Road Safety Audit: A comparative Review of Current Guidelines and Designers' Approach

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ABSTRACT

Road Safety Audit (RSA), as a formal system of checking roadway schemes for safety problems, was originally adopted in Great Britain and spread to many countries throughout the world. RSA is considered the major and most cost-effective proactive road safety measure. Several national guidelines have been published providing guidance and information on how the RSA process should be carried out.

The present paper focuses firstly on a comparative review of the three main current RSA guidelines internationally: those published by Austroads in 2009: those published by the British Institution of Highways and Transportation (IHT) in 2008 and those published in the USA in 2006, by the Federal Highway Administration (FHWA). Relevant legislation and standards were also taken into account while undertaking this comparative review. More specifically both the European Commission's Directive 2008/96/EC on Road Safety Infrastructure Management, issued in 2008, as well as the British standard HD 19/03 for Road Safety Audits, issued in 2003, were considered.

A survey was also carried out in order to determine the approach of highway designers in Greece to this –recently introduced in the country– safety measure. In-depth interviews with designers were carried out on the basis of a questionnaire set up in advance by the authors.

The findings of this paper may contribute to the enhancement of the existing RSA guidelines, as well as to the development of relevant guidelines in countries such as Greece, where the RSA is to be introduced.

Keywords: *Road Safety Audit (RSA), RSA Guidelines, Road Design, Road Safety Auditors, Traffic safety culture.*

INTRODUCTION

Road Safety Audit (RSA) was introduced in the United Kingdom during the 1980s. The main reason for its introduction was that road safety engineers in the country's highway authorities were implementing casualty reduction schemes on roads that were designed and constructed in accordance with the latest design standards (IHT, 2008). This phenomenon was the cause for understanding that firstly, a road design which complies with the technical standards is not necessarily safe and secondly, that the likelihood of collisions should be reduced before the road is used. Thus, instead of waiting until the collision problems appeared on recently constructed schemes, road safety engineering expertise was applied so as to prevent road accidents from occurring (IHT, 2008). In 1990, the first RSA guidelines were published by the Institution of Highways and Transportation. These guidelines were revised in 1996 and 2008. It is noted that, apart from the guidelines, the British Department for Transport added to its Design Manual for Roads and Bridges (DMRB) an advice note (HD 19/03) which is currently the national standard describing the RSA process (DfT, 2003). This national standard –as part of the DMRB– is mandatory for use on trunk roads and motorways but not on local roads.

Road Safety Audits were introduced in 1990 in Australia and New Zealand, after several exchanges and visits of road safety engineers from these two countries and the United Kingdom (Morgan, 2005). Through these exchanges and visits, the British experience in carrying out RSAs was passed on to the Australian and New Zealander engineers. The first RSA guidelines were produced in 1994 by Austroads, the association of Australian and New Zealand road transport and traffic authorities (Austroads, 1994). The publication of the

second edition of the Austroads RSA guidelines followed in 2002 and the third edition was published in 2009. In the third edition of the Austroads guidelines, which is currently in use, significant changes were incorporated including references to the safe system approach to road safety and tools to assist with the RSA process.

In 1996, the Federal Highway Administration (FHWA) sponsored a scanning tour in Australia and New Zealand (FHWA, 2006), giving the opportunity to its engineers to study the Australian road safety audit programmes in order to become familiar with strategies on how to implement RSAs in the USA (Heaslip J. et al., 2010). The first RSA pilot program was then introduced to thirteen States. By 2010, the number of the States where RSAs were conducted had nearly doubled and, gradually, RSAs are becoming more and more accepted throughout the country (Heaslip J. et al., 2010). The first FHWA RSA guidelines were published in 2006 to provide, according to its authors, "*a foundation for public agencies to draw upon when developing RSA policies and procedures and when conducting RSAs within their jurisdiction"*, with the aim that they would *"further the integration of RSAs into everyday engineering practice"*. Apart from the guidelines mentioned above, FHWA has documented a report including ten RSA case studies carried out in several States of the country (FHWA, 2006a). In addition, pedestrian-specific as well as bicyclists-specific RSA Guidelines were published by the same body (FHWA, 2007) (FHWA, 2012). Furthermore, the European Commission's Directive 2008/96/EC on Road Safety Infrastructure Management and the British standard HD 19/03 were also taken into consideration for this review. This advice note was issued by the British Department for Transport in 2003 and it is currently the British regulation (i.e. the official national standard) for Road Safety Audits. In a more general perspective, the European Directive aims to integrate safety into planning, design and operation of the Union's Trans-European Network (DfT, 2011); Member States should integrate this directive in their national legislations and standards. With this Directive, the interoperability of procedures within European countries –and especially within European Union Member States– is established on the Trans-European road network. This could be an opportunity for the enhancement of road design standards through a possible future homogenization of those within the EU.

