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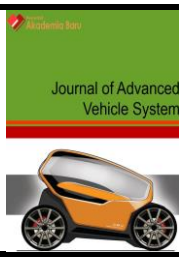

Malaysian Road Crash Data: Current Dimension and Future Potential

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ABSTRACT

Road traffic crash is not only a global pandemic that kills more than a million people a year but has also become a major public health concern in majority of countries, including Malaysia. Various efforts were performed to offset the death figures. And most of the decisions taken to improve road safety are based on traffic crash data, which makes it the backbone of any country's road safety system. In Malaysia, the Royal Malaysian Police (RMP) plays a major role in road crash data collection besides the routine traffic management and enforcement activities. To complement that, Malaysia is among the very few countries in ASEAN that possess its own research-based road crash investigations as an effort in evidence-based approach in tackling road safety issues. Inputs from the in-depth research-based investigation are reported to policy makers and relevant authorities/industries and helped in development of safety countermeasures. However, in a broader sense, there are various other sources of information that could contribute to the richness of road crash information in the country. Future trend understanding and potential efforts in consolidating these data pool will further enhance the national crash database and open for new dimension of Malaysian crash database.

Keywords:
Crash data, authority-based, research-based, in-depth investigations, enforcement, litigation, safety recommendations, data richness

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1. Introduction

Road traffic crash is not only a global pandemic that kills more than a million people a year but has also become a major public concern in majority of countries, including Malaysia. Every year, more than one million people die as a result of road traffic crashes, with more than 30-fold suffers non-fatal injuries [1]. What is more worrying is that despite efforts being put in to curb the number of fatalities and injuries from road traffic crashes, the number of casualties keep on increasing at most parts of the globe [1] and Malaysia is one of it. With approximately 30 million inhabitants, Malaysia is ranked among the riskiest countries by the three internationally comparable indices measured by number of fatalities per 10,000 registered vehicles, 100,000 population, and 1 billion VKT (Vehicle

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Kilometer Travelled) [2]. This is portrayed by the sub-7,000 annual fatalities that never seen a significant drop over the years.

With its status of a fast-growing middle-income country by socioeconomic standpoint (based on Gross National Income) [3], Malaysia has seen people mobility as a vastly increasing trend, both in terms of frequencies and distance travelled. And more exposure on the road tend to contribute higher rate of fatalities among road users. In the 80s, Malaysia recorded an average of 4% annual increment of road traffic fatalities, followed by 5% in the 90s. However, the figure increased at a slower rate of 2% in more recent years (2000–2009) as shown in Figure 1[2].

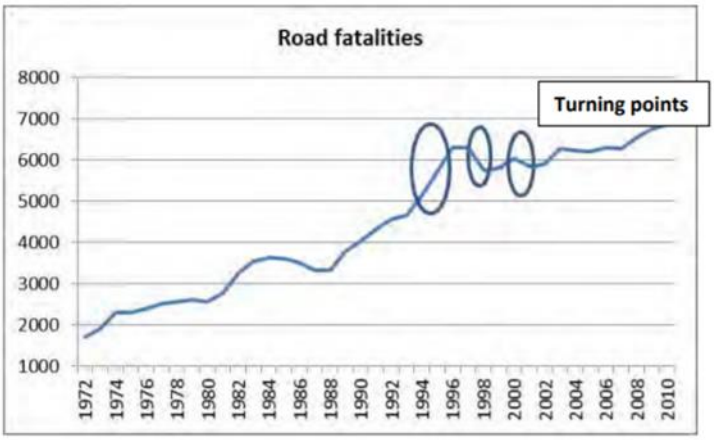

Fig. 1. Malaysian Road Fatalities [2]

Various efforts were performed to offset the death figures. Efforts and interventions has started as early in 1970's from the introduction of the first motorcycle lane along Federal Highway to reduce conflict and crashes [4] to the latest in mandating the use of Child Restraint System (CRS) in year 2020. And most of the decisions taken to improve road safety are based on traffic crash data, which makes it the backbone of any country's road safety system. Errors in this data will lead to misidentification of hazard, road segments, projection of false estimates, and detection of wrong parameters, making the entire road safety exercise ineffective [5]. Therefore, the efficiency and accuracy of crash data collection is crucial.

In Malaysia, the Royal Malaysian Police (RMP) plays a major role in road crash data collection besides the routine traffic management and enforcement activities [4]. To complement that, Malaysia is among the very few countries in ASEAN that possess its own research-based road crash investigations as efforts in evidence-based approach in tackling road safety issues [6].

