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“Rethinking Built Environment: Towards a Sustainable Future”

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**Research, Industrial Linkages, Community
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Co-organiser:
**Department of Built Environment Studies & Technology (JABT),
Faculty of Architecture, Planning & Surveying (FSPU)**

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The Effectiveness of Road Safety Audit in Malaysia: A Systematic Review

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Abstract

The Road Safety Audit (RSA) is an existing road infrastructure tool used to prevent or reduce the severity of injuries and the RSA safety principles are applied in road design and road improvement. Few comparative reviews have been carried out on the implementation of RSA in other countries. The present article was carried out to analyse the existing literature on RSA practices by summarizing the best available international evidence on the effectiveness of the RSA. Guided by the PRISMA Statement (Preferred Reporting Items for Systematic reviews and Meta-Analyses) review method was conducted, a systematic review of the Scopus and Science Direct databases identified 16 related studies. Further review of these articles resulted in four main themes – RSA Practices, Road Safety Toolkit, Road Safety Auditor, and Issues in implementation of RSA. There are some suggestions for potential research proposed in the study. More qualitative studies are required because the RSA activities in Malaysia provide in-depth analysis and thorough explanations. In addition to direct analysis synthesis in the sense of RSA activities, the study requires unique and normal systematic review approaches and needs to practice complementary search strategies such as citation tracking, contacting experts, reference searching and snowballing. Finally, after this study, a set of suggestions was provided for future academics' consideration.

Keywords: *Road Safety Audit; Effectiveness of RSA; RSA Practices; Road Safety Toolkit; Road Safety Auditor*

1.0 Introduction

One of the major problems as the world expands in all respects is lowering the rate of unnatural death and one of the leading causes of fatalities in vehicle collisions. Road transportation is an important mode of transportation in Malaysia as it ensures both people's mobility and transportation resource. Road transportation has dominated Malaysia transportation landscape since the introduction of the road network at the end of the nineteenth century. The Public Work Department (PWD) launched a Road Safety Audit (RSA) in 1997 (PWD, 1997). Since then, the implementation of the RSA has revealed several issues that include insufficient RSA supervision, common designer mistakes, and the lack of a warrant application. According to the ARIMA model, Malaysian road deaths are expected to increase to 10,716 by 2020. To minimise the number of fatal traffic collisions, more efforts and effective solutions should be established creatively (Sarani et al., 2013). Efforts are being made all over the world to reduce the number of people dead or injured in traffic collisions. Two of the United Nations (UN) Sustainable Development Goals, for example, are related to road safety: SDG 3 with target 3.6 aims to cut the number of fatal or serious traffic crashes in half by 2020 relative to 2010, and SDG 11 with target 11.2 aims to provide access to sustainable and secure transportation networks (World Health Organization (WHO), 2017).

1.1 The Necessity of Conducting a Systematic Review

A systematic review, according to (Petrosino, A., Boruch, R. F., Soydan et al., 2001), is described as recognising, assembling, and analysing all available data quantitatively and qualitatively to generate a comprehensive, observationally determined answer to an engaged study issue. In comparison to conventional style literature reviews, the systematic review has several benefits. A transparent article retrieval process, a larger and more prominent research area, and more important goals that control research bias will all help to improve reviews. Apart from that, the researcher is motivated to provide high-quality proof with more substantial outcomes (Mallett et al., 2012).

