

# **UNIVERSITI PUTRA MALAYSIA**

PROTOTYPE DEVELOPMENT OF MOBILE APPLICATION IN ASSESSING COMMUTING ACCIDENT RISK AMONGST COMMUTERS IN THE KLANG VALLEY, MALAYSIA

NUR DEANA SYAFIQAH BINTI ABDULLAH

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By

NUR DEANA SYAFIQAH BINTI ABDULLAH

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

August 2022

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

### PROTOTYPE DEVELOPMENT OF MOBILE APPLICATION IN ASSESSING COMMUTING ACCIDENT RISK AMONGST COMMUTERS IN THE KLANG VALLEY, MALAYSIA

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### NUR DEANA SYAFIQAH BINTI ABDULLAH

August 2022

### Chairman : Associate Professor Ts. Mohd Rafee bin Baharudin, PhD Faculty : Medicine and Health Science

Introduction: Globally, commuting accident risks are always neglected in an organization while most of companies are advancing in Industry 4.0, where technology has enabled the development of innovative products and services that enhance the efficiency and enjoyment of our daily lives. In conjunction with that, there is a need to assess the impact of commuting accidents based on sociodemographic, human, vehicle, road, and environmental factors and to find suitable and effective mitigation strategies to alleviate the associated undesirable outcomes. Methodology: This research was designed to develop a mobile application to assess commuting accident risk levels using artificial intelligence principles, as we are now in the 21st-century technology era. The app was developed by Android Studio and natively used Java languages. A total of 216 respondents from private and government industries participated in this study. The sample population in this study was commuters at Klang Valley from various industries and companies, including private and government sectors, based on Schedule 1, stated in OSHA 1994 using a simple random sampling. Respondents were provided with questionnaires and a link to download the application. The mobile application was tested for indoor testing by relevant organizations to ensure the mobile application function accordingly to all categories of commuters. The mobile application's effectiveness and correlation between each factor's subelement with the risk levels have been analysed. Results: There was a significant difference between with and without mobile applications in determining the level of commuting risks, and the effectiveness was proven with a (p-value = 0.001) at a 95% confidence interval. Chi-square analysis showed that some variables such as driving skill, time-travelling, and travelling distance were insignificant where the p-value was greater than alpha level (0.05). Besides, working industry, e-hailing status, lifestyle, medication intake, alcohol consumption, health status, driving behaviour, type of transportation, vehicle service timing, type condition, travelling in bad weather, road condition, road obstacles, and traffic variables shows that

the was a significant difference with commuting of risk levels where p-value smaller than  $\alpha$  value (0.05) at 95% confidence interval. **Conclusion:** A mobile application is successfully developed and it showed there is a significant difference between risk predicted and risk calculated by the mobile application. Therefore, the mobile application is provenly effective to reduce commuting accidents. In addition, the Communisk mobile application can be an indicator for an organization to monitor exposure risk levels amongst the workers as well as to propose effective solutions.

Keywords: Commuting accident, commuting risk, risk factors, mobile application.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

### PEMBANGUNAN PROTOTAIP APLIKASI MUDAH ALIH DALAM MENILAI RISIKO KEMALANGAN PERJALANAN DALAM KALANGAN KOMUTER DI LEMBAH KLANG, MALAYSIA

Oleh

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### Pengerusi : Profesor Madya Ts. Mohd Rafee bin Baharudin, PhD Fakulti : Perubatan dan Sains Kesihatan

