Assuring road safety quality in the road design process, the Dutch perspective and citing two case studies

Themes: Basis for design policy/Role of road safety audits in design process

Govert Schermers*; Zoran Kenjic ** ,Herman Moning *** and Rien van der Drift****
* SWOV Institute for Road Safety Research,
P.O Box 1090, 2260 BB Leidschendam, the Netherlands
Corresponding author: Govert.Schermers@swov.nl,
tel: +3170 317 33 83, fax: +3170 320 12 61

**Rijkswaterstaat Limburg
P O Box 25, 6200MA,Maastricht
The Netherlands
Tel: +3143 387 0397
Email: zoran.kenjic@rws.nl

*** Rijkswaterstaat – Dienst Verkeer en Scheepvaart
P O Box 5044, 2600GA Delft, the Netherlands
tel: +31 65 152 1592
Email: herman.moning@rws.nl

**** Rijkswaterstaat Zuid Holland
P O Box 556, 3000AN, Rotterdam
The Netherlands
Tel: +3110 402 6454
Email: rien.v ander.drift@rws.nl

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Abstract
The Ministry of Transport, Public Works and Water Management adopted the principles of "leave to the market/industry unless" (in Dutch "de markt tenzij", a form of privatisation) in 2005. These principles support a focus on core tasks of the Ministry, privatisation and self regulation and a strengthening of the relationship with the external market. The concept of the "leave to the market" has had a fundamental impact on the work of the Rijkswaterstaat (RWS), the organisation responsible for the implementation, management and maintenance of national (road and water) infrastructure. Whereas in the past, RWS, through its specialist design divisions, prepared and provided detailed design specifications and drawings as part of traditional build contracts, much of this work is now being outsourced as part of the tender process (design, build, finance and maintain contracts). Consequently, RWS has refined and improved the way in which it specifies contracts for (large) infrastructure projects.

RWS has developed a code of practice for the design and construction of infrastructure that clearly outlines what is expected from potential contractors. Road safety does not have a prominent role in the code. However, RWS has applied procedures varying from functionally specifying road safety criteria in the tender documents, to using road safety audits to evaluate road safety compliance of each submitted design. This paper discusses two such cases. In the first case potential contractors could receive fictitious bonuses where higher levels of safety were offered in the (concept) designs. In effect the tendered amount was discounted by an amount adjudicated to provide extra road safety, making the bids with more expensive design options competitive with bids with "cheaper" designs with fewer safety features. This came down to the road authority being willing to pay more for safer design although overall cost in relation to the overall quality offered still played a dominant role in the final selection of tenders.

A second case describes the application of road safety audits as an instrument for assessing the quality of submitted design proposals. In this case the tendering process was an iterative one and concept designs could be improved during the design process and ultimately the best overall design awarded. The design teams had to invest significantly more time in ensuring optimal solutions. This has the benefit that all designs, irrespective of which one was ultimately awarded, were audited and have a documented developmental history.

In many ways the Dutch approach is unique and to an extent anticipates the requirements as set out in the new EU Directive on Road Infrastructure Safety Management. The RWS has developed an implementation framework for the Directive and this will be highlighted in the paper. All these themes touch upon the drive of the SWOV to introduce quality management as part of the philosophy of sustainable safety, another aspect that will be briefly considered in this paper.

1 Introduction

In an ongoing quest to reduce the negative effects of road traffic accidents, governments have implemented policies aimed at harmonising the relationship between road users , road traffic and the road environment. To enable these, most countries (especially in Europe) have set road safety targets and developed and implemented road safety strategies to meet these. Furthermore, the European Commission has set ambitious European goals and has taken a prominent role in providing instruments and procedures to support member countries in improving road safety management. These include tools such as road safety audits and inspections that are aimed at ensuring that road infrastructure provides the highest possible levels of safety. Since these procedures are becoming mandatory for member countries, national road authorities need to develop strategies to facilitate the incorporation of these into current working practices.