Through the introduction of the Malaysian Institute of Road Safety Research (MIROS), a new spectrum of road crash investigation was seen in Malaysia. In additional to the authority-based investigation conducted by the RMP which covers a larger continuum of crashes and with more generic fields, the MIROS model was more issue-specific, focusing on the element of vehicular, road design and human behavior. This paper will provide systemic review on both approaches of crash data collection, to understand the status-quo and underlies the potential of Malaysian road crash data comprehensively.

Table 1
Current Crash Data Situation among selected ASEAN countries [6]

COUNTRY	AGENCIES COLLECTING CRASH DATA	SOURCES OF CRASH DATA	COVERAGE OF COLLECTION	NATURE OF CRASH DATA	METHOD OF DATA COLLECTION	STATUS OF NATIONAL DATABASE(S)	CURRENT AVAILABLE DATABASES(S)	INTEGRATION AMONG DATABASES?	NATIONAL DATABASE DATA PROVIDER	USERS OF CRASH DATA	TIMELINE FOR DEFINITION OF FATALITY
Malaysia	RMP & MIROS	Government Agency	Nationwide	Authority-based & Research-based	On-the-spot & Retrospective	Available	MROADS CIRD MSEDARS	No	Traffic Police Research Institute	Government Policy Makers Academician	Within 30 days
Thailand	MOT, Royal Thai Police, Road Accident Victims Protection CO, MOPH, MOI & TARC	Government Agency	Nationwide	Authority-based & Research-based	On-the-spot & Retrospective	Available	TRAMS	Yes	Agencies	Government Policy Makers Academician	Within 30 days
Indonesia	Korps Lalu Lintas Kepolisian Republik Indonesia (Traffic Police Corps of Republic of Indonesia)	Government Agency	Nationwide	Authority-based	On-the-spot	Null	IRSMS (Integrated Road Safety Management System)	No	Traffic Police Corps of Republic of Indonesia	Local and Federal Government Agencies	Within 30 days
Philippines	PNP & MMDA	Government Agency	Nationwide & Regional	Authority-based	On-the-spot	Available	DRIVERS	Yes	Traffic Police Local Government Department of Health	Local and Federal Government Agencies	Within 12 months
Vietnam	Ministry of Public Security (Police), MOT, MOH, MO Justice	Government Agency	Nationwide	Authority-based	On-the-spot	Null	Form 45	No	Ministry of Public Security (Police).	Local and Federal Government Agencies	Within 30 days

2. Concepts of Crash Data Collection

Generally, across the globe, research-based crash investigation is considered as an important tool for understanding traffic safety issues through collecting information from a real-world road crash. For the past years, the different levels of research-based crash investigations conducted around globally is categorized in three levels: base, intermediate and in-depth [7].

This concept has been maturely established based on previous the knowledge and experience on the field of crash investigations which are conducted by a group of subject matter expert known as Crash Analysts or Reconstructionist and is widely accepted. The levels are defined by three elements, source of data, definition and functions and stress out on the depth of data, not the frequencies. In context of Malaysia, MIROS investigation is defined as the in-depth level while authority-based investigations conducted by the RMP serves as an important source of secondary data for all level of investigations, as shown in Table 2.

Table 2
Different levels of crash investigation studies [7]

Level	Data Source	Definition	Functions
Base	▪ police accident reports ▪ road crash statistics	Collection of anonymous crashes data elements that are used mainly for monitoring trends and priority identification.	▪ To access crash situations ▪ To examine trends, risk, make predictions. ▪ To evaluate effectiveness of countermeasures
Intermediate	▪ police reports ▪ crash scene inspection ▪ evidence from police or witnesses ▪ court reports	Medium-level investigations between the statistical and the in depth, suitable for black-spot management	▪ To identify hazardous locations ▪ To reconstruct crashes ▪ Determine countermeasures

In-Depth	▪ police reports ▪ data collection at sites & technical vehicle inspection ▪ injuries assessment ▪ police/witnesses evidence ▪ interviews on occupants	Detailed multidisciplinary investigations with a high number of variables (the number of variables usually varies from a few hundreds to more than a thousand). The aim is to prevent the reoccurrence of serious crashes by discovering structural failures and proposing corrective measures	▪ To identify crash factors ▪ To identify injury causation mechanisms ▪ To study crash and injury prevention measures ▪ To reconstruct crashes ▪ To determine countermeasures/ recommendations ▪ To monitor effectiveness of countermeasures

3. Authority-Based Approach

3.1 Road Traffic Law

In Malaysia, the regulation and investigation of road traffic is stipulated under the 1987 Law 333 Road Transport Act (RTA) 1987 or known as Act 333. By definition under this act, road crashes are described as "an accident or incident that causes any person, property, vehicle, structure or animal damage or injury."

