Oversights in road planning leading to unsafe road features: a safety auditor’s perspective

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Abstract
Road safety auditors are required to identify safety deficiencies that may lead to potential hazard on a road project. The available audit tools may only provide the prompt lists that should be followed. Auditors often become a design checker rather than an auditor. They may overlook the critical safety issues. The common oversights during road design have been identified. The experience in auditing a total of 24 road projects from 1998 to 2008 was referred and summarised. As a result, lack of or poor provision for vulnerable road users is the most common oversight done during the road designs.

1. Introduction
Road engineers often pay more attention to have their proposed design to comply with the adopted geometry standard. It is believed that if road geometry requirements are complied with, the road safety features have also been ensured. The design for other road provisions such as the facilities for pedestrian, road lighting and road furniture can be provided at a later stage if necessary or requested. This practice may not be always right as a hazardous situation on a road does not necessarily relate to or depends on geometric parameters. As such, lack of provisions for vulnerable road users and unsafe roadside features shall also increase the probability of road accident and casualty.

Road safety audit (RSA) in road design has been imposed by road authority in many countries. This is to address and solve or minimize the safety issues of road projects from the earliest stage and considered as a proactive approach. RSA guidelines to streamline and ease the audit process have been developed and published. However, the auditors may still get difficulties when conducting the RSA as road projects contain various conditions and many features are needed to be checked. Thus, experience in RSA is required as the more experienced auditors would have better knowledge to avoid items that may be overlooked when doing the RSA.

This paper examines the RSA outcomes of selected road projects. Common oversights experienced by the road engineers during the planning and feasibility stage have been identified. Future road projects may use the findings to avoid the need to redesign due to the unfulfilled safety requirements. The road safety auditors and road engineers could also minimise their oversights leading to unsafe road features when carrying out the road design.

1.1. RSA definition and implementation in road project
In the literature, there are various definitions of RSA [1-4]. Although the RSA guidelines use different words when describing the definition of RSA, however, some similarities are observed as follows:

- RSA is a formal examination;
- It is conducted for existing and future road;
• Conducted by an independent team; and
• To improve safety performance on the road.

The first procedure for conducting a RSA was developed in the United Kingdom in the 1980’s. In 1990, the Institution of Highways and Transportation published the first Guidelines for the Safety Audit of Highways [5]. Then, in 1993 and 1994, guidelines for the audit were established in New Zealand and Australia respectively. Later in the 1990’s, several countries such as Denmark, Finland, France, the Netherland, the USA, Norway and Germany began to explore and then published RSA procedures. In Malaysia, the guideline for safety audit of roads and road projects was published by the Public Works Department, Ministry of Works in 1997. At the initial stage, the RSA was imposed for federal road projects.

Generally, the RSA is conducted for both the existing road and new road project. The stages of auditing for a new road project may comprise of audit on planning and feasibility, preliminary design, detailed design, construction and pre-opening, and post construction stage respectively. Audit for existing road is usually similar to audit during post construction of a new road project.

RSA Guidelines [4] also specify the procedure to carry out RSA in Malaysia. The key points in the procedures involve [1] preparing the audit brief, [2] assembling background information, [3] initial meeting with auditors, [4] doing the audit, [5] preparing the audit report, [6] completion meeting involves the presentation on audit findings, and [7] deciding the action.

1.2. The use of RSA tools
At the moment, there may not be any special tool or software that can detect all the safety features of a road. The auditors will audit most of the road design elements manually. The available software may be used to check the plan and profile, sight distance and vehicle tracking. The earliest tool that has been introduced is the use of RSA prompt list or checklists. Later, several RSA toolkits exist and in recent years, they are available on web-based applications.

The checklists are given within the guidelines and aimed to help the auditors when conducting the safety auditing. The checklists are used as a prompt to help auditors identify potential safety issues in a design. They are particularly useful for less-experienced auditors. Basically, checklists contain a sequence of questions to remind the auditors on items needed to be checked. They may provide general questions and should be associated with the project road. Thus, the auditors should keep the checklists in mind when vetting through the design drawings or while driving throughout the project road. This is to identify the deficiency in road safety aspects of the project road.