Motivated by a move by the government for a more efficient public service, the Dutch Ministry of Transport, Public Works and Water Management initiated a number of programmes in 2003 aimed at predominantly privatisation and self regulation whilst strengthening an externally orientated approach. To allow for a leaner organisation the Ministry was forced to develop ways to work smarter by devolving certain tasks to other authorities and to the market, at the same time improving service provision. In essence this meant that the Ministry would do less herself, organise more efficiently and work differently. This new management philosophy was based on two principles, "the market unless.." and "decentralise what can, centralise what must". Putting this new model into practice however, would have far reaching implications for, amongst others, the Rijkswaterstaat (RWS) who is mandated by government to develop and maintain the national road and waterway networks.

The Sustainable Safety programme has had a major effect on road safety in the Netherlands (Wegman et. al. 2006). In order to maintain and sustain these effects, a system of quality assurance is being advocated (Wegman and Aarts, 2005) . Such systems must ensure that road safety is an intrinsic component of the work procedures and processes of road authorities. This will in future provide a level of certainty that road design and construction provide the highest levels of safety and that these have been exposed to systematic checks for compliance.

This paper provides an outline of the new initiatives affecting the planning, design and construction of roads in the Netherlands. Furthermore, the paper relates these processes to the now mandatory EU Directive on Road Infrastructure Safety Management. The paper gives an outline on how such a quality control system can become an integral part of the design, build and operate process. It discusses work procedures, road safety considerations and developments and describes two case studies where two different approaches were adopted to integrate road safety into the design tendering process.

1.1 Background

The Rijkswaterstaat (RWS) is a government department that falls under the Ministry of Transport, Public Works and Water Management. RWS has a leading role in infrastructure design, construction and maintenance and also traffic and freeway management. At present RWS is responsible for 5050 kilometres of roads (of which 2 637km are divided carriageways) and 2 548 kilometres of waterways (CBS Statline, 2009). Although the Netherlands is small (roughly 310km north to south and 265 east to west with a land area of 33 883km^2) with a relatively large population (16,5 million in 2009), it has a relatively dense road network (in excess of 136 000kms). The national road network accommodates 42% of the annual vehicle kilometres travelled on Dutch roads whereas some 15% of all fatal road traffic accidents in the Netherlands occur on this network. Whilst this proportion has been fairly constant over recent years, the absolute number of fatal accidents has been steadily declining despite increased mobility.

The downward trend in fatal traffic accidents on the major road network is consistent with the overall improvement in road safety in the Netherlands. This improvement has been the result of sustained political will and a strong commitment by road authorities and the road safety fraternity to maintain the declining trend set in motion in the mid 1970s when traffic fatalities were at their peak. Since the 1990s, this was given a further impetus by the introduction of the Sustainable Safety programme (Wegman et. al. 2006) which has certainly contributed to make the Netherlands the second safest country after Malta in the EU in terms of fatalities per inhabitants and one of the safest in the world in terms of fatalities per million vehicle kilometres travelled (Irtad; Care; Eurostat).

While a positive outcome, the decline in the number of fatal and serious injury accidents has made it increasingly difficult to maintain road safety as a key agenda item and promote related projects on the basis of the "significant "road safety improvements effected by the projects.

Consequently a more pro-active approach aimed at detecting potential design defects is needed.

2 New road safety initiatives and the impact on the design process

Three recent road safety initiatives are likely to impact the Dutch approach to road safety in future, in particular the design process. These include changes to provision of adequate quality assurance, the recent approach to decentralise and privatise many government bodies, and the directive on road safety management. These are briefly described below, in context of the impact these will have on the design process.

One of the core tasks of the National road authority (Rijkswaterstaat or RWS) is to facilitate the provision of an efficient and safe traffic system. The design and construction of new national roads in the Netherlands is regulated by the so called Tracéwet (the law governing all new major or national roads). This law stipulates the decision making processes related to the construction or amendment of principally national roads. Major infrastructure projects are listed in a multiyear programme for infrastructure, land use and transport (the so called MIT/MIRT programme) which also sets out the decision making process (RWS, 2009). Apart from the Tracéwet, the Environment Control Act also has a major influence on major infrastructure projects and sets out the conditions for mandatory Environmental Impact Assessments (EIA).