With regards to enforcement, the Royal Malaysia Police (RMP) under Ministry of Home Affairs (MHA) and the Road Transport Department (RTD) under Ministry of Transportation (MOT) have adopted the same act to enforce traffic laws. However, RTD only enforces traffic laws and issues traffic summonses pertaining to vehicular-related issues. On the other hand, the RMP has authority over all matters relating to road traffic crashes. The investigation by the RMP serves as legal purposes grounded by Act 333 covers all level of crash severity; fatal, serious, slight and damage only.

According to the Road Transport Act 1987, 'Injury' was defined as any form of injury sustained by an individual involved in road crashes, including death. Meanwhile, the term 'Vehicle' refers to the device that can be/or shifted or used when travelling to hold any person or object and others in contact with the surface of the earth. 'Motor Vehicle' is typically classified as an engine-driven vehicle. In accordance with the provisions of Section (2) of the act, which describes 'motor vehicle' as a vehicle of any type driven by a device, including a trailer, contained in the vehicle itself and produced or matched for road use. 'Road' means any public road and any other road, including bridges, tunnels, side stops, available to the public. Ferry stations, elevated roads, roundabouts, islands of traffic, dividers of roads, all lanes of traffic, speed lanes, slow lanes, shoulder roads, midline, flyover roads, wall roads, driveways, entrances and exits, toll places, facilities and structures and other equipment to give full effect to its use [8].

3.2 General Flow of Investigation

Figure 2 below shows the flow of Malaysian road traffic authority-based investigation and crash data collection and recording. According to Act 333, all road traffic crash is required to be reported to the RMP and the investigation will conduct at the crash scene by the team from the traffic division, knon as the JSPT (*Jabatan Siasatan dan Penguatkuasaan Trafik*). This department was established after the restructuring of RMP in 2016, previously known as the *Jabatan Penguatkuasaan Trafik* (JPT).

In the event of a road crash, the driver of the involved vehicle and, if there is more than one vehicle, the driver of any such vehicle shall report the crashes at the nearest police station traffic department as soon as reasonably possible and, in any event, within twenty-four hours (24 hours) of the accident (Section 52(2), Act 333). For fatal cases, the Investigating Officer (IO) will receive the

case for recording and conduct investigation. Meanwhile for non-fatal cases, the investigation and recording will be handled by an Assistant Investigation Officer.

Fig. 2. Conceptual Framework of Theory of Planned Behaviour

3.3 Crash Data Management

Since 1992, all road crashes were recorded using a standardized form called POL27. The form consists of 7 sections contains of information on road crash information, vehicle involves and the victims. The form consists of 7 sections contains of information on road crash information, vehicle involves and the victims. Section A describes on report details i.e., time and date or road crashes, the number of vehicles involved, the number of the victim involved and type of crashes. In addition, the definition of "death" is an accident that results in the death of any user involved in the case of a road accident within 30 days from the date of the incident.

Meanwhile, section B describe on-road attribute i.e., type of road surface, road geometry, road condition, type of divider and speed limit. This section also requires police to measures the road and shoulder width. The weather and light condition was explained in Section C. Meanwhile Section D describe more on-road crashes scene such as road number, location, road name etc. The information on the vehicle which involves in road crashes is described in Section E. This include information such as vehicle type, ownership, part of vehicle damage, collision type and vehicle movement during the crash is recorded. Section F and G was recording the victim information included driver, passenger, and pedestrian (if involved). The part of body injured, and driver error also been recorded. The driver also is tested for alcohol and drugs.

This form (POL27) was integrated into the Computerized Accident Reporting System (CARS). Data in this system finally will be compiled at RMP Headquarters and used to generate and analyze the annual road crash statistical trend called Malaysia Road Accidents Statistical Report (Figure 3). This report was published annually and display the findings in descriptive form. This report consists of two (2) section; Section A contains 17 tables (coded as A1 to A17) consists the general road accident statistic i.e., total number of registered vehicles, total number of vehicles involved in road crashes and breakdown of road crashes by state in Malaysia. Meanwhile, the Section B in this report contains 55 tables which described more specific on road crashes (coded as B1 to B55) i.e., statistic vehicle involved in road crashes, road crashes by location, number of road crashes by age group, by road user breakdown etc. All data in this report was published in the table and grouped by fatal/death, serious and slight.