2.0 Materials and Method

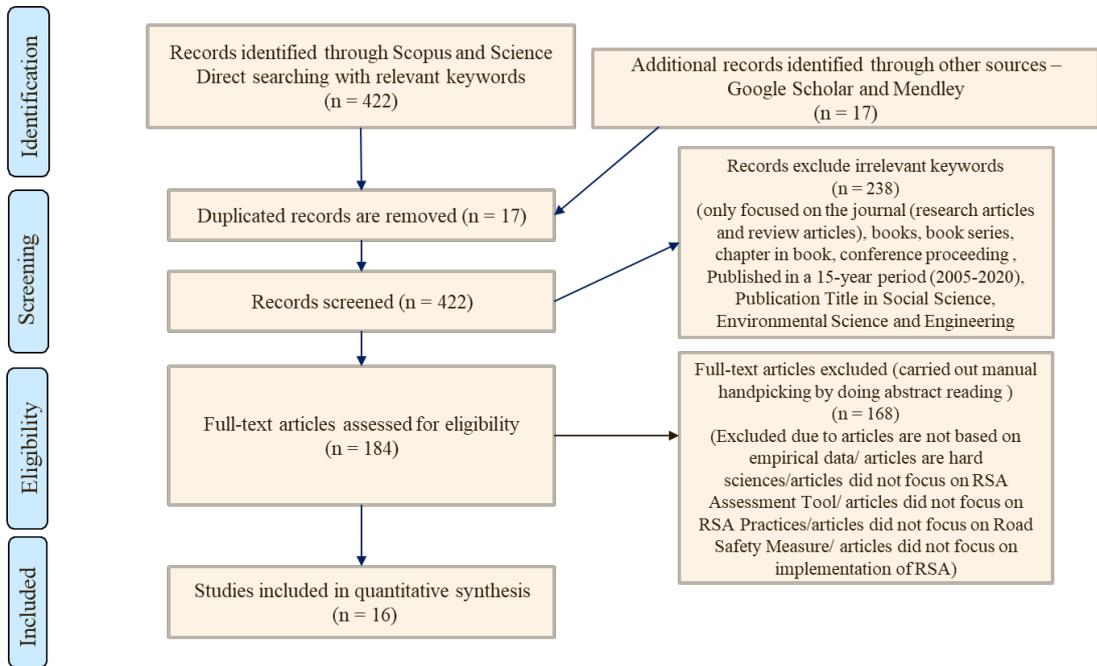
This section explains the method of reviewing articles, namely PRISMA, the systematic review process, and data abstraction and analysis which are employed in the current research.

2.1 PRISMA

The PRISMA acronym stands for Preferred Reporting Items for Systematic Reviews and Meta-Analyses, and it is a recognised guideline for conducting a systematic literature review. In general, publication standards are needed to provide authors with the relevant and necessary information they need to evaluate and examine the quality and rigor of a review. Furthermore, PRISMA places a strong focus on the report of the review, which examines randomised trials and can be used as a foundation for presenting systematic reviews for other forms of research (Moher et al., 2009). PRISMA analyses a large database of scientific literature over a certain period, allowing for a precise search of phrases about the efficacy of the Road Safety Audit. Aside from that, PRISMA allows for coded information on road safety audit reviews.

2.2 The Systematic Review Process for Selecting the Articles on the Effectiveness of RSA

The systematic review process in selecting several relevant articles for the present study consisted of three main stages as shown in Figure 1. The first stage is the identification of keywords, followed by the process of searching for related and similar terms based on the thesaurus, dictionaries, encyclopaedia, and previous research. The second stage is screening serves to remove duplicate articles. Overall, a total of 238 articles were excluded based on these criteria. A total of 184 articles were prepared for the third stage known as eligibility. On an important note, all of the articles' titles, abstracts, and main contents were thoroughly examined at this stage to ensure that they met the inclusion criteria and were fit to be employed in the present study to achieve the objectives of the current research. Consequently, a total of 168 articles were excluded because they were perceived as not being based on empirical data and did not focus on the effectiveness of road safety audits. For data abstraction and analysis, 16 articles were carefully analysed to extract statements or data that answer the research questions. Eventually, the process has resulted in a total of four main themes namely RSA Practices, Road Safety Toolkit, Road Safety Auditor, and Issues in implementation of RSA.



(Moher et al., 2009)

Figure 1. Flow Diagram of Systematic Review Process

3.0 Results in General Findings

In this section, the discussion revolves main findings around four main themes, namely RSA Practices, Road Safety Toolkit, Road Safety Auditor, and Issues in implementation of RSA.