At present the average planning time (time from feasibility to the start of construction) for major road infrastructure projects in the Netherlands is some 12 years. In an attempt to reduce this, a commission led by Mr. P.G. Elverding was set up in November 2007 and tasked to investigate the causes for the long turnaround time and to recommend new or adapted work procedures to shorten the feasibility and design stages of major projects. In order to expedite the planning process the Commission has recommended improvements on three fronts, namely improving the management and administrative culture, improving the decision making process and improvements in legislation (Ministry of Transport et. al, 2009; Schermers et. al 2009). Although road safety is not specifically addressed in these plans, procedures are being introduced to integrate aspects such as road safety impact assessments, road safety audits and road safety network management into the process and in time making it an integral and compulsory element for all new planning, design and construction projects.

Ultimately the new planning procedures proposed by Elverding and the procedures described by the Directive will be combined, leading to a more efficient and holistic approach to road infrastructure provision. Since this has not as yet been realised, this paper describes the relevant road safety initiatives separately.

2.1 Quality assurance

Since the new philosophy of the government expects higher quality with less people, this means that some of the RWS activities will only be supervised by them whilst being carried out by the market (e.g. certain licensing tasks, planning studies, etc.). Although road safety was (albeit largely indirectly) a part of the MIT procedures, especially as an important element of the cost-benefit analysis, it still is not a mandatory component. Explicit attention to road safety in the planning and design process is not a requirement. It is often implicitly dealt with (for example it is assumed that if a design complies to a design standard or guideline it is a safe design) and often the road safety effects are estimated on the basis of best guess rather than by means of for instance formal road safety impact assessments. Furthermore, projects are not always subjected to road safety checks or tests as is intended by road safety audits. However, the road authorities do apply a number of road safety guidelines and standards which in some instances are stipulated as mandatory. Also recently a standardised methodology to assess and report road safety effects of (new)infrastructure projects in the planning stages of a project have been developed and adopted by the RWS (Ministry of Transport, 2009).

To ensure that quality standards are maintained, the road authority acts as the project manager and applies her own quality procedures. Some of these procedures are completely new and ensuring optimal quality (from both a design and a road safety point of view) is proving to be a challenge, especially in cases where the in-house expertise is no longer available as a result of the practice of outsourcing. In *Towards a Sustainable Safe Road*

Traffic (Wegman and Aarts, 2005), SWOV recommends a system of quality assurance as an integral part of the implementation of the various components of a sustainable safety system. Such a system of quality assurance must ensure that the various elements of a sustainable safety system are implemented in an integrated way (i.e. adopting a systems approach) and that there is a high degree of uniformity.

From a sustainable safety point of view there are three issues that could impact the quality of road infrastructure provision and management:

- There are many organisations (both public and private) involved in the provision and management of road infrastructure and traffic. This may lead to inconsistent design, a lack of uniformity and different approaches to problem solving
- Road safety has to be considered against other interests and priorities. These processes need to be transparent to reflect both the complex decision making processes and complex social environment.
- Given the diversity in political and other priorities, compromises in the policy and decision making processes in the transportation sector are almost inevitable. However, from a safety point of view these may lead to a deviation from the Sustainable Safety vision, culminating in non optimal solutions being implemented.

A quality assurance system for road authorities provides procedures for planning, design, evaluation and analyses of potential defects. Quality assurance should be an integral part of the working procedures within those organisations responsible for road safety and should facilitate the development of expertise. All products and processes related to providing road infrastructure and traffic management should be subjected to quality reviews.

The SWOV proposes the following four topics as a start to introducing quality assurance:

- The Minister of Transport reports on not only road safety developments but also on the activities and progress made by other stakeholders
- Implementing road safety audits
- Road safety impact assessments are integrated into future infrastructure planning projects (those by law subject to an Environmental Impact Assessment -EIA).
- Design guidelines are revised so that these facilitate quality assurance (testing) procedures.

Some of these topics are also covered by the recently introduced EU Directive on road traffic safety management and ways are being explored to integrate these initiatives.