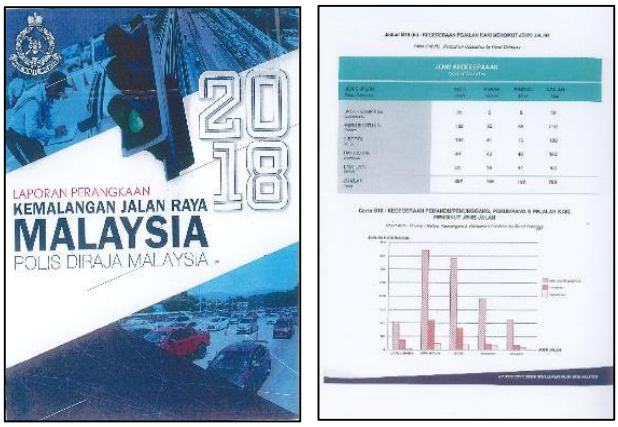

Fig. 3. Malaysian Road Accidents Statistical Report

Generally, data in this report help on set up road safety target, hypothesis for road safety research and study, as evidence for road safety intervention and used for road safety performance monitoring. In addition, data in this report also used to develop Malaysia road safety index as well as to identify road crashes trend of road user categories. Other agencies may also use this information to identify a road crash prone area to propose a repair measure concept. The challenge faced today is that there has been no change in the content of this report since it was first published in the early 90s. No improvement in the analysis is shown although more information can be obtained through POL 27.

4. Scientific Evidence-Based Method

4.1 Malaysian In-Depth Investigation Studies

The main objective of an in-depth crash investigation utilizing research-based approach is to discover in specific contributing factors of a crash and resulting injuries [9]. The investigation results will then be reported to policy makers, relevant authorities, and industries. From this, development of countermeasures with regards to minimizing human and economic impact from road crashes will be conducted [10]. This crucial cycle is illustrated in Figure 4.

Fig. 4. General Cycle from Investigation to Intervention

Realizing this, MIROS, a statutory body under the Ministry of Transports (MOT) was established by the Malaysian government in year 2007. The institute serves as the lead organization in conducting research and development works pertaining to road safety in Malaysia. To propose effective interventions with regards road safety, MIROS not only concentrates on high impact research but also on on-field operations including real-world in-depth crash investigation study. The investigations

are conducted based on evidence-based approach and technical analysis, in contrast to other road crash investigations conducted in Malaysia.

The aspect of the investigations is multidisciplinary, comprising of in-depth inspection on road design and environment factors, vehicle exterior and interior damage, and on occupant safety and injury mechanism. This information is essential to determine the contributing factors of the investigated crashes. It also serves as focal reference for crash database that provides pertinent information on evaluation of the effectiveness of road safety program, generating hypothesis for future area in road safety and supporting the proposed intervention based on real-world evidence.

Crashes investigated by MIROS were reconstructed based on information gathered from post-crash vehicle and site inspection through physics laws and theories and were analysed using specific computer programs for the purpose of vehicle damage analysis, impact simulations and crash animations. Ultimately, the findings are capable in identifying important issues in a particular crash such as the use of seat belts, kinematics of vehicle movement, vehicle speed, vehicle structural integrity and injury factors involved (injury mechanism).

4.2 Process Flow and Scope of Investigation

MIROS investigations cover all types of road crashes throughout Malaysia including Sabah and Sarawak. However, from the magnitude of more than 400,000 reported crashes a year in the nationwide scale [2], MIROS has outlined a screening or scoping criterion before making the decision to conduct investigation i.e. involving three or more fatalities, perceived high profile cases (such as involving important figures in the country), cases requested by the police (RMP), and other reasons which the decision maker(s) thought deem necessary to investigate [11]. These criteria are kept dynamic to cater for current needs. Another category of cases is the MOT National Inquiry Cases, also known only as inquiry cases, which are decided to be such when the number of casualties is too high (usually involving buses) or cases involving multiple vehicles.

A team of two or three Crash Reconstructionist are dispatched to a crash site to collect physical data and evidence with permission from the IO of RMP, which is the main authority handling the case. Case identification is conducted through media monitoring and the information is verified with the authority in charged. Generally, the investigation is conducted retrospectively within a two to three days period, but specifically for inquiry cases, the investigation team normally attend to the case on the same day. The whole process of investigation works conducted by MIROS is certified to the International Organization for Standardization (ISO) 9001 (Figure 5).