3.1. Road Safety Audit (RSA) Practices

The United Kingdom (UK) performed the first road safety audits in the 1980s. In 1988, legislation placed a legal duty on-road regulatory authorities to reduce accidents. In response, the Institute of Highways and Transportation (IHT) published “Guidelines for the Safety Audit of Highways” in 1990 (Al-Adhoobi et al., 2017). The most recent revision of the IHG guideline version was published in 1996. Four (04) applicable audit stages, covering up Feasibility/Initial Design Stage, Preliminary Design/ Draft Plans, Detailed Design and Pre-Opening. RSA Check Lists for different stages and up to Pre-opening only exists. There is no form for existing roads or post-construction. There are also no Safety Inventory and Survey Formats attached for particular features or various types of sites. (Ahmed et al., 2013).

In Australia, the production of the New South Wales (NSW) Road Safety Review Manual began in 1990 and was completed in July 1991 (Abu Mansor et al., 2019). Austroads, Australia's national organisation of road and traffic authorities has established an auditing committee to enhance road safety audit guidelines and create a national force to carry out this mission. In 1994, the first recommendations for the road safety audit process were released, and they quickly became a universal standard policy. A second edition of the recommendations was updated and published in 2002 following the International Road Safety Forum held at Austroads in Melbourne in May 1998. This improved edition reflects global understanding and expertise, and it is an essential instrument in the application of road safety audits (Al-Adhoobi et al., 2017). Austroads developed a series of RSA procedures and checklists for use across Australia. This publication uses five phases; there is the feasibility stage, the draft design

stage, the detailed design stage, the pre-opening stage and an audit of an existing road. Each stage has its own set of checklists, which can help find issues (Abu Mansor et al., 2019).

The national road agency of New Zealand, Transit New Zealand (TNZ) established an Authority in 1989 with the primary goal of providing an interconnected and secure highway network. TNZ published a document called Safety Audit Policy and Procedures after reviewing the practises and procedures of road safety audits established in the UK and Australia (Abu Mansor et al., 2019). To support safety audit practises and regulations, a task force was created with representatives from various segments. The national road and public transport agency, Transit New Zealand (TNZ), adopted and declared these guidelines in 1993 (Al-Adhoobi et al., 2017). In New Zealand initially, a four-stage Road Safety Audit system was developed that includes a stage one RSA (feasibility), stage two RSA (project assessment), stage three RSA (final design) and stage four RSA (pre-opening). The checklists used in TNZ 'Policy and Procedures' were mainly based on the original UK 'Highways safety and traffic advice note HA 42/90 Road Safety Audits' which was published by the UK Department of Transport. Each stage has a list of its own, and a 'master checklist' combines all checklists into one A4 page which can be used as a quick reference (Abu Mansor et al., 2019).

The United States Department of Transportation's Federal Highway Administration (FHWA) has been aggressive in educating roadway agencies and encouraging RSAs as a proven safety mechanism. As described in the publication FHWA Road Safety Audit Guidelines, FHWA defines an RSA as a formal examination of the safety performance of an existing or planned road or intersection by an independent audit team (FHWA-SA-06-06, 2006). Safety Audit is divided into four (4) basic Phases; Pre-construction Stage RSA (including planning, preliminary design, detailed design), Construction Stage RSA (Work Zone Stage, Construction Stage, Pre-opening Stage), Post-construction Stage RSA of Existing Roads, Development Project RSA – For Land Use Developments. RSA Check Lists attached seven (7) checklists in the form of “Prompt Lists” are attached for different stages and specific items (Ahmed et al., 2013).

In early 1997, Road Safety Audit (RSA) was started in Public Works Department (PWD) and a Guidelines for the Safety Audit of Roads in Malaysia, Public Works Dept. (Roads Branch), 1997 was produced as the primary guide for Road Safety Auditing by PWD and its consultants engaged in this work. RSA and subsequent actions are classified into five (05) specific stages Stage 1: Planning and Feasibility Stage, Stage 2: Preliminary (Draft) Design Stage, Stage 3: Detailed Design Stage, Stage 4: During Construction or Pre-Opening of a New Project and Stage 5: Audit of Existing Roads. Individual stage checklists are included for all stages, including the Existing Road and Post-Construction stages. However, no Safety Inventory and Survey Formats for special features or a specific type of location are attached (Ahmed et al., 2013).