2.2 Decentralisation and Privatisation

The concept of "the market unless" and "decentralise what can and centralise what must" (in Dutch "de Markt tenzij" and "Decentraal wat kan en centraal wat moet") principally means outsourcing as many of the Governments' road infrastructure related tasks as is possible. Generally these take the form of public-private partnership agreements locked in contracts such as Service Level Agreements (SLA) or work orders. These tasks are not left entirely to the market but are carried out under the strict supervision of the Ministerial departments.

As mentioned earlier, the design and construction of roads in the Netherlands is regulated by the Tracéwet, the law stipulating the decision making processes related to the construction or amendment of principally national roads. Apart from the Tracéwet, the Environment Control Act also has a major influence on major infrastructure projects and sets out the conditions for mandatory Environmental Impact Assessments (EIA).

Up until 2008 the Netherlands applied the MIT procedures as required by the Trace/EIA laws. This entailed following the classic feasibility, plan/concept design, detail design and implementation stages with in each stage decision moments based on extensive study reports and general consensus. In 2008 the MIT was replaced by the MIRT although the actual process followed remained essentially the same as before. In 2008, the Elverding Commission (Ministry of Transport, Public Works and Water Management, 2009) recommended radical changes to these procedures. These are aimed at decreasing the turnaround time by half through changing the decision making processes, giving the feasibility stage a more prominent and guiding place, shortening the planning/design stage and introducing a commissioning test during the construction/realisation phase. This will have a material effect on the work procedures of all those organisations and bodies involved in infrastructure planning and design, and especially those of the road authority.

The new policy and regulatory framework (and consequently, the new work procedures), significantly changes the way that the RWS conducts her work. As opposed to doing the majority of the work herself, RWS now prepares written design briefs for road design and construction tenders. To effectively privatise demands a clear

interpretation and understanding of RWS goals in order to translate these to specifications which form the basis for granting contracts to the market. In preparing these functional specifications, a programme of requirements is drafted defining the study area, project description and scope, budgets and time frames. Within these constraints the market is asked to design the solution. These solutions are adjudicated on the basis of the economically most justified tender. This utilises not only price but also aspects such as sustainability, road safety, orientation to the public/users and project management as criteria in the evaluation process. These aspects are subsequently incorporated into contracts and compliance is carefully monitored (penalty/reward clauses which can be financial or increase or decrease the potential for follow-up contracts).

In practice this means that the designs must specify all conditions and objectives. Ideally these are quantifiable or measurable. The problem with road safety is that it is an extremely difficult item to specify in terms of measurable performance criteria. A design may comply with all recommended guidelines but this is in itself no guarantee for a safe design. Furthermore, complying with all the specifications does not either mean that the result is an optimal one from a safety point of view (for instance if a safety element is overlooked in the specification it is possible that it is not explicitly dealt with in the submitted design proposals). This complicates the process of evaluating submissions.

Once tenders are submitted these are usually assessed by a team of RWS specialists who score the tender on the basis of compliance with the request for tender and adjudication documents. The tender with the highest score, often reflecting the most favourable price/quality ratio, is awarded the contract. During contract execution, progress and quality is continually monitored and assessed.

2.3 The Directive on Road Infrastructure Safety Management

In 2005 the European Parliament adopted recommendations to reduce the number of road traffic casualties by half by 2010. A major enabling instrument was seen to be the introduction of a European Commission Directive on Road Infrastructure Safety Management (Commission of the European Communities, 2006) which was passed into legislation by the European Parliament in November 2008.

The Directive aims at ensuring that European road authorities responsible for the Trans European Road Network (TERN) have the necessary guidelines, training and information available to them for increasing safety levels on the road network. It stipulates a minimum set of procedures deemed essential to achieve positive road safety effects. These are road safety impact assessments (RSIA), Road safety audits (RSA) and Network safety management (NSM) and road safety inspections (RSI).

The implementation of the Directive is estimated to reduce road traffic fatalities on the TERN by 600 fatalities and 7000 injury accidents annually, corresponding to economic savings of more than €2,4 billion per year. Assuming that these procedures are adopted for all major roads in all the member countries, these savings can conservatively be doubled. The benefits far outweigh the costs of implementing the Directive.