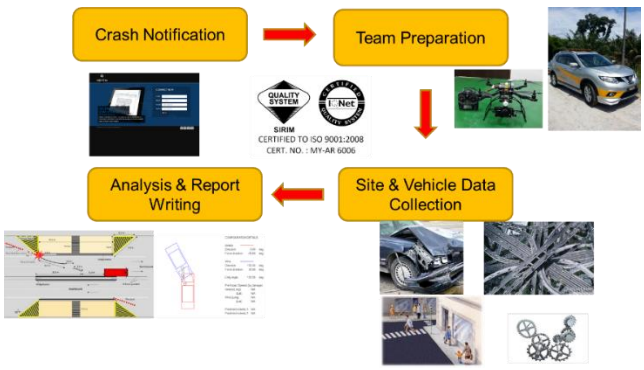

Fig. 5. General Process of MIROS Research-based Investigations

4.3 Outcome from MIROS In-Depth Investigations

In the span of eight years (2007-2020) MIROS has so far investigated more than a thousand cases (1163 cases) with 20 Ministry of Transport (MOT) National Inquiry Case (Figure 6 and Table 3). The findings and recommendations from each of the National Inquiry Case investigation reports have been tabled and presented to relevant agencies and authorities such as the MOT, RMP, and other relevant government and non-government agencies.

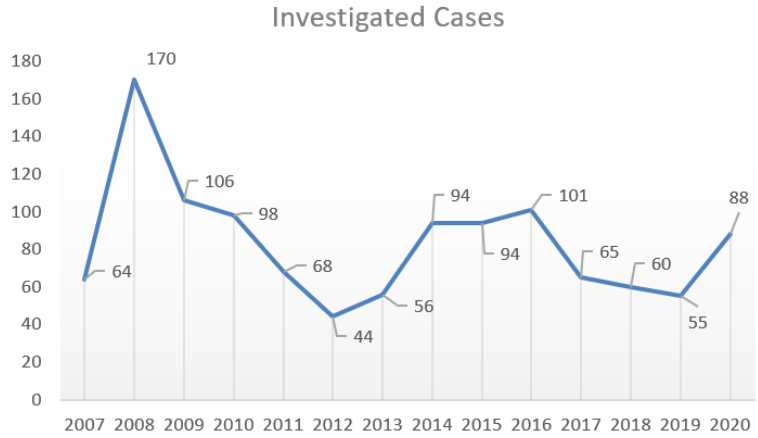

Fig. 6. Investigated Cases by MIROS

Table 3
Inquiry Cases Investigated by MIROS

No	Date	Crash	Casualties
1	7 Mar 2007	Single Bus Crash KM 254 PLUS near Kuala Kangsar	6 fatal, 22 injured
2	29 May 2007	Multiple Vehicle Crash PLUS - E1, Hutan Kampong Toll Plaza	9 fatal, 1 injured
3	13 Aug 2007	Single Bus Crash KM 229 PLUS near Bukit Gantang	22 fatal, 9 injured
4	11 Dec 2007	Bus – Lorry Crash at PLUS Jelapang Toll Plaza	8 fatal, 27 injured
5	1 Aug 2008	Multiple Vehicle Crash, KM 6.7 Cheras-Kajang Highway	2 fatal, 4 injured
6	7 Dec 2008	Single Bus Crash KM 146.5 PLUS near Tangkak	10 fatal, 19 injured
7	13 Apr 2009	Single Bus Crash KM 442.9 PLUS near Rawang	6 fatal, 3 injured
8	26 Dec 2009	Single Bus Crash KM 272.8 PLUS E1 near Ipoh	10 fatal, 3 injured
9	10 Oct 2010	Multiple Vehicle Crash KM 223 PLUS near Simpang Ampat	13 fatal, 40 injured
10	29 Oct 2010	Single Bus Crash KM 36 Lebuhraya Karak near Gombak	7 fatal, 16 injured
11	20 Dec 2010	Single Bus Crash KM 15 Jln Simpang Pulai-Cameron Highlands	28 fatal, 9 injured
12	31 Dec 2011	Batu 6 Jalan Lekir-Setiawan-Teluk Intan, Manjung	7 fatal, 1 injured
13	1 May 2012	Single Bus Crash KM 434.4 PLUS near Bukit Beruntung	3 fatal, 3 injured
14	21 Aug 2013	Single Bus Crash KM 3.6 Genting Highlands-Kuala Lumpur Road	37 fatal, 16 injured
15	24 Mar 2014	Single Bus Crash Jalan Persendiriran, Menara Tinjau Hulu Langat	1 fatal, 5 injured
16	12 July 2016	Multiple Vehicle Crash KM265.8 PLUS near Terowong Menora	2 injured
17	15 Jan 2015	Single Bus Crash KM 326.3 PLUS near Tapah	8 fatal, 21 injured
18	27 Jul 2016	Single Bus Crash KM 17.2 Genting Highlands-Kuala Lumpur Road	14 injured
19	24 Dec 2016	Single Bus Crash KM 137.1 PLUS near Pagoh	14 fatal
20	18 Feb 2017	Multiple Fatality Crash involving Passenger Car vs Bicycles at Johor Bahru	8 fatal, 8 injured