The availability of RSA checklists is found very helpful by the parties involved in planning, design and construction of a project road with RSA requirement. This could minimize the overlooks during the road design and construction, in particular for those related to safety features. However, the available checklists may not specify their relation to accident severity. While knowing how severe accident occurs if the particular road element not properly designed is essential. This will also assist the auditors when advising the road authority on whether the oversight is accepted or should be improved later at operational stage or must be rectified during the design stage.

1.3. More comprehensive rsa tool is required
There are reports on evidence of crash reduction due to the improvement or treatment on the safety feature of a road [6-8]. The crash reduction effectiveness of any treatment on the existing road is very useful, particularly for road safety auditors. The data could be the basis for them to define whether the risk level of the deficiency is intolerable, high, medium or low. Austroads and iRAP have developed the web-based RSA toolkit that deals with crash reduction effectiveness. Although the toolkit does not specify the common oversights during a RSA, it can be utilised as an advanced tool by a road safety auditor. How serious the unsafe road features are after they have been implemented can be identified based on the information provided.

Studies on RSA, however, have focused on how to conduct an auditing on road elements, attempt to improve the safety audit procedures or conduct the before and after treatment measurements. For example, the safety audits conducted for intersection/interchange, road bends, pedestrian zone and school area. Nevertheless, an adequate RSA tool is needed especially by the less-experienced auditors. Moreover, improvement on the RSA has been outlined since the beginning and being one of the communiqué points during the Austroads International RSA Forum in 1998. The forum also stated that
research into the processes, methods and effectiveness of the RSA must be encouraged and supported [9].

1.4. RSA checklists and crash reduction

Several researchers have investigated and published the crash reduction effectiveness of the improved road design and road equipment. This involves the crash reduction due to the road or traffic countermeasures developed [6-8]. Based on those data, the correlation between audit items (if they complied with the safety requirements) and the crash reduction effectiveness was obtained.

RSA Guidelines [4] provide the main audit items within its checklists for Stage 1 audit (planning and feasibility stage). The checklists may assist the auditors to identify any potential safety issues and not overlook something important. The auditors often include the audit items as the sub chapter titles of their RSA report. At the moment, similar to other RSA guidelines, the checklists are not associated with the crash reduction data if the items complied with the safety requirements. Thus, auditors may not know how important an audit item to be fulfilled.

- Road Network Effects.
- General Geometric Standards.
- Outline Provision for Users with Special Needs.
- Access Control Details.
- Environmental Considerations.
- Consideration of Alternatives.

Correlating the audit items in RSA Guidelines [4] and the available information provided by Ogden [6], Austroads [7] and Elvik [8], it was found that the treatment on facility for vulnerable road users provides up to 60% crash reduction. The treatment on road networks, geometry, intersection and design standard adopted achieved the crash reduction up to 40%. While the treatment on lane arrangement at intersection and the traffic management provide up to 25% crash reduction. This shows that a treatment for vulnerable road users’ facility will result in the highest crash reduction. Overall, at least about 25% of crash reduction achieved if the RSA properly carried out.

1.5. Exploring oversights on safety features in road design

Oversights in RSA may result in hazardous location on a road being left unidentified. Property damaged only, serious injury or even casualty may occur frequently due to the hazardous road section. An experienced safety auditor may have good knowledge to identify the potentially unsafe road feature in the design drawings as well as on the existing road. The less-experienced safety auditor, however, may need to give more attention during the audit to avoid the oversights. Although the checklists for auditing a road are available in the guidelines, knowledge on the common oversights leading to unsafe road feature, particularly for those causing severe accidents is needed.

The experience in auditing a total of 24 road projects from 1998 to 2008 was referred and summarized. All the sample projects are road construction projects and not the roadside development projects. As shown in figure 1, 67% of the reviewed road projects are the upgrading projects while the rests (33%) are new road projects. Moreover, 79% of the projects are situated in rural area while 21% in urban area. The audit summary of each sample road project was analysed. The analysis, however, is limited to audit conducted for the planning and feasibility stage, the first stage conducted for a road project. Nevertheless, poor auditing during this stage may cause the requirement for major redesign or rectification works during or after road construction. The unsafe road feature may even exist when the road is in operation due to the oversights during the first audit stage.
The RSA conducted for the sample road projects is based upon the audit items and checklists in RSA Guidelines [4]. Every audit item in all project reports was checked. This was to determine whether the design, in particular the audit item complied with the standard and/or accepted by the auditors. Then the number of the audit items accepted or refused by the auditors was counted. Having completed the descriptive statistics, the order from the most to the least unacceptable item was obtained.