This paper focuses firstly on a comparative review of the Austroads RSA Guidelines that were issued in 2009 in Australia, the British RSA Guidelines which were published by the Institution for Highways and Transportation in 2008 and the RSA Guidelines of the Federal Highway Administration that were published in the USA in 2006.

Secondly, the present paper includes a survey carried out in Greece which investigates highway designers' approach regarding Road Safety and Road Safety Audits as part of their work. Road Safety Audit was legislated for in Greece in the end of 2011, following the European Directive 2008/96/EC issued in 2008. As a new process to be implemented, RSA could be seen as an opportunity to develop a road safety culture among designers.

COMPARISON OF THE RSA GUIDELINES

As it was noted in the introduction, the RSA was "born" in the United Kingdom; it was then passed on to Australia and New Zealand where it was significantly enriched and enhanced; finally the USA Road Authorities, having been convinced of the benefits of the RSA in Australia and the UK, started exploring the opportunities that this process offers. It is widely accepted (Bulpitt, 1996) (Morgan & Jordan, 2000) that the RSA Guidelines produced in the countries above were pioneers in promoting the key idea-reason for carrying out an Audit, which, simply put, is that Design Standards do not guarantee a safe design. The USA guide, on the other hand, is a useful handbook especially for countries –like Greece– that are

currently in the process of integrating the RSA in their own road safety programmes. Therefore, comparing the RSA Guidelines published in these countries was deemed as the best way to understand how the RSA process evolved internationally.

Nevertheless, it is noted that other countries like the Netherlands, have managed to maintain high levels of road safety without the process of Road Safety Audit being widely applied in their road schemes. According to SWOV (2012), although the RSA is legislated for in Europe, it "*is not applied on a large scale in the Netherlands*". Furthermore, in a report prepared by van Schagen (2000), quoted in SWOV (2012), it is mentioned that, inter alia, some road authorities failed to understand the benefits from distinguishing the RSA from other processes that have to do with the design and planning of a scheme.

The aim of this paper is to focus on a comparative review of RSA Guidelines in countries where the RSA is mostly infiltrated into the planning, design, construction and management process of road schemes and, of course, where RSA Guidelines have been prepared, published and implemented. The comparison between the aforementioned guidelines was carried out considering the following key elements: the defining philosophy of each guide; how vulnerable users are addressed in each one; the relation of each RSA guide to the road design standards; the approach of each guide to the road safety audit "checklists" and the benefits of the RSA process to the designer. In the following we address similarities and differences between these three Guidelines. Differences are actually viewed as variations in the emphasis put on the above key elements or specific issues that are discussed in the sections to follow.

It is important to point out that there is a clear consensus within the three guidelines on the basic elements that define the Road Safety Audit. Indeed, they all agree that the RSA is a formal examination, a systematic assessment of the road safety performance of an existing or future road or intersection, carried out by an independent multidisciplinary team of people with the appropriate experience and training (Austroads, 2009) (IHT, 2008) (FHWA, 2006). In addition, it is a common argument underlined in all guidelines that the safety audit has to address the safety issues affecting all road users, it must report the opportunities for safety improvement and, finally, it must not be confused or interfere with any kind of technical audit or check of the road scheme, either at the design or the operation level. Despite the above convergence of the guidelines on the essentials of the audit process, different approaches can be spotted when one tries to compare the three documents.

Road Safety Audits were introduced in the USA following the Australian model (Navin, F. et al., 1999). However, the corresponding RSA Guidelines in the United States focus more on the process of the Road Safety Audit (i.e. on how local highway authorities should adopt the RSA process into their programme) rather than the safety principles of the audit process, on which the Australian guidelines shed more light. The British Guidelines (IHT, 2008) and the corresponding national standard (DfT, 2003) provide adequate information both on the formal "step-by-step" process (for example on how the audit process should be carried out according to the national standards, how to develop a related policy on a local government level etc.) and on several principles of safety, by means of presenting examples or case studies that include photographs and plans. This kind of information is comparatively limited in the US RSA Guidelines; however, it is noted that real RSA case studies are separately provided in a report issued by FHWA (2006a).

Furthermore, it is noted that although the very first RSA guidelines worldwide were published in the UK in 1990, M. Bulpitt, one of the authors of the first British guidelines characterised the Austroads (1994) guidelines as "*the definitive document on safety audit, for its messages and recommended procedures transcend hemispheres and are applicable*

anywhere in the developed world" (Bulpitt, 1996). Moreover, the first Austroads guidelines, published in 1994, were also recognised as a very easy to read document by Morgan R. and Jordan P. (2000).

Indeed, the Austroads RSA guidelines, especially the third edition, is a handbook that not only offers guidance on the formal step-by-step process of the RSA, but also includes a variety of information and prompts, allowing its users (who are possibly road safety auditors or designers) to enrich their knowledge of recent research and experience-related findings in road safety engineering. The reference to the "Safe System Approach", which is included in the current 2009 edition of the Austroads guidelines, is an example in this direction.

In addition, several practical examples which are relevant to each chapter or paragraph are reported throughout the guide. For instance, when analysing the aspects of the road safety audit of the preliminary design stage, the authors of the Austroads Guidelines provide a practical example of a rural highway on-ramp link. What is more, a whole chapter of the guidelines is dedicated to reporting and analysing case studies based on actual road safety audits.

The defining philosophy of each RSA guide

In the British Guidelines' introduction, the highway's contribution to human error, which may lead to a crash, is recognised. A key question that has to be answered in order to understand this contribution to highway collision is: "*Why did this road user fail to cope with their road environment?*" (IHT, 2008). Following this fundamental concept, the IHT guidelines specify the role of the Road Safety Auditor, as the person who is to ask the following two questions, when looking at a design or a newly constructed scheme (IHT, 2008):

– *"Who can be hurt in a collision on this part of the highway, and how might that happen?"* and
– *"What can be done to reduce the potential for that collision, or to limit its consequences?"*

The questions above, combined with the motto of the British RSA guidelines from the very first edition that "*prevention is better than cure*", form the defining British approach to the RSA process.

The FHWA (2006) guidelines, as mentioned in the introduction, are considered a document which serves to assist the local highway authorities when conducting RSAs, or when developing road safety–related policies and procedures. The main approach to the RSA process is the existence of flexibility when integrating the RSA process in an agency's programme, which, according to the FHWA (2006), should be done in such a way that "*public agencies need to make RSAs work for them*".

The Austroads Guidelines' approach to the RSA is primarily based on the "Safe System Approach" (Austroads, 2009), a term originating from Sweden's "Vision Zero" (SNRA, 2006) and the Dutch "Sustainable Safety" strategies (SWOV, 2006) (Kanellaidis G. & Vardaki S., 2011). The Safe System introduces a humanitarian approach to road safety and is built on the basis that, although accidents cannot be fully prevented due to the road users' fallibility, the impact forces on human bodies in a crash should be such that *"no deaths or serious injuries occur in road traffic"* (OECD/ITF, 2008). Apart from the "Safe System" approach, the Australian guidelines' philosophy may be described by the quote "Getting it right the first time", which is a concept used primarily in quality assurance. This general objective can be applied for example in the audit process, where those involved (designers,

auditors, project managers etc.) seek to ensure the road operates 'right the first time' once it opens, with road users making fewer mistakes (Austroads, 2009), leading in this way to a less costly and also more effective road network. In road design, the idea is for designers to 'get the design right' from the beginning, i.e. make fewer 'safety mistakes' that will, in turn, be spotted as early as possible. By being more conscious about safety when designing, designers save both time and unnecessary costs related with future modifications of the initial plans and/or designs (Austroads, 2009).

Vulnerable road users

It is widely accepted throughout the guidelines examined that RSAs should not only focus on motorised traffic, but should equally consider the needs and limitations of all potential road users (FHWA, 2006) (Austroads, 2009) (IHT, 2008). Focusing on the needs and limitations of all road users, including the most vulnerable ones, is an aspect of the RSA process which seems to be mentioned in the Austroads guidelines in more detail, compared to the other two. More specifically, the chapter which describes the 'safety principles' of the Austroads (2009) guide includes detailed information on how to design generally for all road users –something which is also included in the IHT (2008) guide– but also on how to design for safe speeds, for older road users, for pedestrians and for motorcyclists. In this section, the needs and limitations of vulnerable users are clearly stated. This is a fundamental starting point for any auditor, who has to audit/check the design through the eyes of all road users. Although the other two guidelines refer to the term "vulnerable user" throughout the text, they do not provide any specific information for their needs and limitations.

The relation of each RSA guide with the road design standards

As mentioned in the introduction, the need to carry out Road Safety Audits first emerged when newly constructed road schemes designed to standards presented a poor crash performance. The audit process is a continuous structured and systematic exchange of information between auditors and designers that leads to the improvement of the design from a safety perspective. More specifically, the guidelines for Road Safety Audit can supplement the design standards and thus prove to be a catalyst to help the designers. The iterative feedback process between the audit and the design could also benefit the gradual update of the design standards.

With regard to the relation of the RSA and the road design standards, there is a common view throughout the examined guidelines, which agrees with the discussion (Kanellaidis G., 1996) (Hauer E., 1999) (Morgan R. & Jordan P., 2000) that compliance with road design standards does not guarantee a safe design, nor does failure to comply with the standards necessarily lead to an unacceptable design from a safety perspective (FHWA, 2006). The Australian RSA guidelines state that "*standards are an important starting point in any road design*" (Austroads, 2009) and the FHWA guidelines add that standards compliance should be checked, "*if non-compliance is a relevant road safety issue*" (FHWA, 2006). Overall, it is widely accepted that the RSA is definitely not a way of merely checking compliance with technical standards (Kanellaidis G., 1999; Austroads, 2009) (IHT, 2008) (FHWA, 2006).