Findings from MIROS crash investigations not only highlight future potential research but are also used as indicators for high impact interventions and baselines for new national policies towards road safety. A number of national policies related to road safety have been implemented since year 2007, as a result from the investigation findings. Among the prominent ones were the adoption of United

Nations Regulation (UNR) for buses into the Malaysian vehicle approval framework, specifically related to the superstructure and seat anchorage, nationwide upgrading of crash barriers along road network from Test Level (TL) 2 to TL 3, the introduction of Safety, Health and Environment (SHE) Code of Practice for commercial vehicles and the implementation of rear seatbelt for passenger cars (refer Figure 7). The findings of the investigations are published in technical reports in the form of specific case investigation reports which are classified as restricted documents and statistical reports which are publicly assessable (Figure 8).

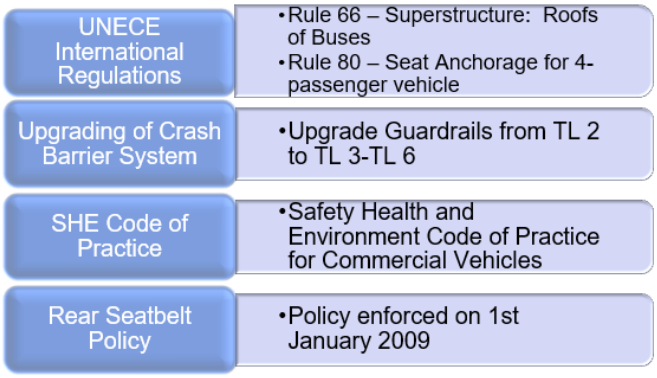

Fig. 7. National Policies on Road Safety Adopted based on In Depth Crash Investigation Findings and Recommendations

Fig. 8. MIROS Technical Reports on Crash Investigation

Other than serving as the basis for implementation of new safety policies, many other countermeasures apart from policy making were implemented from a result from the investigation findings and recommendations. The in-depth crash investigation MIROS is conducted for specific purposes from academic, technical, and systemic views to provide or suggest countermeasures, among others. The outcome of the analysis by MIROS will be channeled to specific organization, department, or ministry as the proposal for countermeasures such as the following [e.g., 12,13]. These interventions involve multiple agencies and stakeholders from varies background and practice for example the road authority, government ministerial level, non-governmental agencies, and also private sectors. Nonetheless these multidisciplinary interventions by various agencies possessed a similar aim in improving the safety requirements of the infrastructure and services related to transportation safety in the country (Table 4).

Table 4
Implemented Countermeasures based on Crash Investigation Findings

Countermeasures	Year
Relocation of Jelapang Toll Plaza	2007
Improvement of Road Signage involving Emergency Escape Ramp at Jelapang Toll Plaza	2007
Removal of Jati trees along North-South Expressway (PLUS)	2008
Development and Implementation of Ambulance Safety Policy	2010
Upgrading of Barrier System along Spg Pulai-Cameron Highlands Road	2012
Upgrading of Barrier System along Genting Highlands Road	2014
Improvement of Speed Management System along Genting Highlands Road	2014
Improvement of Road Signage involving Emergency Escape Ramp at Jelapang Toll Plaza (PLUS)	2014
Banning of Double Deck Bus along Hilly Roads	2014
Establishment of Malaysian Transport Safety Board	2014

The in-depth crash investigation has serves as supporting evidence and technical reference for crash database that provides pertinent information on evaluation of the effectiveness of road safety program, generating hypothesis for future area in road safety and supporting the proposed intervention based on real world evidence. Moreover, the findings from the investigation and analysis conducted not only provide invaluable information relating to a specific crash, but also enables a collective statistical analysis with regards to the crash statistics. As shown in Figure 9 and 10, crucial information such as the crash and injury factors of a crash, e.g. survival rate of vehicle occupants based on seatbelt wearing and many others not only provides a clearer picture for policy makers and industry players for current and future interventions, but also paving the opportunity for further research to be performed on areas which requires more attention.