Rijkswaterstaat has been mandated with the implementation of the newly adopted EU Directive. To enable this, the RWS must introduce or adapt a number of new activities into her work processes (Twijnstra Gudde, 2009). However, to facilitate these activities changes will have to be introduced in legislation and in the MIRT procedures, specifically the project stages (including those new changes proposed by Elverding, Ministry of Transport, 2009). RWS will have to make decisions in this regard before any changes in current work processes can be introduced.

To implement the Directive the RWS adopted a phased approach beginning with finalising the decision making process during the first 9 months of 2009. The second phase, which in time runs partially in parallel to the decision making process, entails preparing the supporting guidelines and documents and incorporating these into the work processes of the RWS (20 specific activities ranging from developing guidelines for RSA, RSIA, NSM and RSI to concluding contracts with the police on accident reporting). The third phase intends testing the newly adopted work procedures and processes on a number of dummy projects. Following the testing phase, the new work processes will be introduced throughout the organisation.

3 Converting Principles into practice – 2 case studies

In 2005 the Ministry of Transport, Public Works and Water Management adopted a new management philosophy encouraging a more active role for the private sector in a number of her core activities. Consequently the role of the RWS became more that of the quality controller than that of the designer. For earlier projects this meant that innovative new tools had to be developed for the integrated evaluation of project submissions and proposals. Evaluating specifically road safety as part of adjudicating and awarding new infrastructure design proposals within this new working context presented new challenges. Two projects with similar goals but using different approaches in assessing road safety are the A4 Design and Build (2007) and the A2 Maastricht Design, Build and Operate (2009) contracts.

3.1 Functional specifications – A4 Design and Build contract

Project description

The A4 motorway between Amsterdam and the Hague is one of the busiest roads in the Netherlands with AADT's well in excess of 100 000 vehicles per day (on some sections in excess of 200 000). In the short term, the A4 project involves widening the two carriageways of the A4 from two to three lanes, 1,4 kilometres of which will be underground. The overall design must allow for future expansion to 4 lanes in each direction. The project will also include the provision of several kilometres of noise barriers as the section of road passes through highly populated areas. The affected section of the A4 is a primary corridor with no viable alternative routes, requiring extensive traffic management plans to be implemented during the construction phase.

Tender process

This project was brought to tender, supported by comprehensive tender and adjudication documentation. The tender process was undertaken in dialogue with the potential contractors; three sessions of discussions were held with increasing levels of detail included in each subsequent discussion.

As a first step, a reference design was created by RWS to support the contractors. A panel of RWS experts was appointed to compare each submission with the original reference design specification. Based on these evaluations, submissions were compared and the contract awarded to the submission with the most favourable price-quality relationship. The quality of the constructed project will also be assessed by RWS prior to hand over.

Road safety was identified as a key issue that would be compromised if not addressed specifically. Consequently a separate document containing a specific list of functional road safety requirements was produced. The aim of this document was to encourage bidders to strive for optimal investment in road safety features. A discount to the tender price was provided as an incentive for bidders to complete the extra road safety proposal. Assuming that their proposals scored a perfect 10, a maximum amount of €18million could be subtracted from the tendered price. This amount is based on the difference in safety levels between the best and worst design scenarios.

The Term of Reference (TOR) stipulated numerous conditions to be met by the bidders including the submission of separate proposals for the construction and post construction phases as well as design compliance with the principles of sustainable safety (functionality; homogeneity; predictability and forgivingness). Each of these principles were described by a number of design requirements, for example the width of emergency lane, distance to obstacles (clear road side area), placement of guardrails, delineation etc. are all elements describing forgivingness. Each of these should be specifically addressed in the proposals and should have some compliance with current design and safety standards and practice.

Submitted tenders were independently reviewed and assessed in relation to its compliance with all requirements. Aspects of the designs that were felt to meet the requirement were scored neutral whereas aspects exceeding the requirement (implying a safer design) were scored positively. Once all criteria had been assessed a total score per submission was calculated. As mentioned earlier, the higher the score, the higher the level of safety offered by the design and therefore the higher the discount that could be applied. Tendering parties offering higher overall contract prices could therefore incorporate more safety features in order to reduce this total (incidentally only for the purpose of winning the contract, the eventual awarded contract price was still based on the tendered amount). Tendering parties not paying specific attention to safety could not receive this discount reducing their chance of being awarded the contract.