Pengenalan: Di peringkat global, risiko kemalangan berulang-alik kerap diabaikan dalam sesebuah organisasi sementara itu, kebanyakan syarikat semakin maju dalam Industri 4.0, di mana teknologi telah membolehkan pembangunan produk dan perkhidmatan inovatif yang meningkatkan kecekapan dan keseronokan dalam kehidupan seharian. Sehubungan dengan itu, terdapat keperluan untuk menilai kesan kemalangan berulang-alik berdasarkan faktor sosiodemografi, manusia, kenderaan, jalan raya dan persekitaran serta mencari inisiatif yang sesuai dan berkesan untuk mengurangkan faktor kemalangan yang tidak diingini yang berkaitan. Metodologi: Penyelidikan ini direka bentuk untuk membangunkan aplikasi mudah alih untuk menilai tahap risiko kemalangan berulang-alik menggunakan prinsip kecerdasan buatan, kerana kita kini berada dalam era teknologi abad ke-21. Aplikasi ini dibangunkan oleh Android Studio dan bahasa Java yang digunakan secara asli. Seramai 216 responden daripada industri swasta dan kerajaan telah menyertai kajian ini. Populasi sampel dalam kajian ini adalah penumpang di Lembah Klang yang terdiri daripada pelbagai industri dan syarikat, termasuk sektor swasta dan kerajaan, berdasarkan Jadual 1, yang dinyatakan dalam AKKP 1994 menggunakan persampelan rawak mudah. Responden telah dibekalkan dengan borang soal selidik dan pautan untuk memuat turun aplikasi. Aplikasi mudah alih yang dibina telah diuji untuk ujian dalaman oleh organisasi yang berkaitan untuk memastikan aplikasi mudah alih berfungsi dengan sewajarnya kepada semua kategori penumpang. Keberkesanan dan korelasi aplikasi mudah alih antara setiap sub-elemen faktor dengan tahap risiko telah dianalisis. Hasil Kajian: Terdapat perbezaan yang ketara antara responden menjangkakan tahap risikonya dengan aplikasi mudah alih menentukan tahap risiko berulang-alik, dan keberkesanannya dibuktikan dengan nilai (p = 0.001) pada selang keyakinan 95%. Analisis chi-square menunjukkan bahawa beberapa pembolehubah seperti kemahiran memandu.

perjalanan masa, dan jarak perjalanan adalah tidak signifikan di mana nilai p lebih besar daripada tahap alfa (0.05). Selain itu, industri kerja, status e-hailing, gaya hidup, pengambilan ubat-ubatan, pengambilan alkohol, status kesihatan, tingkah laku pemanduan, jenis pengangkutan, masa servis kenderaan, keadaan tayar, perjalanan dalam cuaca buruk, keadaan jalan raya, halangan jalan raya dan keadaan trafik. mempunyai perbezaan yang signifikan dengan tahap risiko kemalangan berulang-alik di mana nilai p lebih kecil daripada nilai  $\alpha$  (0.05) pada selang keyakinan 95%. **Kesimpulan:** Aplikasi mudah alih berjaya dibangunkan dan ia menunjukkan terdapat perbezaan yang ketara antara risiko yang diramalkan dan risiko yang dikira oleh aplikasi mudah alih. Oleh itu, aplikasi mudah alih terbukti berkesan untuk mengurangkan kemalangan berulang-alik. Di samping itu, aplikasi mudah alih yang dikenali sebagai Commurisk boleh menjadi penunjuk bagi organisasi untuk memantau tahap risiko pendedahan dalam kalangan pekerja serta mencadangkan penyelesaian yang berkesan.

Kata kunci: Kemalangan perjalanan, risiko perjalanan, faktor risiko, aplikasi mudah alih.

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This thesis was submitted to the Senate of the Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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# **Declaration by Members of Supervisory Committee**

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

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# LIST OF ABBREVIATIONS

UPM	Universiti Putra Malaysia		
SOCSO	Social Security Organization		
COMMURISK	Commuting Risk		
JKEUPM	Ethics Committee for Research Involving Human Subject		
WHO	World Health Organization		
ILO	International Labor Organization		
RAM	Risk Assessment Matrix		
IBM	International Business Machines Corporation		
API	Application Programming Interface		
UI	Usability Interface		
UX	Usability Experience		
XML	Extensible Markup Language		
PHP	Hypertext Preprocessor		
APK	Android Package Kit		

## CHAPTER 1

### INTRODUCTION

### 1.1 Study Background

Worldwide, in the region of 1.35 million people ended abruptly as a consequence of a road traffic crash. In other words, road traffic injuries became a significant issue and cause of death. Non-fatal injuries affect an estimated 20 to 50 million people, with many of them resulting in bodily injury (WHO, 2020). In Malaysia, a number of accidents reported from 2017 to 2018 showed an increment of 3.88% or 2,714 cases, where 48.49% were commuting accidents (SOCSO, 2018). There was a 28.3% increase from 2001 to 2010 about 17,170 to 22,036 claimed number for commuting accidents have been shown, which is higher compared to decreased workplace accidents from 2001 to 2010 with 31.8% claimed number 61,163 to 35,603 (Hoe, 2014).