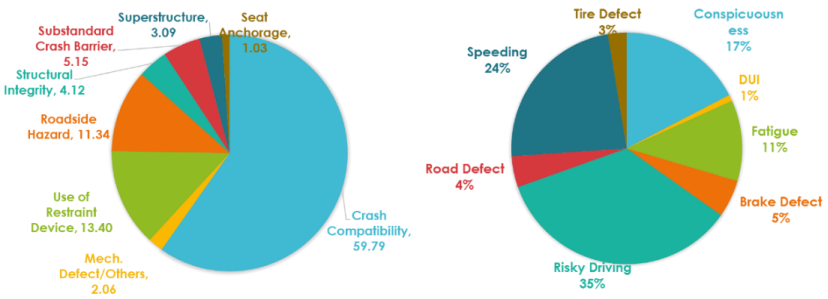

Fig. 9. Crash Occurrence and Occupant Injury Factors in Fatal Bus Crashes

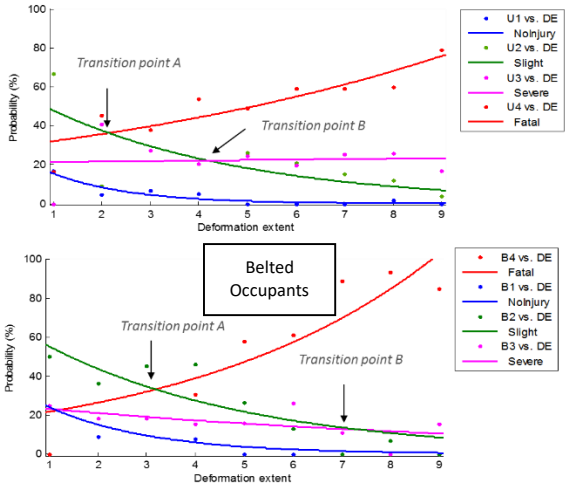

Fig. 10. Survivability Comparison Between Belted and Unbelted Passenger Car Occupants in Crash

5. Richness and Depth of Data

5.1 Depth of Information on Road Crash Data

When discussing Malaysian road crash data, it is well known that the main source of refence is the one collected by the RMP (authority-based approach). This is due to the nature of the crash investigation operation by RMP as it involves large spectrum of coverage with regards to the number of crash cases in Malaysia. As mentioned above, all crash cases need to be reported to the RMP as the main authority in handling road traffic crashes. Failure to report these cases will result in incapability to proceed with subsequent process on medical and insurance claims. This resulted to more than 400,000 reported crashes annually from the RMP database. From case-by-case point of view, the RMP crash data consists of a total of 92 variables covering aspects from the general information of crash up to the injury details of occupant involved. As the main purpose of this investigation approach is mainly to identify the perpetrator in a crash from drivers' point of view, these data set mainly focuses on general variables of the crash itself namely include the general information such as the location, road environment and animal involvement (if any), vehicle and driver information, as well as the details of the passenger(s) and pedestrian (if any). Once identified under the current legal process, the person shall undergo processes of litigation including receiving traffic summonses and penalties under the RTA (Act 333).

On the other hand, MIROS sets of crash data obtained from its research-based investigation brings an additional dimension to the national road crash data availability. As it is aimed to search for answers on how to improve the situations and avoiding the same nature of events from recurring through crash and injury factors identification and safety recommendations, it is purposely done in scientific and technical style. For that reason, the gathered information from the research-based approach is more detailed. The crash variables collected via this approach are relatively in-depth with more than three-fold of the number of variables (more than 300 variables per case). Moreover, it possesses more than just surface degree information; among others availability of information on vehicle dynamics and kinematics, pre-crash travelling speed and impact speeds, details of internal contacts and information on systemic defect found upon investigations which are not offered by the authority-based investigations. With this in-depth knowledge, researchers, investigators, and policy makers may understand the crash thoroughly, provide opportunity for potential research studies on specific areas, and ensuring the proposed safety recommendations are backed with scientific evidence thus sound and justified. The general comparison of crash data variables between the two approaches are showed in Table 5.

Table 5
Crash Data Comparison between Different Approach in Malaysia

Variables	Authority-based	Research-based
General Information		
General case information (location, time, day, weather, lighting conditions)	✓	✓
Crash location (km, adjacent areas, GPS coordinate)	✓	✓
Casualties information	✓	✓
Occupant general details (age, gender, license conditions, employment)	✓	
Crash narrative	✓	✓
Sketch diagram	✓	✓
Road Information		
Road details (measurements, class, carriageway, speed limit)	✓	✓
Pavement details (types, conditions, road markings)	✓	✓