Four tenders were submitted for consideration. Tenders were assessed on the basis of the economically most viable option making use of life cycle costing and indexing. Review scores for road safety ranged between 2,4 and 5,4 out of a potential 10, implying that discounts of between €4,3 and €9,7 million could be applied. Effectively this meant that all bidders had incorporated safety improvements that exceeded the requirements. The road safety measures and features incorporated in the tenders formed part of the contract and the contractor is required to comply with these elements at both construction (managing road safety at roadworks) and hand over stages (comply with standards and guidelines). The contract was awarded in December 2006.

A goal of this project was to present road safety as a realistic investment and this goal was reached. All the designs paid specific attention to features that improve road safety (e.g. improved sight distances, adding visual cues to enhance curves, load bearing foreslopes/sideslopes; width of clear zones etc). However, the implementation of these additional features will need to be contractually stipulated and monitored by the road authority. Its actual effect on accidents can only be assessed after a number of years. Should this effect be negative, it is unlikely that the contractor can be held accountable. The contractor is responsible for delivering the project according to the safety and other design specifications. Upon project completion, the legal responsibility of the road is transferred to the road authority; road accidents occurring as a direct result of (hidden) design defects will then be the responsibility of the road authority (unless specific provision for this is included in the maintenance contract).

3.2 Road safety audit as an integral component of calls for tender – the A2 Maastricht Design, build and operate contract

The A2 is a national freeway linking the Netherlands to Belgium. The A2 route currently passes through the city of Maastricht with the freeway section interrupted by a section of urban arterial. The intention is to upgrade this section by providing a freeway tunnel under the city. The current A2 urban roadway will be remodelled into an urban boulevard, including a new commercial development, parks and urban streets.

The primary goal of the project is to provide a plan with multiple objectives for the improvement of the traffic flow on the A2 and the accessibility of Maastricht. It must also promote the quality of life and road safety, resolve bottlenecks within the city, and create opportunities for urban development.

Project organisation, budget and goals

The A2 project organisation was set up in 2003 and consists of representatives of RWS, the Provincial Government of Limburg, and the municipal councils of Maastricht and Meerssen. The government partners have a budget of over €630 million available to them. This budget has been fixed and stipulated in a Collaborative Agreement (for more information see www.a2Maastricht.nl and www.sdu.nl) The Collaborative Agreement defined both the scope of the project (Figure 1) and the project goals which had to be achieved within the A2 planning area.

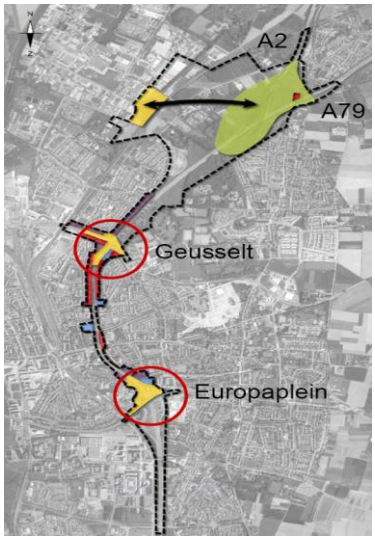

Figure 1: Scope of the A2 project in Maastricht

The specific project goals were:

- A full connection in both directions between the A2 and the A79;
- A connecting road between the A2 and the Beatrixhaven industrial estate;
- Improvement of the traffic flow on Viaductweg;
- A tunnel with two carriageways of four lanes each and full connections in both directions at the Geusselt and Europaplein junctions;
- Construction of a new above-ground city boulevard on the site of the current A2 route;
- Property development in relation to urban renewal; more than 1100 homes (new construction and reconstruction) and 30,000 m2 gross floor area for commercial use;
- Possible extra property, if this fits in with the urban programming of the Maastricht municipal council.

Nationally, the A2 Maastricht project is regarded as an innovative project for integrated regional development in the Policy Document on Mobility and in the Ministry's policy for public-private cooperation. The project is of international importance with a primary cross-border transport function and consequently was awarded a European grant from the TERN fund.