Based on the previous research, many existing factors contributed to the commuting accident. A study found that an accident that happened resulted from a combination of the road users, vehicles, roads, and the environment system comprising, and how they interrelate with each other (Yahia et al., 2016). For this study, several factors have been categorized: human factors, vehicle factors, road, and environmental factors, and each element addressed different variables. Apart from the above factors, sociodemographic characteristics were found to be one of the contributing factors to commuting accidents. The critical variables were age, with the elderly being at a higher risk than teens due to vision problems (Sehat et al., 2012), gender (female or male), and occupational, with a person working either shift hours or overtime as a result of stress and fatigue (Wong et al., 2019).

Nowadays, the developments of mobile applications have brought an excessive change in daily lifestyle to every employee. The use of smartphones or mobile devices was widespread in all aspects of the working environment (Sturn et al., 2016). Worldwide, companies were advancing in Industry 4.0, where technology has made possible new products and services that enlarged the efficiency and pleasure of our personal lives [Xu et al., 2018]. Besides, every day, thousands of mobile apps are released on Google Play and Apple App Stores. There are games, social networking applications, and e-commerce apps among these mobile apps (Gao et al., 2014). Furthermore, smartphones or any mobile devices were widespread in all aspects of the working environment. Therefore, it has led to intense demand for developing artificial intelligence software on mobile devices (Sturn et al., 2016).

## 1.2 Problem Statement

Accordingly, Malaysia is one of the countries with diverse industries where workers involved in traffic accidents are primarily the result of fatalities. Most work-related road accident statistics were recorded as commuting accidents (SOCSO, 2012). Furthermore, commuting accidents were large because the majority of workers commute from home to the workplace by private transportation, and the workers exposed to the risk contributed to surging the number of accidents. The World Health Organization (WHO) estimates that 1.24 million people die each year on the road, with about 3,400 people killed every day (Nordin, 2014).

Based on Table 1.1 below, the highest number of cases of fatal accidents is in Selangor followed by Johor in the year 2017 and also the highest number of accidents recorded from 2013 to 2017. Besides, Table 1.2 shows the percentage of road accidents by different transportation from year 2004 to 2013 in Malaysia. Thus, the study decided to conduct the research at Klang Valley.

State/ Year	2013	2014	2015	2016	2017
Perlis	72	61	65	67	37
Kedah	517	525	530	572	327
Pulau Pinang	381	378	360	411	240
Perak	770	750	726	789	429
Selangor	1019	1068	1028	1140	627
Wilayah Persekutuan	243	238	256	232	132
Negeri Sembilan	396	379	355	414	214
Melaka	258	236	256	247	120
Johor	1128	1018	1040	1135	596
Pahang	592	539	532	539	293
Kelantan	378	354	426	453	260
Terengganu	320	276	307	342	191
Sabah	420	420	392	379	211
Sarawak	421	432	433	432	236
Total	6915	6674	6706	7152	3913

Table 1.1 : Total number of fatal cases accident in Malaysia

(adopted from Mohd Khairul Amri, K., Roslan, U., Noorjima, A. W., & Ahmad Shakir, M. S. (2018). Road traffic accident in Malaysia: trends, selected underlying, determinants and status intervention. International Journal of Engineering & Technology, 7(4), 112-117)



Year	Private	Private Mo-	Lorries/	Buses	Taxis
	Vehicle	torcycles	Van		
2004	6.44	1.51	8.42	22.12	10.94
2005	5.85	1.39	7.62	15.06	10.49
2006	5.93	1.40	7.80	16.19	11.01
2007	5.77	1.41	7.92	16.52	12.12
2008	5.01	1.22	4.91	29.57	8.90
2009	5.58	1.28	7.06	14.17	11.00
2010	5.68	1.28	7.20	13.95	11.83
2011	5.65	1.30	7.14	13.94	12.47
2012	6.37	1.23	6.84	16.28	11.83
2013	6.11	1.11	6.48	16.28	11.83
Average	5.84	1.31	7.14	17.23	11.32

Table 1.2 : The percentage of road accident categorized by different transportation