Details of crash barriers & pavement (types, detail measurements)		✓
Types of pavement defects	✓	✓
Types of intersection	✓	✓
Vertical alignment	✓	✓
Gradient height at crash site (min, max & average)		✓
Horizontal alignment	✓	✓
Radius of curvature, super elevation		✓
Vehicle Information		
Role of vehicles in configurations (impacting & impacted)		✓
Details of vehicle involved (types, usage)	✓	✓
Areas of vehicle damage	✓	✓
Damage profiles (damage type, damage width, height, location)		✓
Intrusion details		✓
Vehicle structural conditions (defects type, measurements)		✓
Tyre details		✓
Tyre defects	✓	✓
Helmet & seatbelt wearing	✓	✓
Types of helmet & seatbelt application		✓
Internal contacts (e.g., loading on seats, evidence of contacts on components)		✓
Details of survival space		✓
Airbags deployment		✓
Other details of safety device (e.g., CRS availability, type, application)		✓
Physical evidence & marks (e.g., on airbags, seatbelt webbing, buckle)		✓
Occupant seating details		
Details Kinematics		
First impact configurations	✓	✓
Vehicle movement during impact	✓	✓
Pre impact vehicle movement and locations		✓
Post impact vehicle movement and locations		✓
Details of vehicle kinematics (e.g., types of movement, number of rolls		✓
Secondary impact configurations		✓
Post-crash vehicle kinematics		✓
Pre-crash vehicle speed		✓
Impact speed and energy		✓
Principle direction of force		✓
Collisions deformation classification		✓
Details of occupant ejection		✓
Injury Details		
Injury severity	✓	✓
Injured body regions	✓	✓

5.2 Potential Enrichment of Current Crash Data

As explained earlier, RMP crash database is the main source of the country's road crash data by virtue of its coverage while MIROS in-depth crash data provides a more detailed information of a crash and its issue, thus providing the capacity for evidence-based approach for future related policies and interventions. These are the two renowned sources when talking about Malaysian crash database which is often referred in this moment of time. However, in a broader sense, there are

various other sources of information that could contribute to the richness of road crash information in the country as depicted by Figure 11.

Having said that, these sources are indeed poses different set of ideology with regards to aim and criteria of their data gathering. These sources are either limited to certain type of involvement or function of the involved stakeholders, or even exclusively owned by private entities. For example, as mentioned by Zulhaidi et. al. [11], the involvement of the Fire & Rescue Department (JBPM) is only based on certain conditions e.g., occurrence of fire, victims trapped in severely damaged vehicle, and vehicle carrying hazardous material. Moreover, the highway concessionaires that owned the tolled highways also execute their own crash investigations, in which interested parties can request for the data upon official request and subject to approval by their management [11]. Other potential sources also come from the insurance companies/association, and other government departments which specific role e.g., Department of Chemistry and Ministry of Health.

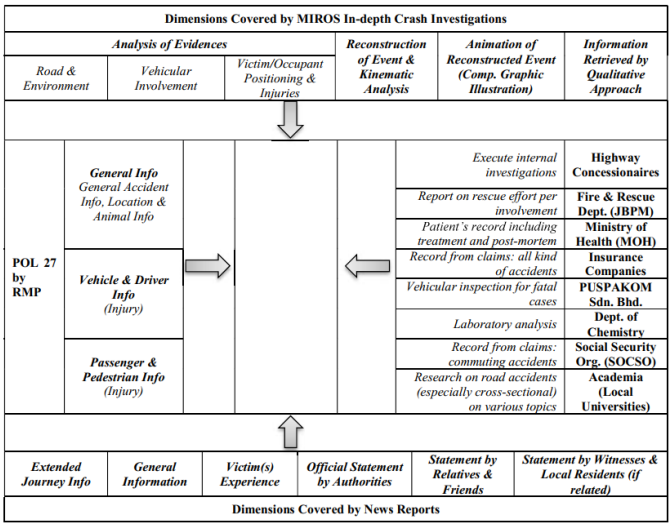

Fig. 11. Current dimension in Malaysian road crash data [11]

6. Conclusions

This paper highlights the current situation of Malaysian road crash data and provides a thorough explanation and comparison between the two investigation/data collection method performed in Malaysia. The first and second part of this review has provided narrative on the role of crash data in Malaysia and ASEAN and explained the concepts of crash data collection conducted worldwide. The third part had discussed on the authority-based approached conducted by the mostly referred crash data pool, which is the RMP, focusing on the aims and the outputs of the investigation. The fourth part has explained on the new dimension offered by MIROS in-depth crash data and how the qualitative approach of it had helped MIROS to come out with relevant safety interventions through its crash reconstruction and scientific evidence-based method. The fifth section has analysed the content of data pool with side-by-side comparisons of the overall variables gathered using the two approaches.

Nevertheless, there are opportunities to further increase richness of current crash data through consolidating other potential data sources which limited to certain type of involvement or functions by a stakeholder of the data thus worth to be explored. Incorporating subsequent types of data focus pertaining to road crash to the national crash data pool will further enhance the national crash database and open for new dimension of Malaysian crash database.

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