1.6. Common oversights leading to unsafe road features

Figure 2 shows the percentage of road projects with unsafe features identified in this study. Most of the road projects were unacceptable by the road safety auditors due to lack of provisions for vulnerable road users. It can be seen in figure 2 that up to 92% of the road projects did not provide adequate provision for vulnerable road users. Thus, the road design was unacceptable to the auditors and recommended to be improved. The second most common audit item that was not acceptable in the road projects is the appropriateness of cross-section and traffic planning strategy. Out of 24 road projects, 16 projects (63%) were identified to be potentially hazardous due to inappropriate cross-section and traffic planning strategy.
Moreover, the location and type of control of the intersection at 10 road projects (42%) had received comments from the auditor as they did not fulfill the safety requirements. Surprisingly, about 33% of road projects received comments from the auditor in terms of road geometry and standard adopted, whereas road geometric standards should be ensured by road engineers. The other audit items such as suitability of design criteria, access control, location of terminal ends of the project, lane and carriageway arrangement, and road capacity were not fulfilled by less than 30% of the project.

![Figure 2. Percentage of road projects with unsafe feature due to unacceptable design.](image)

As mentioned earlier, the treatment in the provision for vulnerable road users has the highest crash reduction effectiveness i.e. up to 60%. However, this item received the most comments by the auditors. The lack of information for the location where the vulnerable road users’ activities exist is the main possible explanation to this finding. Of the 24 road projects, it was noticed that six projects (21%) do not have a comprehensive traffic study report. The other projects only quoted traffic data at the nearest traffic census stations. Unfortunately, the available traffic data at traffic census stations was only for mid-block segments of the road network. There were no turning volumes or pedestrian data available.

The inadequate paved shoulder, inadequate clear zone, and median width received the most comments from the auditors for the cross-section design. In practice, provision of adequate paved shoulder will help the drivers of the run-off-road vehicle to redirect their vehicles to the travel lanes. Adequate paved shoulder can also be used by the motorcyclists and breakdown vehicle whenever necessary. Proper physical median shall be used by pedestrians as their refuge when crossing the road.

Traffic planning strategy and the adopted route standard that may cause an increase traffic conflicts often receive comments or refusal from the auditors. For example, many road projects upgraded the trunk roads that traverse through the residential and commercial areas to a higher standard. The activities of vulnerable road users were relatively high within the area. After the construction, the road provides higher operational speed due to better alignment and formation. Through traffic would have the priority rather than local traffic as well as the vulnerable road users. Road accident or the severity of accidents may increase as more high-speed traffic passes through the community areas. This concept is not desirable and thus, bypassing the community areas is recommended by the auditors.
Designing suitable intersection location and spacing may be a problem for road engineers, particularly for a dual carriageway road. Junctions that are too close to one another will result in inadequate weaving section, while junctions that too far between one another may cause difficulty for local residents’ movements. In many cases, the provision of a service road is 11.

2. Conclusion
Common oversights in road design that lead to unsafe road features have been identified and shown as follows. These oversights are based on auditors’ comments and findings in the 24 road projects in Malaysia from 1998 to 2008.
1. Lack of or poor provision for vulnerable road users, i.e. provisions for pedestrian and cyclist. The road engineers often focus on the provisions for motorists and overlook to facilitate the non-motorized;
2. Inadequate paved shoulder, clear zone, and median width. This may be due to site or budget constraints;
3. Preferring to upgrade the existing road rather than construct a new road even though the road traverse through the community areas;
4. Design for intersections is inappropriate. Often this is due to the absence of a comprehensive traffic study report; and
5. Road standard chosen is inappropriate. Upgrading the existing road is often meant to increase the vehicles’ speed.

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