(adopted from Mohd Khairul Amri, K., Roslan, U., Noorjima, A. W., & Ahmad Shakir, M. S. (2018). Road traffic accident in Malaysia: trends, selected underlying, determinants and status intervention. International Journal of Engineering & Technology, 7(4), 112-117)

In light of the possible consequences for the parties concerned as well as the organization's sustainability, the case is considered as being of the utmost importance by many organizations, and more effort is required to prevent this situation (Sukor et al., 2020). Accidents can have major negative effects on a company since they might result in high compensation costs, missed workdays, and decreased productivity. Moreover, it can be argued that the impact of commuting accidents is greater when compared to industrial accidents because these accidents typically result in multiple injuries and because the injuries sustained during these accidents are much worse and more traumatic than those sustained during workplace accidents (ILO, 2010).

Subsequently, the increasing figure of commuting accidents was due to a deficiency of awareness, concentration, focus, comprehensive training programs, commuting safety management, road safety elements in occupational safety and health management systems. Besides, based on SOCSO statistics published, commuting accidents happen as worker rushes to the workplace and other fundamental factors, for instance, speeding, rushing, reckless driving, and texting during driving (Selamat et al., 2015).

Furthermore, from 18 March 2020 until 31 December 2021, the whole of Malaysia was placed under the Movement Control Order (MCO). There was an emerging trend in online delivery services during the pandemic and an increasing trend of road accidents (Lau and David, 2019). Other than that, the influences factors interposed to the commuting accidents are workplace demography such as type of industry, occupation, and exposed hazard; workers

demography, for example, gender, age, duration of employment, health status, and kind of commutes; and journey management, for instance, driving profile, route hazards, vehicles condition, and mileage (Bachani et al., 2012).

Generally, road accidents happen in any part of the globe based on various reasons and where the accident happened. In fact, different areas possess different types of factors, and different persons acquired different attitudes. Hence, the factors have been categorized as human factors, vehicle factors, and road and environmental factors with different variables (Manan et al., 2018). In addition, mobile applications have become vastly crucial in recent years but most of the applications focus on mobile gaming and lifestyle (Konstantin and Frank, 2019). Mobile application is the best platform increasingly used by the current generation in every aspect such as projects, games, social media, and networking (Montiel et al., 2020).

In contrast to face-to-face training awareness and lifestyle change programs, a variety of technology solutions have recently become accessible to give help anywhere and at any time (Granja et al., 2018). Unfortunately, while developing a mobile application, technology is frequently built first, and content and usage environment are only taken into account afterwards (Thomas & Bond, 2014). This results in technical solutions that are time-consuming and frustrating for many users and organizations, leading to less effective treatments, issues with acceptance, and expensive developmental procedures. In order to establish a strong alignment with user needs and preferences, researchers concentrated on stakeholder involvement and accessibility throughout the early development phase (Kelders et al., 2020).

### 1.3 Study Justification

In accordance with this study, the new mobile application was developed, verified, and implemented to analyze commuting risk among commuters in Klang Valley based on existing factors categorized as sociodemographic, human, vehicle, road, and environment. The main perspective was to provide systematic approaches for top management in the making decision based on the level of commuting risks calculated by the 'CommuRisk' mobile application exposed by their employees.

Furthermore, the study was focusing to enhance employees' awareness of the importance of assessing commuting risk factors while traveling to or from a place of work. By developing and implementing the 'CommuRisk' App, the organization is able to monitor the risk level that workers expose as well as can plan and provide immediate suggestions to those workers who have high and medium risk levels for traveling. Thus, the commuting accidents can diminish and factors that contribute to the commuting accidents can be encountered. The mobile application was intended to calculate risk levels.

Digitalization in the health and medicine field, according to Lehne et al. (2019), promises to greatly improve world health. An ever-growing stream of digital health data is produced via electronic evaluation and records, mobile health applications, medical imaging, affordable gene sequencing, novel sensors, and wearable technology. This wealth of data holds enormous potential for healthcare and the organisation when combined with artificial intelligence, cloud computing, and big data analytics. It can also improve the lives of millions of users around the world with better diagnostics, individualised treatments, and early prevention (Insel, 2017).