The innovative approach of tendering

A so-called state Infrastructure (Planning Procedures) Act-based/EIA procedure was followed. Based on extensive research (RWS, Limburg 2006) , the ministers of Transport, Public Works and Water Management and of Housing, Spatial Planning and the Environment opted for a tunnel through the city. Market parties opting to submit tenders were expected to design their own alternative for the project, providing different solutions for the problem. These designs were assessed in terms of their impacts in the second phase of the Environmental Impact Assessment (EIA).

The basis for the European tendering procedure was the Collaborative Agreement (A2 Maastricht, 2006) between the Government, the Provincial Government of Limburg, and the Municipalities of Maastricht and Meerssen. This agreement set out all the project elements, rights, obligations and risks involved in the project, and it put governmental bodies in a position to work in close collaboration with the private sector (the market). The innovative approach to tendering was particularly unique. The government parties had not prepared a ready-made plan for which a party was simply sought to carry out the construction work. Instead a programme of requirements was developed, the planning area defined, the budget and the property opportunities finalised and finally the market was asked to design the best total solution for the transport and traffic-related project elements (infrastructure) including town and country planning and urban development elements (property). "The market" was encouraged to form consortia in order to take part in the tendering process jointly. The consortium approach was followed by all eventual bidders. The consortiums comprised a mix of contractors, consulting engineers, landscape and other architects. Thanks to the combined approach of tendering and compulsory procedures, interested parties had two interim opportunities to give their interpretation and view on plans.

Optimising road safety quality in design

A unique component of the project was the integration of Road Safety Audits (RSA) as part of the specification and programme of requirements for the project. RSA were incorporated to make clear to tendering parties that their submissions would be subjected to an independent audit at each stage of the tendering process and at each subsequent stage of the project once awarded. RSA were deemed to be a suitable instrument to strive for the safest design within the overall project. Given a number of potential design constraints introduced as a result of severe space restrictions, an objective safety assessment was an essential requirement in view of potential negative road safety effects introduced as a result of:

- Tunnel concept
  - Lower design speed in tunnel (V=100 km/h)_
  - Restricted capacity in the tunnel ,
  - Poor Visibility, sight distances ,
  - Complete interchanges connection with Geusselt and the Europaplein either side of the A2-tunnel,
  - No emergency shoulders in the tunnel.

- Road design and traffic management
  - Relation between design speed and design elements
  - Visibility criteria Con- and divergence points in and close to the tunnel
  - Weaving
  - Design of interchange and connections

The awarding of the A2 contract commenced with the selection phase during which three consortia were selected to participate in the following dialogue phase (comprising 4 separate stages of discussion). During this first phase submitted plans were discussed iteratively with the project team and the relevant consortium. The aim was to progressively improve the concept submissions to the extent that most risks had been minimised and made manageable in what would become the final tender. In view of the limited experience of Dutch road safety auditors, particularly with projects of this nature, it was decided to contract auditors from a leading English road safety audit consultant for the initial audits. To facilitate on-the-job training and technology transfer, a team of local auditors were deployed as a "shadow" audit team (to gain experience with audits of this nature and to bring in local experience). In addition a number of road safety specialists of the Rijkswaterstaat were trained by the English audit team (conducted an audit although their findings had no status other than to compare and discuss results with the actual audit team) .

Five consortia were selected and participated in the dialogue phase. Following first round discussions, concept designs were submitted and the best three were selected. These submissions were subjected to various quality tests (design compliance, safety audit, urban planning, traffic impact and management, environmental, landscape etc). The results of these tests were used during subsequent discussions with the consortia in an endeavour to improve the concept plans. Following this the consortia were afforded the opportunity to implement these recommendations and finally the plans were made public. Once again reactions to the proposals were discussed resulting in final tender submissions. At each stage the amended concept designs were subjected to a road safety audit. Irrespective of which submission was ultimately awarded the contract, road safety received explicit attention and potential design constraints/safety impacts were identified and could be addressed. Apart from providing input for the following design phase, the audit also gave insight into the overall safety performance of the three concepts and this was used as one of the criteria during tender adjudication.