According to some feedback reports, the road safety audits experiences in the United Kingdom, Australia, and New Zealand was successful (Al-Adhoobi et al., 2017). According to the findings, RSAs are required at all stages of the project, from the feasibility study to the post-construction stage, as well as for existing roadways. The Malaysian document has a comprehensive list of checklists for each audit stage, but no unique form for specific design features or difficult locations. The documents from the United States should be used as examples of extensive checklists in Malaysia's document. The Malaysian materials also lack a flow chart for the activities to be carried out in an RSA process and should be referred to the documents from the United States, which have flowcharts that show the overall processes in the audit process. According to the findings of the study, an overall or stage-by-stage flowchart of the audit activities should be included in the guideline document to provide a clear picture of the procedures to be followed in the audit process, hence making the RSA Guidelines more effective.

3.2. Road Safety Toolkit / Accident Prediction Models

Based on the Austroads Guide to Road Safety – Part6: Road Safety Audit, 2009, the Austroads Road Safety Engineering Toolkit was developed in Australia (Dr Aut Karndacharuk & Hillier, 2019). Austroads (2009), the Road Safety Audit Toolkit was developed to assist practitioners in conducting thorough and efficient road safety audits. These toolkits are utilised as a reference tool for road engineering practitioners in both state and local governments in Australia and New Zealand. In

Virginia, the Field Review Assessment Tool was developed to provide a register of information and evidence obtained before and during the field study, as well as a checklist of site features and requirements for the review and guidance of the suggested safety countermeasures (VDOT, 2008).

The Generalised Linear Model approach (GLM) was used in New Zealand to construct accident prediction models that assessed the statistical relationship between collisions and traffic numbers, road geometry, cross-section, road surfaces, roadside hazards, and pavement density (Turner et al., 2012). Cafiso et al. (2010) use the Generalized Linear Modeling (GLM) method to develop accident prediction models based on a mix of exposure, design, accuracy, and context variables directly connected to safety performance. Caliendo et al. (2007) created a model for predicting accident reductions as a result of infrastructure and road development, as well as accident predictions while comparing alternative design options. As a result, this study might serve as a guide for engineers who are adjusting or designing multilane highways. Using Generalized Linear Modeling methods, Montella et al. (2008) constructed different crash prediction models for total accidents and extreme (death plus all injuries) collisions on Italian rural highways. The research was conducted in Mexican Hat, Utah, to develop a Roadway Safety Assessment Tool (RSAT) for states to utilise to identify and evaluate the safety of rural roads used by motorcoaches in a user-friendly manner (Blatt et al., 2014). Jurewicz and Excel (2016), presented the Australian National Risk Assessment Model (ANRAM) and demonstrated how it may be used to guide the development of the Road Safety Infrastructure Program. The research shows how a hybrid risk assessment and accident prediction technique were utilised to calculate the individual and cumulative risk of a major accident.

From the previous study that has been discussed above, it can be concluded that most of the analysis techniques was using the statistical method, especially the general model of linear regression. Researchers have attempted to look into road safety by developing statistical correlations between accidents and other variables. For an overview of the Road Safety Audit (RSA) Toolkit that has been used in other countries, it is an online tool that assists practitioners to carry out road safety audits. The Road Safety Audit Toolkit is not intended to be used in place of a formal road safety auditing course. Rather, it's a tool for doing road safety audits comprehensively and efficiently. The goal of the Toolkit is to lower the severity and frequency of collisions caused by road environment factors.

3.3 Road Safety Auditor

An RSA team must be a self-contained, competent group that discovers and prioritises safety issues and makes recommendations for change. The capacity and comfort of team members to speak openly about potentially contentious safety problems are critical to the audit's success (Mahgoub et al., 2010). The auditors' education and training are probably one of the weakest areas in the whole safe system approach in the nations of South-Eastern Europe (Jovanov et al., 2017). In Malaysia, the Public Works Department (PWD) developed its training centre, the Centre of Excellence in Engineering and Technology for JKR's Staff (CREaTE) and began introducing road design training modules. This is part of a larger effort by JKR engineers and technical personnel to improve their road design skills. (Abu Mansor et al., 2019).

A Road Safety Audit (RSA) may be carried out by one appropriately skilled person or by a team of professionals bringing together a range of skills and experience. To analyse the specification with "fresh eyes," the Road Safety Auditor must be impartial. Nonetheless, effective coordination between the parties must be developed and maintained if the audit is to be done properly and without wasting time and effort. Furthermore, the delicate nature of having one's design work "judged" should be recognised. Auditors must be objective in their assessments while also acknowledging that no one enjoys hearing comments. To get the most out of the experience, designers and clients must think about audit findings separately. The audit team's collective knowledge in the major areas indicated in the preceding section must be considerable. Audit checklists are valuable for highlighting key items or locations to consider, but they should only be used as memory aids for individuals with a lot of experience, not as a comprehensive list of issues (Abu Mansor et al., 2019).

3.4 Issues in Implementation of RSA

Time constraint for auditing, when the practice of late appointment of an RSA Auditor causes audits to be executed late or at inopportune times (Abu Mansor et al., 2019). The scheme planning must provide adequate time for audits to be conducted on schedule. The time between when a design is finished and when invitations to tender are issued is critical. In most cases, there isn't enough time to conduct a full audit and follow-up. There are several factors to consider for a Road Safety Auditor working on particular planning initiatives. Some of these are connected to the accuracy of the design. Since these audits must be completed, the Road Safety Audit Team Leader must choose between rejecting the commission due to insufficient information and trying to enhance the report.

The Designer hasn't provided enough information for the Auditors to fully comprehend what's being designed. Often road safety auditors are presented with rough and incomplete projects, which do not include any traffic or pedestrian flow studies or miss some of the required drawings (e.g., road profile or cross-sections, etc.). That is why regulations on road design should include information on the completeness of a project to be presented to auditors. Also, they should clearly describe what kind of studies must be carried out by the designer before submitting the project for audit (Tumavičė et al., 2017).

Another issue is the implementation of RSA was the misunderstanding of the roles and responsibilities of auditors. Auditors are allowed to make reasonable suggestions, but it is not their job to make specific recommendations or advocate for a particular solution. The primary role of auditors should be to "describe the issue and what it means," with project owners/designers making the final decision.

4.0 Conclusion and Recommendation

The study makes several recommendations for further research based on the findings of the systematic review. The following conclusions are drawn, as well as recommendations:

- According to the study's findings, Malaysians should evaluate design guidelines and standards every five years to ensure that they are up to date with current best practices, thereby making the RSA Guidelines more effective.
- The Road Safety Audit Toolkit is a proactive way to assess the proposed road design's level of safety. Transportation professionals require a tool that can look at the complexity of the highways to enhance decision makers' ability to assess the safety of the roadways. The toolkit will assist practitioners, and future research will look into ways to calibrate the tool to real benefits obtained from the Road Safety Auditor (RSA) recommendations.
- There is room for improvement, particularly in terms of developing a hierarchy ranking of safety flaws to allow for faster decision-making, as well as an enhanced documentation system to aid in the traceability and retrieval of RSA decisions.
- To overcome these concerns, Malaysians must increase designer skills and enhance design verification methods. RSA management issues, warrants, and suggestions were also reviewed.
- More qualitative studies are required because the RSA activities in Malaysia provide in-depth analysis and thorough explanations. In addition, the study requires unique and normal systematic review approaches and needs to practice complementary search strategies such as citation tracking, contacting experts, reference searching and snowballing.

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Tarikh : 20 Januari 2023

Prof. Madya Dr. Nur Hisham Ibrahim
Rektor
Universiti Teknologi MARA
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Tuan,

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Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

“BERKHIDMAT UNTUK NEGARA”

Saya yang menjalankan amanah,

SITI BASRIYAH SHAIK BAHARUDIN
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