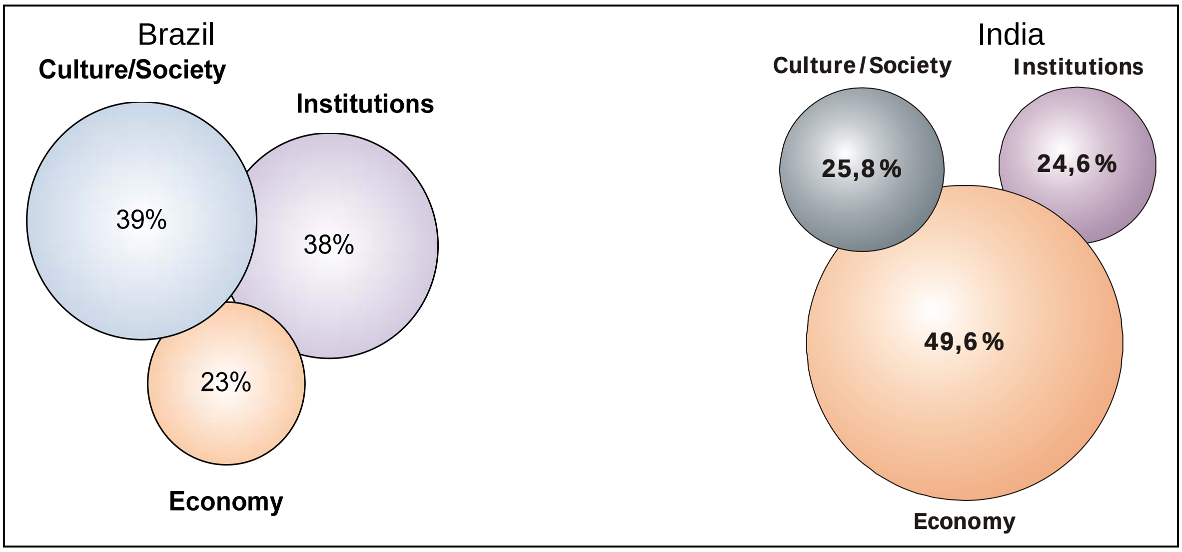


Figure 8 – Road Safety Space: Brazil and India

Results describe the changing situation in Brazil and India. Keeping the potentials of such a change to a more balanced situation in mind, one should not forget the strong influences of culture and be aware that a concept adaptation - not the implantation - with hard and soft components are in some cases preconditions of the safety concepts' acceptability in the targeted recipient entity. It also indicates that concepts have to be seen in the timeline of development before becoming transferable.

Results for single measures

The analysis also found main barriers to implementation of single road safety measures in India and Brazil.

Table 1 andTable 2 show the scores and weights associated with two road safety measures frequently used in Europe: a) implementation of tactile paving for visually- impaired people and b) implementation of road lighting for Vulnerable Road User safety.

Table 1 – Example of assessment of single measures – Tactile paving

		Society/Culture		**Institution**		**Economy**		
		People	**Environ-ment**	**Regulation**	**Political commitment**	**Costs affordability**	**Technical skills**	**Problem score**
Brazil	W	1	1	1	1	1	1	
	S	3	3	3	3	3	1	16
India	W	3	1	1	1	3	1	
	S	2	3	5	5	5	5	39

Using tactile paving was found to be easier in Brazil than in India (total scores are respectively 16 and 39 on a maximum of 150).

In Brazil this measure is considered to directly affect pedestrians (weights are always equal to 1) and as not very challenging in terms of popular acceptance, regulations required, political commitment, and affordability. In addition, this measure is not considered at all challenging in terms of technical skills necessary for its implementation. In general, no major barriers need to be overcome.

The situation is less easy in India, where the tactile paving measure more markedly affects two-wheelers in the areas of costs and behaviors. The measure presents few challenges from the society point of view, but its adoption is considered quite challenging in terms of political commitment, regulation, costs affordability, and technical skills required.

Table 2 – Example of assessment of single measures – Road Lighting for VRUs Safety

		Society/Culture		Institution		Economy		
		People	**Environ-ment**	**Regulation**	**Political commitment**	**Costs affordability**	**Technical skills**	**Problem score**
Brazil	W	4	4	4	4	4	4	
	S	3	2	2	2	2	1	48
India	W	1	2	1	1	3	1	
	S	5	3	3	3	5	5	37

Contrary to the previous example, adopting Road Lighting for Vulnerable Road User Safety was found to be easier in India than in Brazil (total scores are respectively 48 and 37 on a maximum of 150).

In Brazil this measure highly affects vehicle safety (weights are always equal to 4) and is not considered challenging in terms of technical skills necessary for its implementation. The other characteristics present more challenges, even if the scores are in general equal to 2. The main barrier to be overcome is in popular acceptance.

In India, for most of the characteristics considered, the measure directly affects pedestrian safety. Despite this, its implementation is considered very challenging in term of popular acceptance, affordability, and technical skills necessary. The other characteristics are considered not very challenging.

It is clear that what are certain and effective solutions in Europe may still be less viable in India and Brazil, as also proved, for example, from the assessment done for Road Safety Audit procedures in Brazil (where such a tool is currently on trial); indeed, local panelists gave it a partially negative assessment since it may cause delays in project schedules or conflicts between designers and auditors), in spite of the universal acknowledgement of Road Safety Audits as a useful tool for accident prevention (also in other Emerging Economies; e.g. India).

CONCLUSIONS

Any single measure can be theoretically transferred from one place to another, provided it is affordable and technically/legally feasible in the receptor context; but outcomes can be unpredictable. There is plenty of scientific literature on single measures transferred from one city to elsewhere, but even in the successful cases, there is no certainty of further positive “replicability,” which paves the way for two general principles:

a) any measure is theoretically transferable, but what makes it potentially transferable is the full availability of technical data concerning its performance, implementation costs, enforcement of regulatory drivers/barriers, and, above all, information about the level of acceptance among the end-users, which enable participants to assess whether the measure has been successful or not. This is the reason why social and cultural aspects become paramount in the Transferability Audit process;
b) if there exists enough information about the success of a given measure, such a measure can be eligible for transfer only if consistent with the “road safety space” of the receptor context, which moves the focus to the importance of consistency.

Consistency calls for a logical coherence among the three domains that constitute the “road safety space” (i.e. economic resources, institutions and social/cultural patterns) between the origin and the target contexts; such a coherence provides a third transferability principle, suggested also from local negative assessments of what are universally acknowledged as sound safety concepts (as from the aforementioned lesson from the Road Safety Audit evaluation by the Brazilian panelists), i.e.:

c) it is necessary not only to transfer individual measures but also the concepts behind them, specifically the political visions supporting them, which means the export not only of technical know-how but also of consensus building, along with procedures for the long-term assessment of the transferred policies/measures.

Building acceptance and awareness, the ultimate step in importing safety concepts will help to avoid recurring failures, as happens, for instance, when importing technologically-advanced measures to “immature” contexts. Such measures may be initially saluted for their potential, even though such contexts play the role of mere recipients of technologies not locally-developed, with poor control over them. Needless to say, this is an “implant” of measures 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 in part explains some criticisms about the from-west-to-east transferability process itself (Mohan and Tiwari 1998).

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