The results of the road safety audits identified potential areas for improvement in each of the concept design. The results of each audit were documented in separate (confidential) reports which, due to the tendering procedures, were not made publicly available. A summary of the findings for the winning bidder are provided in Table 1. The audit identified 24 potential areas for improvement. Of these 16 related to concerns regarding design constraints or road safety concerns on the new freeway sections (6 in and around the tunnel, 5 related to the on/off ramp connections to the freeway and 4 to the layout of interchanges). Before commencing the next design phase the bidder was expected to draft a written reaction to the audit findings, including the manner in which these are to be addressed in the next design stage.

Table 1: Road safety audit results A2 Winning bidder: Areas of potential improvement

Category	Aspect	Number of incidents observed
Network vision	Road classification	1
	Design speed	1
	Emergency lanes	1
Main roads	Interchange layout	4
	Terminal layout	5
	Alignment	1
	Tunnel alignment	6
Regional roads	Alignment	2
	Intersection layout	2
Non motorised traffic	Cycle routes	1
Total		24

The contract was awarded in June 2009 and the project will now enter the detailed design and implementation phases. During these more traditional phases the RSA will be used to assess the designs from a road safety perspective. The design will in this way be optimised from a road safety perspective.

4 Conclusions

Since the 1990s the Dutch Sustainable Safety programme has been widely supported by road safety practitioners and policy makers. The implementation of Sustainable Safety has certainly contributed to improving road safety in the Netherlands (Wegman et al 2005). In an ongoing quest to further improve the road safety situation, Dutch road authorities are being encouraged to provide road infrastructure that facilitates not only efficient movement of people and goods but also complies with the requirements of Sustainable Safety and offers the highest possible levels of safety.

In an effort to increase its efficacy regarding service delivery and quality of service to the Dutch public, the Ministry of Transport, Public Works and Water Management has strategically realigned herself (I'm more familiar with referring to organisations as "itself" but this is perhaps less common here?) by adopting the principles of decentralisation to lower tiers of government and devolution of certain functions to the private sector. This has had far reaching consequences for the Rijkswaterstaat who is responsible for, amongst other aspects, national road infrastructure. One such consequence is the outsourcing of road design. The RWS has had to adopt new procedures aimed at ensuring similar or higher levels of quality in the design, construction and operation processes as was the case in the past. For RWS, road safety is an essential component in this process. In developing these procedures the RWS has applied different approaches, two of which were aimed at assessing road safety in the design process. In a project to improve an existing motorway near Leiden, road safety criteria were functionally specified in the contract documents and compliance to these were assessed by road safety specialists. Where designs exceeded the road safety specifications, a financial reward was calculated to weight the offered tender price. In essence this meant that the more the design complied or exceeded safety specifications, the bigger the discount applied and the greater the chance of being awarded the contract. In this way tendering parties were stimulated to pay explicit attention to the road safety aspects of the design. This new procedure achieved its goal of providing more safety for a realistic investment.

In a second project for upgrading the A2 national freeway through the City of Maastricht, Road Safety Audits were applied during the tender process. All submitted designs were audited and potential contractors offered the opportunity to amend the designs before the next stage of submission. By the time the tender was awarded the submitted design had been optimised from not only road safety point of view, but also from a design, traffic impact, and environmental point of view. In this way the awarded concept design offers the highest degree of compliance to all the requirements and can progress to detailed design. The RSA will continue to be applied in all the phases until project completion.

Indirectly related to this, the European Commission passed a directive on road safety infrastructure management making it compulsory for all member states to adopt road safety impact assessments, road safety audits, network safety management and road safety inspections for application on all current and future TERN (?) roads. The Dutch RWS has embraced the directive and has embarked on implementing steps supporting the introduction of these procedures.

It can be concluded that road safety in design has been taken up a level in the Netherlands. A number of steps have been undertaken to ensure that safety becomes an integral part of the design process, and similar to environmental considerations, will be weighted and tested to ensure that the highest standards are met. A system of quality assurance as advocated by the SWOV (Wegman and Aarts, 2006) seems to be an acceptable solution. Road safety engineers and specialists are currently looking at ways to develop and implement instruments and tools and to make these part of standard working procedures and processes.

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