This mobile application will help users and stakeholders in monitoring the risk levels before starting to commute by providing the actual risks level not by predicting the risk levels. Besides, users can easily do the assessment since it is a handheld IT. The platform has suggestion and statistic features to help coordinate each user's journey and monitor users' progress by stakeholder/organization. In addition, the usability and attractiveness of this mobile application technology can be increased by design simplicity and design strategies such as reduction (e.g., clear design, not providing too much information), and suggestion (e.g., providing the right behaviour to follow).

#### 1.4 Research Questions

- 1. What is the sociodemographic distribution of commuters?
- 2. Are the factors / sub-factors contributing to commuting accidents?
- 3. Is there any mobile application (app) available in assessing commuting risk accidents?
- 4. How does the mobile app contribute to the effectiveness of commuting accident risk levels?
- 5. Is there any association between sub-elements factors and levels of commuting risk?

### 1.5 Objective

### 1.5.1 General Objectives

To develop a mobile application in assessing commuting risks amongst commuters at Klang Valley.

# 1.5.2 Specific Objectives

- 1. To determine the sociodemographic (working industry, e-hailing driver status, age, gender, driving experience, driving skill) among commuters at Klang Valley.
- 2. To determine the sub-element factors (human, vehicle, road, and environmental factors) in assessing commuting accidents.
- 3. To develop a commuting risk mobile app with three risk levels (low, medium, and high).
- 4. To evaluate the application effectiveness of the identified risk factors in determining the level of commuting risks between the predicted risk level by the respondent and the calculated risk level by apps.
- 5. To determine the association between sub-element factors (human, vehicle, road, and environmental factors) and the level of commuting risks.

### 1.6 Hypothesis

**Ha:** There is a significant difference between with and without the mobile application in determining the level of commuting risks.

**Ha:** There is a significant difference between sub-element factors (human, vehicle, road, and environmental factors) and the level of commuting risks.

### REFERENCES

- Abu Bakar, A. (2016). Using a mobile phone while driving as a contributing factor to road crashes among motorist in Klang Valley: a self-reported study.
- Al-Anbari, S., Khalina, A., Alnuaimi, A., Normariah, A., & Yahya, A. (2015). Risk assessment of safety and health (RASH) for building construction. Process Safety and Environmental Protection, 94, 149-158.
- Ali, S. I. A., Elturki, F. A. A., & Jibrel, S. N. (2020, March). Analysis of increment of road traffic accidents in Libya: Case study city of Tripoli. In IOP Conference Series: Materials Science and Engineering (Vol. 800, No. 1, p. 012003). IOP Publishing.
- Alonso, F., Esteban, C., Sanmartín, J., & Useche, S. A. (2017). Reported prevalence of health conditions that affect drivers. Cogent Medicine, 4(1), 1303920.
- Amalfitano, D., Fasolino, A. R., Tramontana, P., & Robbins, B. (2013). Testing android mobile applications: Challenges, strategies, and approaches. In Advances in Computers (Vol. 89, pp. 1-52). Elsevier.
- Aschkenasy, M. T., & Rothenhaus, T. C. (2006). Trauma and falls in the elderly. Emergency Medicine Clinics, 24(2), 413-432.
- Ashraf, I., Hur, S., Shafiq, M., & Park, Y. (2019). Catastrophic factors involved in road accidents: Underlying causes and descriptive analysis. PLoS one, 14(10), e0223473.
- Azadeh-Fard, N., Schuh, A., Rashedi, E., & Camelio, J. A. (2015). Risk assessment of occupational injuries using Accident Severity Grade. Safety science, 76, 160-167.
- Bachani, A. M., Koradia, P., Herbert, H. K., Mogere, S., Akungah, D., Nyamari, J., ... & Stevens, K. A. (2012). Road traffic injuries in Kenya: the health burden and risk factors in two districts. Traffic injury prevention, 13(sup1), 24-30.
- Baldock, M. R. J., & McLean, J. (2005). Older drivers: Crash involvement rates and causes. Centre for Automotive Safety Research.
- Baskara, S. N., Yaacob, H., Hainin, M. R., & Hassan, S. A. (2016). Accident Due To Pavement Condition–A Review. Jurnal Teknologi, 78(7-2).
- Beasley, E., Porath-Waller, A. J., & Beirness, D. J. (2011). A comparison of drugand alcohol-involved motor vehicle driver fatalities. Canadian Centre on Sustance Abuse.

- Bhogaraju, S. D., & Korupalli, V. R. K. (2020, January). Design of smart roadsa vision on indian smart infrastructure development. In 2020 International Conference on COMmunication Systems & NETworkS (COMSNETS) (pp. 773-778). IEEE.
- Bin, N. R. (2014). Rising trend of work-related commuting accidents, deaths, injuries and disabilities in developing countries: A case study of Malaysia. Industrial health, 52(4), 275-277.
- Borsos, A., Birth, S., & Vollpracht, H. J. (2015, October). The role of human factors in road design. In 2015 6th IEEE International Conference on Cognitive Infocommunications (CogInfoCom) (pp. 363-367). IEEE.
- Bucsuházy, K., Matuchová, E., Zůvala, R., Moravcová, P., Kostíková, M., & Mikulec, R. (2020). Human factors contributing to the road traffic accident occurrence. Transportation research procedia, 45, 555-561.
- Carfora, A., Campobasso, C. P., Cassandro, P., Petrella, R., & Borriello, R. (2018). Alcohol and drugs use among drivers injured in road accidents in Campania (Italy): A 8-years retrospective analysis. Forensic science international, 288, 291-296.
- Chai, L. T., & Yat, D. N. C. (2019). Online food delivery services: making food delivery the new normal. Journal of Marketing advances and Practices, 1(1), 62-77.
- Chang, L.Y., & Wen, H. (2006). Analysis of traffic injury severity: An application of non-parametric classification tree techniques. Accident Analysis & Prevention, 38(5), 1019-1027. https://doi.org/10.1016/j.aap.2006.04.009
- Charland, A., & Leroux, B. (2011). Mobile application development: web vs. native. Communications of the ACM, 54(5), 49-53.
- Christoforou, Z., Cohen, S., & Karlaftis, M.G. (2010). Vehicle occupant injury severity on highways: An empirical investigation. Accident Analysis & Prevention,42(6),1601-1620.https://doi.org/10.1016/j.aap.2010.03.019
- Colom, A. (2021). Using WhatsApp for focus group discussions: Ecological validity, inclusion, and deliberation. Qualitative Research, 1468794120986074.
- Costa, N., Silva, R., Mendonça, M. C., Real, F. C., Vieira, D. N., & Teixeira, H. M. (2012). Prevalence of ethanol and illicit drugs in road traffic accidents in the centre of Portugal: An eighteen-year update. Forensic science international, 216(1-3), 37-43.
- Cuerden, R.W., Edwards, M.J., & Pittman, M.B. (2011). Effect of vehicle defects in road accident (Published project report, PPR565). Berks, UK: Transport Research Laboratory (TRL).

- Darma, Y., Karim, M. R., & Abdullah, S. (2017). An analysis of Malaysia road traffic death distribution by road environment. Sādhanā, 42(9), 1605-1615.
- De Boni, R., Bozzetti, M. C., Hilgert, J., Sousa, T., Von Diemen, L., Benzano, D., ... & Pechansky, F. (2011). Factors associated with alcohol and drug use among traffic crash victims in southern Brazil. Accident Analysis & Prevention, 43(4), 1408-1413.
- DEKRA (2005). International strategies for accident prevention. Technical road safety (DEKRA technical paper 58/05). Stuttgart, Germany: DEKRA Automobil GmbH.
- Department of Occupational Safety and Health Malaysia (DOSH), —Occupational Safety and Health (Notification of Accident, Dangerous Occurrence, Occupational Poisoning, and Occupational Disease) Regulations, 2004.
- Department of Statistics Malaysia. (2015) ICT use and access by individuals and households survey report. pp. 1-3, The Office of Chief Statistician Malaysia Department of Statistics, Malaysia.
- Dhondt, S., Macharis, C., Terryn, N., Van Malderen, F., & Putman, K. (2013). Health burden of road traffic accidents, an analysis of clinical data on disability and mortality exposure rates in Flanders and Brussels. Accident Analysis & Prevention, 50, 659-666.
- Diah, J. M., & Hamidun, N. Q. A. (2018, March). The methodology review of traffic safety monitoring by using video recording for express bus in Malaysia. In 2018 IEEE 14th International Colloquium on Signal Processing & Its Applications (CSPA) (pp. 1-6). IEEE.
- Dingus, T.A., Guo, F., