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**Special Issue**

**Thailand Roadside Safety Strategic Plan**

## **PREFACE**

Dear Readers,

Welcome to the third issue of the JOURNAL OF SOCIETY for TRANSPORTATION and TRAFFIC STUDIES, a new international peer-reviewed on-line journal. Four issues of the journal will be published annually. This issue covers topics ranging from road design guideline implementation in Thailand, a Euro- Thai collaborative road safety action research project; value of life in non-fatal crashes in Malaysia; speed humps; estimation of CO<sub>2</sub> emission; and effectiveness of transit in university environment, and speed on expressway. The special issue covers the important topic of roadside safety.

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## **APPROACH OF A METHODOLOGY FOR ROAD DESIGN GUIDELINE IMPLEMENTATION IN THAILAND BASED ON INTERNATIONAL TECHNOLOGY AND KNOWLEDGE TRANSFER**

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**Abstract:** In the past decades several successful road traffic safety measures were implemented to improve road safety situation in various countries around the world based on international technology and knowledge transfer. A new methodology for implementing design guidelines based on international technology and knowledge transfer is described in this paper. The objective of the proposed methodology is to foster the development and implementation of design guidelines for road infrastructure in emerging and developing countries. The transfer and adaptation of proven European design methods and technologies is an appropriate measure to close existing knowledge gap and help improve road traffic safety in these countries.

The paper was prepared by the partners of the international network “NICE on RoadS – EU-Asia Network In Competence Enhancement on Road Safety” with financial support from the European Commission.

**Key Words:** road traffic safety, technology transfer, knowledge transfer, NICE on RoadS

## 1. INTRODUCTON

Road traffic accidents are a trans-boundary problem affecting European as well as Asian countries. The socio-economic cost of road accidents with immense human suffering is far too high a price to pay for mobility. Around the world, national and international organisations have set the reduction of the number and the severity of road accidents as one of their major transport policies.

For instance in 2001 the European Commission declared in the **White Paper** “*European transport policy for 2010: time to decide*“ the ambitious objective to reduce the number of fatalities on roads by half by 2010. Also several Asian countries proclaimed similar objectives in their countries. For instance in Thailand the **Thailand Road Safety Manifesto (TROSAMAN)** proclaimed the goal to substantially reduce the number of road deaths by setting the objective of saving 5.000 lives in 5 years.

“For the past five years, 2002-2006, some 66,300 people died in road traffic accidents in Thailand or an average of 13,260 deaths per annum. Some 5,0 million people were injured, some of them severely. The economic loss resulted from traffic accidents were estimated at 232,000 million Baht, corresponding to approximately 2,81% of the country’s Gross National Product” (Thailand Road Safety Manifesto, 2007).

In 2009, the Thai government has adopted a similar target to those proclaimed by the UN Road Safety Collaboration which called for 50% reduction in number of fatalities worldwide by 2020.

The **World Health Organisation** (WHO, 2004) pointed out the need for activities to counteract the current situation, otherwise “without increased efforts and new initiatives, the total number of road traffic deaths worldwide and injuries is forecast to rise by some 65% between 2000 and 2020, and in low-income and middle-income countries deaths are expected by as much as 80%”

In response to this problem the WHO (2004) has recommended that “in developing countries, ..., 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 among other lowincome countries”.

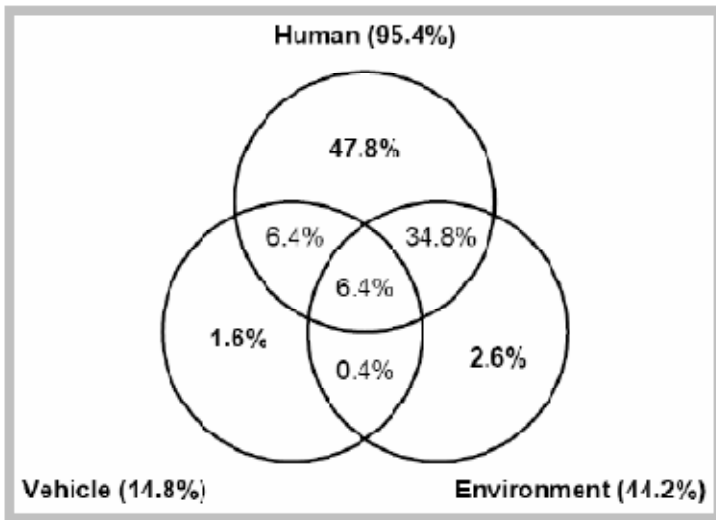
Following this recommendation, a new approach for design guideline implementation based on international technology and knowledge transfer” will be described in this paper. This approach, which is as far as the authors know, is the first of its kind being carried out in Thailand in the area of road design, gives an overview of working steps and important aspects which should be considered for an efficient technology and knowledge transfer in order to effectively improve road traffic safety.

This paper was prepared by the partners of the international network “NICE on RoadS” in the framework of the Thai-EC project “Improving Road Traffic Safety in Thailand – A Common Challenge for European and Thai Universities” with financial support from the European Commission ([www.nice-roads.com](http://www.nice-roads.com)).

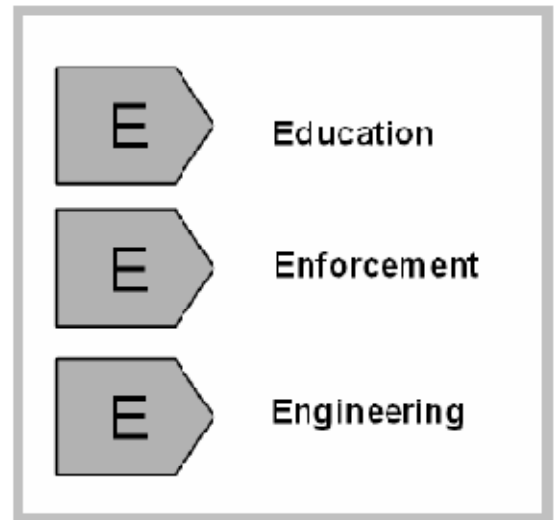
## 2. INFLUENCING ELEMENTS - AREAS OF ROAD TRAFFIC SAFETY ACTIONS

A study originally published by Treat (1977) revealed that the influencing elements HUMAN, VEHICLE and ENVIRONMENT are to be blamed for the occurrence of accidents. Following this approach a traffic accident is a result of the failure of at least one of these elements as shown in *Figure 1a*.

A lot of influencing variables can be assigned to the influencing elements, for instance: Element 1: “HUMAN” includes the behaviour of the drivers and other road users; Element 2: “VEHICLE” includes e.g. the intrinsic safety of the vehicles with the view on technical aspects; Element 3: “ENVIRONMENT” includes amongst others the intrinsic safety of roads and environment with the view on the design of road infrastructure.



**Figure 1a. Influencing elements on road traffic safety (Treat, 1977)**



**Figure 1b. Triple-E Model**

Furthermore one can distinguish between three action areas which comprise measures to address road traffic safety problems - also known as “Triple-E Model” (see *Figure 1b*).

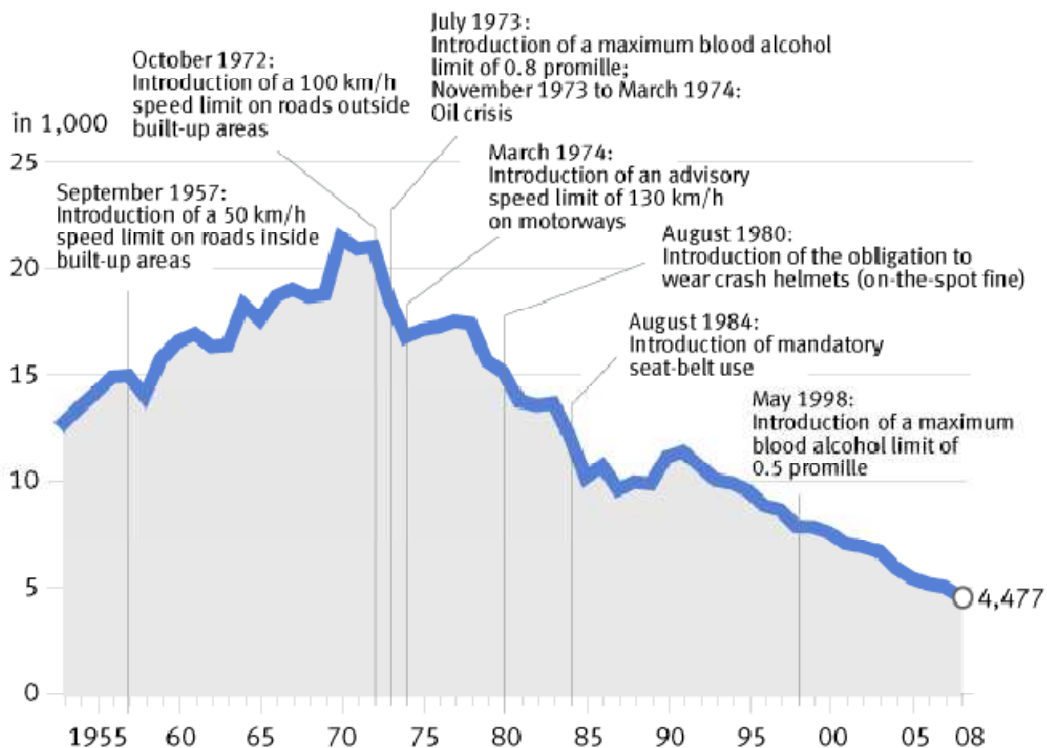
The first “E” (**E**ducation) comprises different education related measures to improve road safety like e.g. training courses for drivers or children. The second “E” (**E**nforcement) comprises measures which punish road users if they do not follow official rules and regulations in road traffic like for instance drunken driving

or exceeding speed limits. The third “E” (**Engineering**) deals with measures relating to engineering aspects, here for instance with the design of road infrastructure which have, beside other sub-areas of engineering (e.g. design of vehicles, etc.) a significant influence on road traffic safety.

### 3. EFFICIENT ROAD SAFETY MEASURES

In the last decades different road safety measures were implemented in European countries to improve road safety. These road safety measures addressed all influencing elements and action areas as mentioned above.

The trend in fatalities in road traffic accidents in Germany is shown in *Figure 2* as an example during the period 1953 to 2008. Some selected road safety measures and the respective points of introduction are marked in this figure. Measures like the introduction of speed limits, maximum blood alcohol limits, obligatory use of helmets and seat belts contributed to improved road traffic safety. Of course, beside the measures mentioned, other aspects like e.g. the technical development of vehicles and developments in the design of road infrastructure also had a strong influence on road traffic safety. Nevertheless it is estimated that the above mentioned measures had a significant influence on the decrease of the number of fatalities in road traffic accidents in Germany.

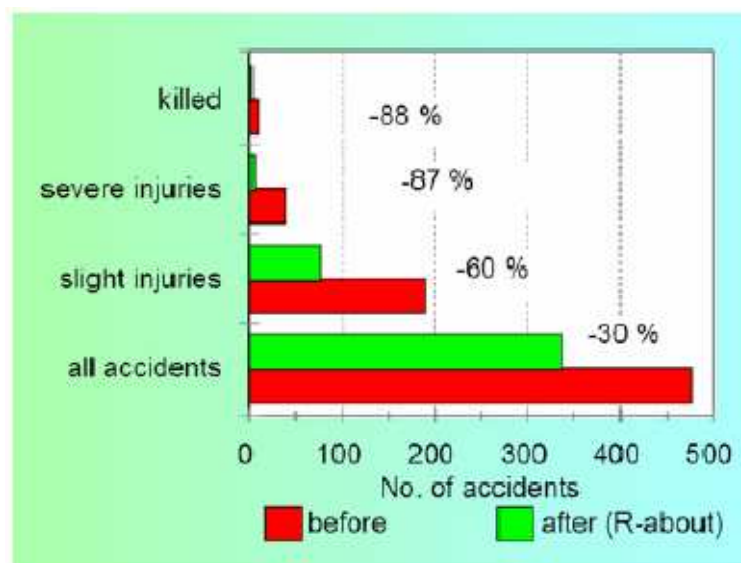


**Figure 2. Trend in the number of fatalities in road traffic accidents in Germany**  
**Source: Statistisches Bundesamt (2009)**



Various road traffic safety measures and methods were successfully implemented related to the influencing-element “ENVIRONMENT” and the action-area “Engineering” in Germany in the last decades. In a series of cases the new measures and methods were the result of international technology and knowledge transfer, like e.g. the implementation of Road Safety Audits in the planning process of roads. Here German experts took comprehensive experiences from other countries around the world, e.g. European countries Australia, into consideration in the preparation process of their national guidelines.

Another impressive example is the introduction of the compact one-lane roundabout as a new intersection type in Germany about two decades ago. Good experiences gained from this intersection type in several countries, e.g. France and the United Kingdom were the main reason why this intersection type was introduced in Germany. Nowadays an estimated 3000 to 5000 compact one-lane roundabouts are in operation in Germany (Brilon, 2008). Several comparisons and before-after studies came to the conclusion that compact one-lane roundabouts can serve traffic volumes with a high safety level. For this reason the application of this intersection type is acknowledged as an appropriate measure for redesign of existing intersections (see *Figure 3*) and for the design of new intersections in the road network.



**Figure 3. Before-after study of intersections which were rebuilt to compact one-lane roundabouts in Germany, Source: Brilon (2008)**

Similar experiences were also obtained with roundabouts in various countries around the world as shown in Table 1 (FHWA, 2000).

**Table 1. Mean crash reductions by re-design of intersections into roundabouts  
Source: FHWA (2000)**

Country	Mean Reduction (%)	
	All Crashes	Injury Crashes
Australia	41-61%	45-87%
France	-	57-78%
Germany	36%	-
Netherlands	47%	-
United Kingdom	-	25-39%
United States	37%	51%

Figures shown in Table 1 give a clear example to the fact that the implementation of similar design approaches in the design of road infrastructure around the world was an effective measure to improve road traffic safety. Efficient transfer of technologies and related knowledge between organisations and institutions at international and national level can foster the process of implementation and diffusion of successful design methods of road infrastructure.

Several other design methods and measures and their impact on road traffic safety are explained by provision of comprehensive comparison studies by Elvik et al. (2009).

#### **4. TECHNOLOGY AND KNOWLEDGE TRANSFER**

##### **4.1 Context**

The WHO (2004) recommended technology and knowledge transfer as an appropriate way to improve road traffic safety: “in developing countries, ..., 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 among

other low-income countries”. This statement can also be applied to emerging countries like Thailand.

Following this recommendation different road safety manuals were published in the last years e.g. by World Health Organisation (WHO), Global Road Safety Partnership (GRSP), PIARC World Road Association and FIA Foundation (FIA) in order to foster the implementation of successful road safety measures (cf. *Figure 2*) like:

- wearing helmets (WHO, 2006),
- counteracting drinking and driving (GRSP, 2007),
- introducing road safety audits (PIARC, 2007),
- introducing speed management (GRSP, 2008),
- and considering seat-belt use and child restraints (FIA, 2009).

Furthermore several guidelines for the design of road infrastructure were implemented in various European countries with essential input based on international technology and knowledge transfer in the last decades.

Following the recommendation of WHO and good experiences made in Europe, the network partners of “NICE on RoadS - EU-Asia Network in Competence Enhancement on Road Safety” are of the opinion that development and implementation of new design guidelines, based on international technology and knowledge transfer can contribute significantly to safer roads in Asian countries like Thailand in the future.

The impact of improved road infrastructure (influencing element: ENVIRONMENT) on road traffic safety can be estimated on basis of *Figure 1a*.

In the framework of the Thai-E.C. project “Improving Road Traffic Safety in Thailand – A Common Challenge for European and Thai universities” five partner universities from Germany, Hungary and Thailand are developing and testing a “Methodology for design guideline implementation based on international technology and knowledge transfer”.

With the planned methodology the partners want to foster the implementation process of design guidelines based on international technology and knowledge transfer in Thailand.

In this paper a first approach of the structure of the methodology is introduced.

#### **4.2 Terms and definitions of technology and knowledge transfer**

The term “technology transfer” can be defined as the diffusion of technological knowledge inside an economic area or from an industrialised to a developing country (Woll, 2008). Another similar definition defines technology transfer as the transfer of technological knowledge (e.g. research and development results) for application in production process. Here technology transfer can be realised between universities, inventors,

research units and companies, between multi national companies, between different companies, between industrial countries, between industrialised countries and developing countries (Brockhaus, 1998). Transfer of practical and educational knowledge is not part of technology transfer (Brockhaus, 1998) and can be identified as knowledge transfer.

Following the two definitions the term “technology transfer” can be regarded in the context of this paper as follows:

**Technology transfer** in the field of road traffic infrastructure is the transfer of technological knowledge (research results, available guidelines and best practice) for application in the design process of road infrastructure, including the adaptation to national and local specifics.

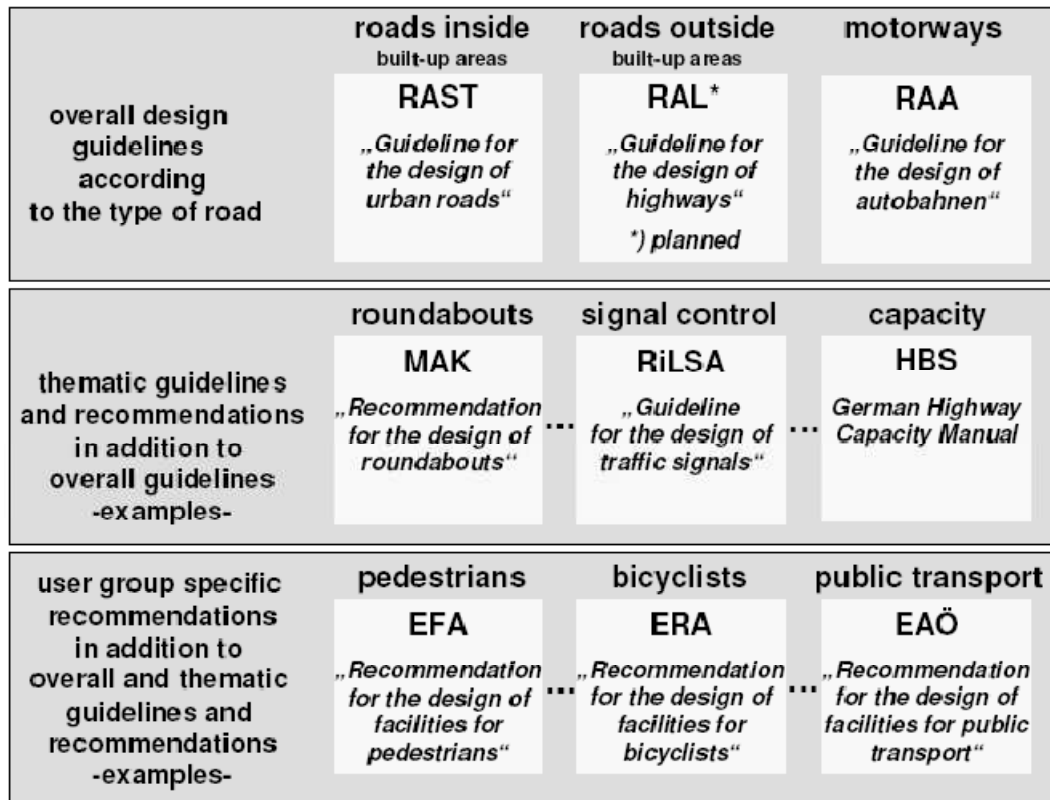
Technology transfer can be realised e.g. between universities, research units and further organisations from industrialised and developing/emerging countries.

Whereas knowledge transfer can be regarded in the context of this paper as follows:

**Knowledge transfer** can be defined as the exchange and transfer of practical and educational knowledge between universities, research units, organisations and further experts, stakeholders and interested persons e.g. in the design of road infrastructure or road traffic safety.

#### **4.3 Design guidelines - status quo in Thailand and Europe**

In European countries rules and regulations for the design of road infrastructure are normally defined in guidelines which are compulsory or partly recommendatory. If road and traffic engineers follow these rules and regulations, the design should have a high safety level.



**Figure 4. Structure of design guidelines used in the design of road infrastructure in Germany**  
**Source: Vesper (2009)**

German and Hungarian road engineers have for instance access to various design guidelines and recommendations which cover nearly all aspects of the design of road infrastructure. The selection of respective guidelines and recommendations, which need to be considered in the design process, depends mainly on the type of road, the subject of design and the affected road user groups by the planned road infrastructure. The structure of available German design guidelines is shown exemplarily in *Figure 4*.

Thai road engineers often have no such guidelines to follow because only a few national guidelines exist and relate to only a few topic areas. Even for topics where they are available, for most areas, no research based knowledge exists, which would adapt foreign guidelines or standards to national conditions. Instead of national guidelines, often guidelines from other countries like Japan, Australia or the United States are used and they are only available in foreign language and are not adapted to national conditions in Thailand. In many cases, road and traffic engineers, for lack of appropriate guidelines, have to design road infrastructure based only on individual decisions, assumptions or estimations which could be the reason for the inadequately designed roads especially from the point of road traffic safety.

Experiences of road safety audits and results of research projects executed by Thailand Accident Research Centre (TARC) confirm this statement. There is therefore an urgent need to develop Thai national guidelines for the design of road infrastructure in different topic areas in order to provide for Thai road and traffic engineers the research-based knowledge for the design of road infrastructure and traffic control.

#### 4.4 Structure of Methodology

The “Methodology for design guideline implementation based on international technology and knowledge transfer” comprises different working phases with involvement of institutions, organisations and target groups which belong to different knowledge-levels. The structure of methodology is shown in *Figure 5*.

The **first part of the methodology is the technology transfer** of available design technologies from Europe to Thailand. Here design methods will be exchanged between international research organisations and institutions on the same knowledge level (horizontal transfer). Based on the results of the activity “exchange”, the transferred design technologies need to be adapted to national conditions. With adaptation one considers differences of behavioural aspects of road users as well as general aspects in the design like right/ left-hand driving, traffic signs or traffic

rules in the design guidelines. In general one should consider that it depends on the specific subject, method or parameter of design technology, whether it needs to be adapted to national conditions or not. Here the spectrum of adaptation is in between the range of no adaptation up to full adaptation. Beside engineering aspects the adapted knowledge should meet requirements of the target groups “scientific institutions, associations and committees”, “universities and technical colleges” and “engineers and practitioners”. Here especially the scope and the preparation of knowledge should meet the respective requirements.

The adapted design technologies are ready for implementation in the **second part of the methodology – the knowledge transfer**. The main objective of this part is the knowledge transfer of generated and adapted knowledge from research level to lower knowledge levels like education, user and impact level (vertical transfer). Diffusion of knowledge can be realised amongst others by publications, campaigning, training and education as shown exemplarily in *Figure 5*. The diffusion of knowledge is an essential part of the proposed methodology because it makes the knowledge available for target groups in practice. Improvement of road traffic safety can only be achieved if the generated knowledge achieves the target groups and will be applied in practice.

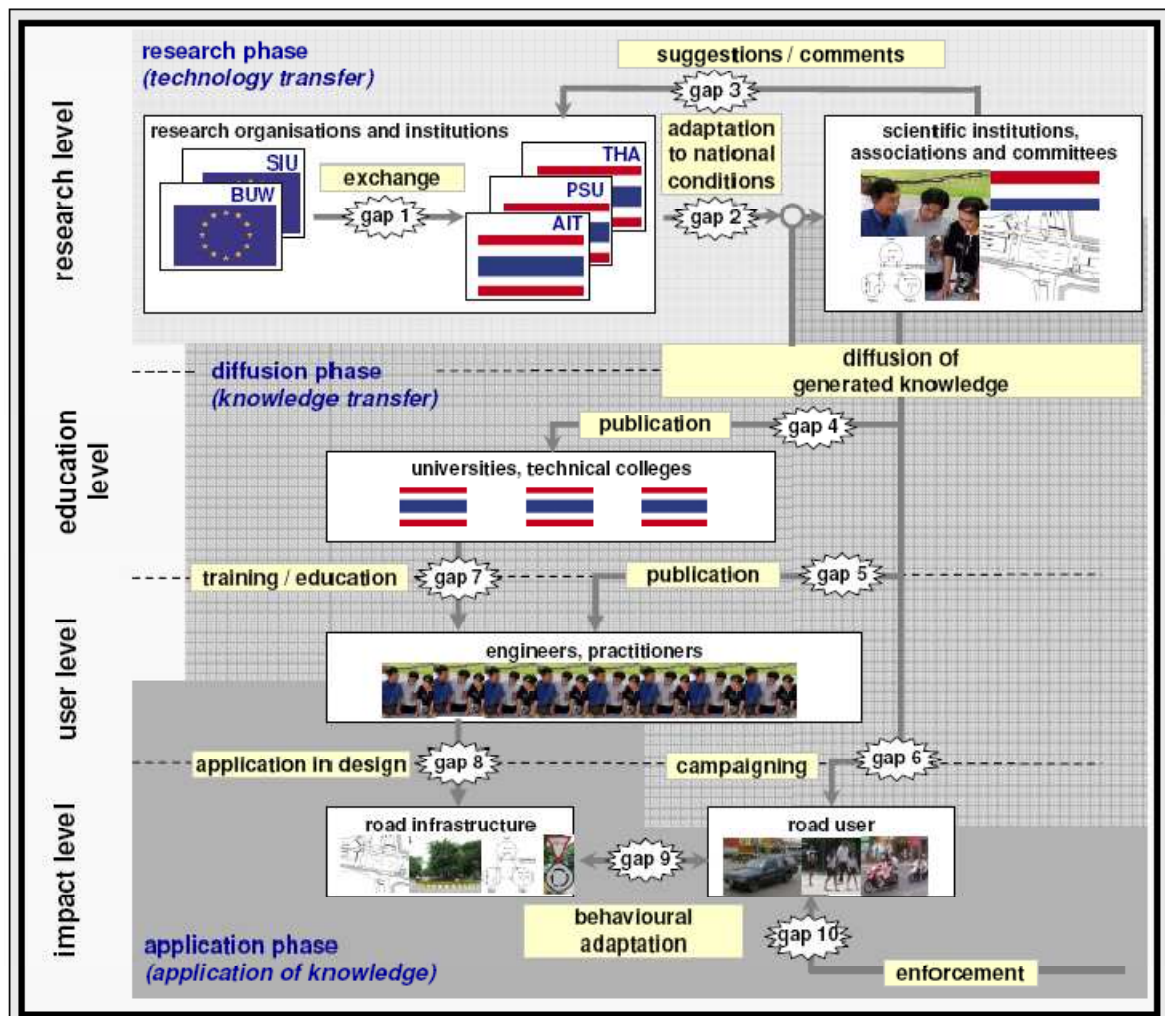


Figure 5. Structure of methodology for design guideline implementation  
Source: Vesper (2009)

The **third part of the methodology – the application of knowledge** - comprises the application of generated knowledge in the design of road infrastructure as well as in the use of road infrastructure by road users in practice. Here new design methods need to show their impact on road traffic safety. Further measures, like enforcement can contribute to behavioural changes of road users and can contribute to higher acceptance of new design methods.

#### 4.5 Target groups

In order to implement the design guidelines successfully, several target groups need to be addressed. The design guidelines should meet amongst others the requirements of the following target groups:

- universities and technical colleges (multipliers of generated knowledge on education level),
- engineers and practitioners (users of generated knowledge on user level),
- road users which belong to different user groups (beneficiaries of generated knowledge on impact level),

- scientific institutions, associations and committees for these purposes (promoting the process of design guideline implementation).

Institutions and organisations that are responsible for legal implementation of design guidelines as well as for the process of legal guideline implementation are not considered in this paper because this process differs in each country significantly. In this paper the legal implementation is mainly regarded as a parallel process. For this reason it is not mentioned in *Figure 5*.

**4.6 Acceptance gaps in methodology**

The methodology of design guideline implementation can be subdivided in different phases. Here one can distinguish between the research, diffusion and application phase. In each phase several institutions, organisations or person-groups from the same or different knowledge levels are involved in the process. Subject of each implementation phase are one or more specific activities which will be

realised during the phase. The chronological order of activities depends on the phase considered and can be conducted in general alternatively one after another or simultaneously, as shown in *Figure 5*.

As mentioned above, different parties (institutions, organisations or person groups) are involved in the implementation process and in this way they are involved also in the activities of the three implementation phases. The involved parties have often different characteristics (like objectives, requirements, behaviour ...), which can lead to acceptance gaps (gap 1 to gap 10) in the process of design guideline implementation (see *Figure 5*). In consequence of this fact, one main precondition of a successful “design-guideline implementation” is the overcoming of the mentioned acceptance gaps during the application of the methodology. In *Table 2* and *3* typical issues or respective problems are listed exemplarily which could be the subject of acceptance gaps.

**Table 2. Acceptance gaps in the methodology for design guideline implementation (part A)**

phase	activity	selected issues/problems which could be subject of acceptance gaps
research phase	exchange	- determination of the subject of technology transfer, - selection of appropriate methods and measures for technology transfer.
	adaption to national conditions	- differentiation of methods and parameters, which can be / should be adapted or not (wide spectrum from no adaptation to full adaptation to national conditions, depending on considered methods and parameters), - adaptation of guideline structure and content according to requirements of target groups, - consideration of behavioural aspects of road users in adaptation process.

**Table 3. Acceptance gaps in the methodology for design guideline implementation (part B)**

<b>phase</b>	<b>activity</b>	<b>selected issues/problems which could be subject of acceptance gaps</b>
diffusion	publication	- way of guideline provision for target groups, - language of publication, - missing recognition for need of new guidelines.
	campaigning	- missing understanding of rules and function of new design methods / measures by road users, - behavioural opposites to new design methods / measures.
	training/education	- need for consideration of new design methods and measures in lectures and training courses, - readiness to adapt content of current lectures and training courses, - provision of training and pre-training courses to target groups.
application	application in design	- availability of new design methods for target groups, - practicability of new design methods, - comprehensibility of new design methods, - recognition by public authority, awarding authority, etc.
	behavioural adaptation	- impact of new infrastructure design on behaviour of road user (physical and mental impact of new design method on road user), - impact on workload of road user (cf. Fuller, 2005).
	enforcement	- necessity of compulsory measures to influence behaviour of road users, - general effectiveness of enforcement measures.

#### **4.7 Application of methodology**

In the framework of the Thai-E.C. project “Improving Road Traffic Safety in Thailand – A Common Challenge for European and Thai Universities” the proposed methodology for design guideline implementation will be practically tested by the implementation of two design guidelines in Thailand.

Here one design guideline will deal with the “Design of traffic control at signalised intersections” and a second one with the “Design of roundabouts” in Thailand.

The outlines of the two guidelines are introduced by Vesper et al. (2010) and Koren et al. (2010) in more detail.

#### **5. FORECAST**

It is acknowledged that the design of road infrastructure has a strong influence on road traffic safety. According to Treat (1977) more than 40% of accidents are influenced by the element “Environment” which comprises road infrastructure.

Several studies (Brilon, 2008, FHWA, 2000, Elvik et al., 2009) have shown that proven design methods and measures – e.g. with the view on road traffic safety - can be transferred successfully from one country to another.

The new approach to developing a methodology for design guideline implementation gives an overview of the implementation process of design guidelines based on international technology and



knowledge transfer. The methodology will foster the implementation of design guidelines and the application of research based knowledge in the design process of road infrastructure.

The authors are convinced that the guideline implementation and the associated design of safer road infrastructure will be a main measure to improve road traffic safety and to counteract the current road traffic safety situation

especially in emerging and developing countries in the future.

## 6. ACKNOWLEDGEMENTS

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