In the United Kingdom, the Departmental Standard HD 19/03 for the Road Safety Audit (Volume 5 of the DMRB – Assessment and Preparation of Road Schemes) is included in the Design Manual for Roads and Bridges (DMRB) and is actually as much a part of the DMRB as any other technical standard (IHT, 2008) (DfT, 2003). In this way, designers who are concerned with road safety issues when planning, designing or even operating a road (or a

road network), can easily have access to this standard, since it is included in the Manual that they already use in their work (DMRB).

However, since this standard (HD 19/03) is used by safety auditors, the aforementioned practice does not guarantee that recent safety and human-factors developments, expressed as principles of the RSA that are written in the specific standard, will be passed on to the highway designers. A promising way of achieving the objective is the effective integration of relevant information from the fields of the safe-system approach, user-centred design and road-safety auditing, into highway geometric design guidelines (Kanellaidis G. & Vardaki S., 2011). In this way, the designers will merely be using an updated version of the standards that they are already familiar with.

The approach of each guide to road safety audit "checklists"

It is accepted in each guide that checklists should not be used as simple 'tick sheets' (Austroads, 2009); instead, they should assist the safety audit process as a memory aid or a prompt to ensure that no potential or important safety issues (i.e. a category of road user) are ignored (IHT, 2008) (FHWA, 2006). They should also not be seen as exhaustive or inclusive of all safety issues, since different circumstances in each scheme lead to the need for a different approach in checklists (FHWA, 2006). Austroads' (2009) viewpoint that "*Checklists are a means to an end, not an end in themselves*" seems to summarize the concept of using the checklists properly.

The appellation of checklists in the US Guidelines as *'prompt lists'* is a way of making their users to see them only as prompts and not as 'expert lists' that should be ticked off. In addition, the prompt lists that are included in the FHWA Guidelines are only general, meaning that they only address "general topics". Their purpose is to encourage RSA team members to get into specific issues after they have considered the more general ones (FHWA, 2006). Auditors are therefore encouraged to write their own detailed checklists, tailored to each road scheme and each stage. In the Austroads' guidelines however, both master (general) checklists and detailed checklists are included. Although the US approach urges the users of the checklists to have a more critical attitude, less experienced users (auditors or designers) can benefit from more detailed checklists (Austroads, 2009) (IHT, 2008).

Checklists are not only addressed to safety auditors; designers may also use them to identify potential safety issues proactively in their design (Austroads, 2009) (FHWA, 2006). This opportunity for safety checklists to 'infiltrate' into the design process is mentioned in the Australian and American RSA Guidelines.

The benefits of the RSA process to the designer

Road safety audits can benefit not only the design or scheme that is being audited, but future designs too, thus gradually developing a "safety culture" among road designers (Kanellaidis G. & Vardaki S., 2011) (Austroads, 2009). Feeding back the knowledge and experience gained from RSAs into the design process is a critical step of the audit process, since its purpose is that the recipients of this feedback (designers and public agencies) will not be making the same mistakes again and again (Austroads, 2009). According to the FHWA guidelines, the last step of the road safety audit process is to incorporate the RSA findings into the project when appropriate, ensuring that the audit process is a learning experience for all parties. This last step ensures that the knowledge gained from the project owner and the design team will ultimately result in the management and design of a safer road network (FHWA, 2006).

Austroads guidelines specify, providing detailed advice, the opportunities for feedback that exist: feedback into the existing project; feedback into other projects within the same organization; feedback generally to the profession; feedback into revised standards; feedback to auditors (Austroads, 2009).

The authors of the British RSA guidelines acknowledge that, in the UK, designers and public agencies must have the opportunity to benefit from RSAs that have been conducted in the past. In addition, some auditors in the UK have noted that the number of safety issues per audit diminish over time, when several audits are undertaken for a long period of time for the same designer (IHT, 2008). This is owing to the fact that the audit process is a learning experience for the designers, who gradually *"anticipate the safety issues and design in safety features from the start*" (IHT, 2008).

GREEK HIGHWAY DESIGNERS' APPROACH TO ROAD SAFETY AUDIT

The European Directive 2008/96/EC on Road Infrastructure Safety Management was integrated into Greek law in November 2011, which is approximately six months after this survey was carried out. However, some designers were involved in RSAs that were mostly carried out on the newly constructed or under construction national freeways. The lack of a formal process by the State Authorities, according to the respondents who took part in such Audits, had resulted in "relaxations" of the RSA process in some cases. The comparative review of the three main RSA Guidelines internationally, presented in the previous section, can be a useful tool in helping the practitioners (auditors and/or designers) to understand the way the RSA process is approached in different guidelines. It can also provide them with a critical insight on each Guide's practices and help them shape their own "best" approach. Furthermore, this comparative review could be exploited in Professional Development programmes.

The previous review of RSA guidelines showed that a fundamental element for the success of the Audit process is the existence of proper cooperation between the two parties: highway designers and road safety auditors. Examining the extent to which Highway Designers accept the application of the RSA to their design is crucial for the successful implementation of the process in a country.

In order to investigate the approach of highway designers to the RSA, twenty-three (23) interviews were carried out. The questionnaire was designed after carrying out a research on RSA Guidelines published internationally as well as a wider literature review on research related to RSAs as well as to traffic safety culture, specifically attitudes and behaviour investigation (Transportation Research Board 2010). Although the sample size is relatively small, it corresponds almost to the actual population of Greek road designers that were actively carrying out road designs and RSAs at the time of the survey. This undoubtedly constrained the authors from carrying out extensive statistical tests. Further discussion on the statistical analysis is reported in the sections to follow. During each interview, designers were asked a number of questions that were included in a questionnaire developed by the authors. More detailed aspects of the designers' characteristics, approach to RSA and reported behaviours were recorded for this survey. However, due to the restrictions on the maximum length of this paper, we present the main features of the collected data by reporting some general trends in the descriptive statistics section below.

Results from the survey: descriptive statistics

Firstly, it is important to understand a fundamental characteristic of the respondents- their experience. As it can be verified from Figure 1, the majority of the designers have more than 21 years of experience. However, groups of medium and low experience are also represented. Regarding the size of the company the respondents were working for, the majority of them were free lancers or employees of medium-sized consultancies. Some interviews from designers working for larger organisations were obtained too but these represented a small percentage of the sample.

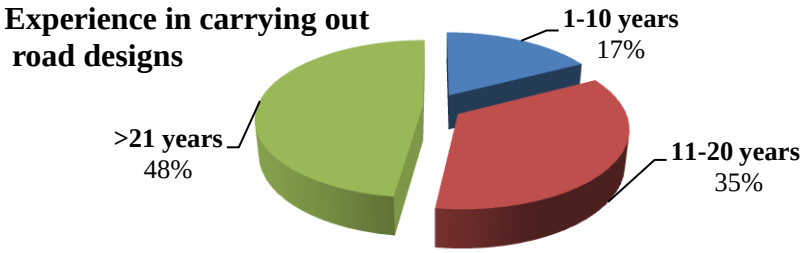

Figure 1 – Designers' characteristics: experience

The 'compliance behaviour' of highway designers with geometric design standards also needed to be investigated. As is illustrated in Figure 2, more than half of the engineers in the sample state that they seldom choose substandard parameters when they design. Also, more than one out of three respondents state that they sometimes design substandard elements in their road designs. The extreme responses of 'always' and 'never' correspond to marginal percentages of 4% each.

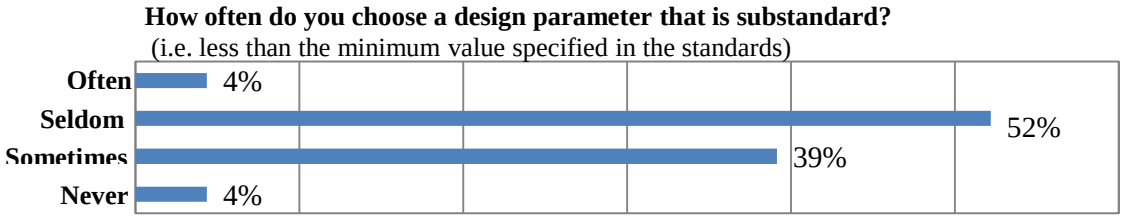

Figure 2 – Designers' characteristics: choosing substandard design parameters (variable code name DC1)

Apart from the frequency with which the respondents "obey" or "ignore" the design standards, it was also considered important to identify which safety checks, if any, they apply to their designs (Figure 3). An interesting aspect of the responses to this question is whether each safety check was applied on the designer's own initiative or if it was carried out following a suggestion from the highway authorities (i.e. the client, to whom engineers usually submit their road designs). As can be concluded from this survey, highway designers are more likely to apply a safety check without any suggestion from the highway authorities.

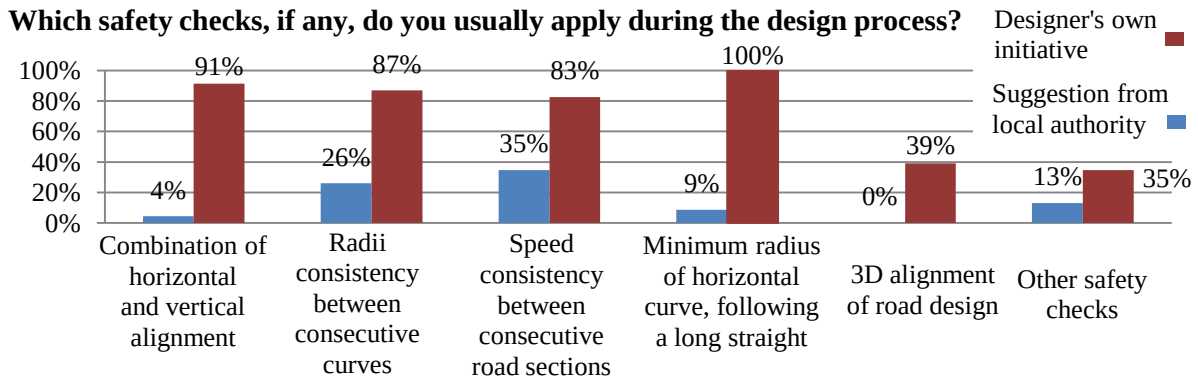

Figure 3 – Designers' characteristics: applying safety checks (var. code name: DC2)

The designers were then asked to state to what extent they agreed or disagreed with a phrase that summarises a "prevalent" view, according to which *if design standards are met, then the road is safe for its users.* Responses to this phrase can give a hint of the level of awareness that the designers have about road safety and of their safety culture (Figure 4). As it was argued in a previous section of this paper, the phrase given to the respondents is incorrect, as compliance with technical standards does not necessarily result in a safe design (Hauer, 1999). There is no clear trend in the designers' approach, as half of them roughly agree and the other half of them roughly disagree with the given phrase.

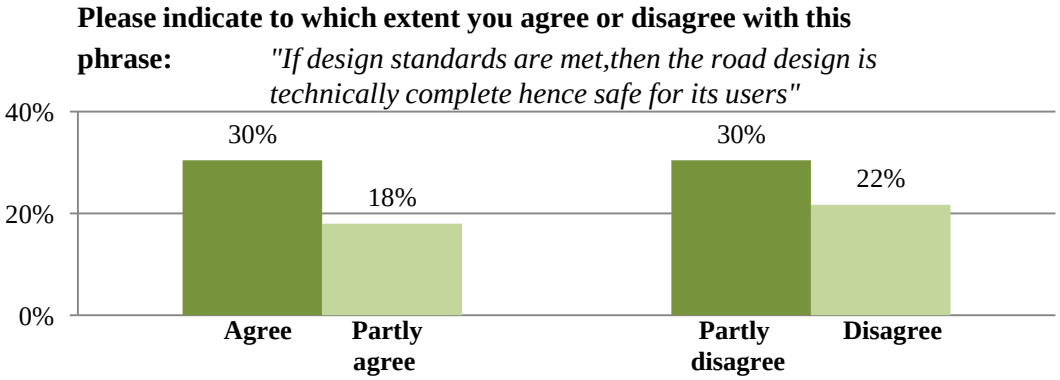

Figure 4 – Designers' approach: the 'prevalent' view (variable code name: DA1)

The two figures below aim to present the approach or attitudes of the designers towards the effectiveness of the RSA process in enhancing road safety (Fig. 5) and the extent to which RSAs can contribute to the improvement of the road safety level of the Greek road network (Fig. 6). It is worth noting that although the majority of the respondents believe that the audit is an effective measure to improve road safety ('Great extent' figure: 70%), they seem to be more sceptical when they are asked specifically about Greece ('Great extent' figure: 52%).

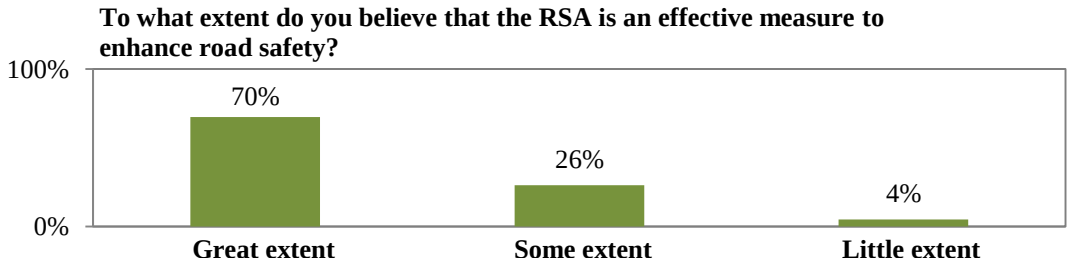

Figure 5 – Designers' approach: the effectiveness of the RSA in enhancing road safety (var. code name DA2)

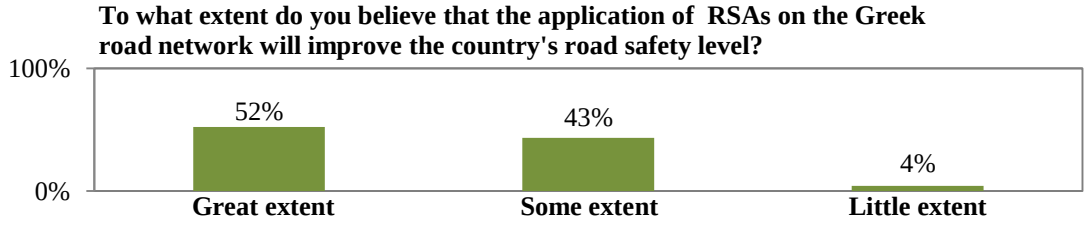

Figure 6 – Designers' approach: the RSA as a measure to improve the Greek network road safety level (var. code name DA3)

The responses obtained from each designer also depend on whether he or she has ever taken part in a Road Safety Audit. The small percentage of Road Safety Auditors (almost one fifth of the sample – Fig.7), can be explained by the fact that the survey was carried out only some months after the process was legislated for in Greece.

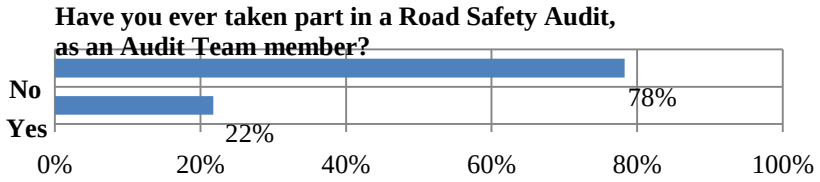

Figure 7 – Designers' characteristics: Road Safety Auditor (var. code name: DC3)

According to the Australian 'Safe System' (Turner et. al, 2009) (Austroads, 2009), part of the solution suggested for obtaining safer travel is delivering safer roads and road sites to the road users, something which primarily links to the work of highway designers. The following question (Figure 8) practically shows whether the respondents share and appreciate the aforementioned principle. It can be seen that almost everybody agrees or partly agrees that the designer's work can significantly contribute to the improvement of road safety.

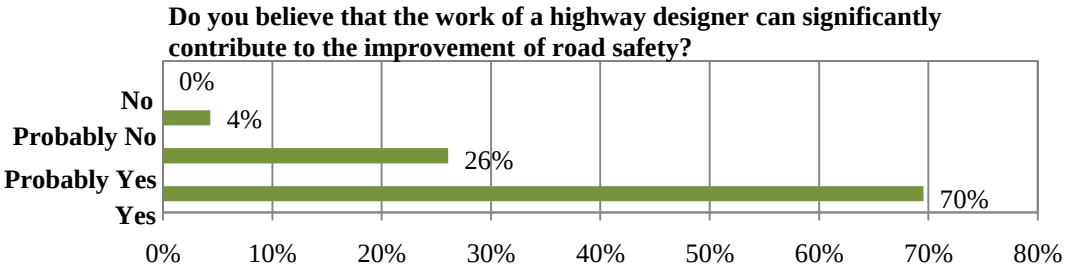

Figure 8 – Designers' approach: the contribution of the highway designer to improving road safety (var. code name DA4)

The graph below (Figure 9) shows the trend of the designers' approach on whether road safety principles should be included in the design standards as a separate section. Design standards are documents that highway engineers normally get advice from on a regular basis. Therefore a positive approach towards the inclusion of safety principles in the design standards might suggest that the respondents hold either raised awareness of road safety or a willingness to learn and enrich their knowledge more in this field. Although some negative ('probably not' and 'no') answers were obtained, the majority of the designers (83% of the sample) do indeed have a positive approach.

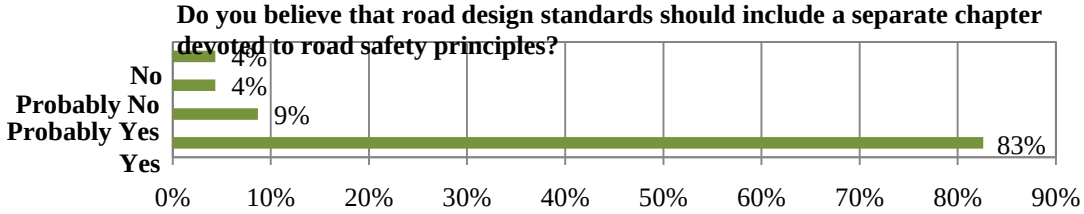

Figure 9 – Designers' approach: The inclusion of road safety principles in road design standards (var. code name DA5)

Results from the survey: Exploratory Factor Analysis

Statistical analysis was carried out in order to further investigate the existence of any significant correlations between the respondents' approach and/or characteristics. The variables are actually the questions asked during the interviews (i.e. from the questionnaire); the variables describe several characteristics or reported behaviour of the designers (variable code name "designers' characteristics – DC") as well as their approach to specific road safety-related issues in the design process (code name "designers' approach – DA").

Exploratory factor analysis (EFA) was applied on five variables that described the designers' approach regarding Road Safety Audits (DA) and their own characteristics (DC). The suitability of EFA method was confirmed using Bartlett's test of sphericity and the Kaiser-Meyer-Olkin index (KMO); both tests suggested that EFA was likely to give satisfactory results (significance $p=0.007<\alpha=0.05$ and $KMO=0.651>0.5$). Varimax orthogonal rotation method was applied. Factor Analysis on five variables indicated that two factors could explain 71.8% of total variance, with the first factor explaining 38.6% and the second one explaining 33.2%. The fact that the two factors explain 71.8% of the total variance almost equally, suggests that they are almost of equal importance.

Variables DA2, DA3 and DA5 that describe the designers' attitudes/perceptions towards road safety, load highly on factor 1, whereas variables DC3 and DC9 describing their involvement

in the RSA process, load highly on factor 2. It is worth noting here that loading factors smaller than 0.2 are not reported below (Table 1).

In an attempt to create a label for both factors from the underlying variables, we could name factor 1 as the designers' "attitudes to RSA and road safety" and factor 2 as their "involvement in the RSA process".

Table 1 - Rotated two-factor matrix containing 5 variables of designers' attitudes and reported behaviour-characteristics

Variable	Factor	
	1	2
DA2 *(To what extent do you believe that the RSA is an effective measure to enhance road safety?)*	0.839	
DA3 *(To what extent do you believe that the application of RSAs on the Greek road network will improve the country's road safety level?)*	0.730	0.315
DA5 *(Do you believe that road design standards should include a separate chapter devoted to road safety principles?)*	0.809	
DC3 *(Have you ever taken part in a Road Safety Audit, as an Audit Team member?)*		0.906
DC9 *(Have you ever used RSA handbooks when carrying out an Audit or design?)*		0.856

CONCLUSIONS

The comparison of the three documents revealed that Road Safety Audit guidelines must not only focus on the process of the RSA, but should also include the road safety principles that are identified from the research and experience in road safety engineering. In this way, the users of the RSA Guidelines –who are not necessarily limited to road safety auditors– will receive useful and up-to-date feedback about road safety issues. This need to provide up-to-date information on road safety principles is addressed more systematically in the Australian guidelines.

The RSA, as a process, must be implemented and applied with the appropriate flexibility by highway authorities. This process should therefore not be seen by the authorities as another rigid 'legal obligation' that they have to meet –although in some sense it is– but as an opportunity that has to be integrated into their work plan. Making the *RSA "work for you"* is a key recommendation to the highway authorities by the authors of the FHWA (2006) guidelines.

The RSA is also a beneficial process to the highway designer; as is explicitly mentioned in the British RSA Guidelines, the more audits are undertaken (on a specific engineer's designs), the more safety problems the designer will avoid during the design process (i.e. before the audit is carried out). This may lead to the conclusion that highway designers should be encouraged to use the RSA Guidelines to assist them in the design process. The use of these guidelines by the designers can range from the simple integration of safety checklists into the design process (as part of the checks that are applied) to the thorough study and understanding of safety principles (e.g. the 'safe system' approach). In the American and the Australian RSA guidelines, an important step in the audit process is the feedback of the

knowledge and the experience gained from the audit to a variety of stakeholders, including the designer.

The investigation of the Greek highway designers' approach to RSA revealed that, firstly, the majority of the respondents find the RSA an effective process towards improving the safety of a design and, at the same time, almost every designer believes that the implementation of this process will have great or some positive impact on the safety level of the Greek road network. These results indicate, on the basis of this survey's sample, a positive approach on behalf of the highway designers in Greece towards this recently introduced process. Furthermore, the designers in the sample explicitly recognise their own share of responsibility for road safety problems and it can be said that they have developed some awareness regarding their role in building a safe road network.

Although the aforementioned positive approach and awareness were identified from the survey, almost half of the designers agreed with the prevalent view, according to which "*compliance with standards equals a safe design*". This might reveal the existing need for further education and training on road safety issues. It is worth noting that this need was also appreciated by the majority of the respondents, when they were asked about their own opinion for the inclusion of a separate road safety-related chapter in the technical standards. In addition, during the interviews, some of the respondents pointed out that a Greek RSA guidelines document would be a substantial aid during their work. This is a 'practical verification' of the conclusion stated above that the user group of the RSA guidelines should not be confined to road safety auditors.

Finally, the survey has shown that the level of knowledge about road safety is related with the individual's involvement in undertaking road safety audits, so that the designers who also served as auditors had a higher level of awareness of road safety issues. Hence the implementation of the RSA and the subsequent involvement of designers in the audit process are expected to positively affect the designers' approach to road safety.

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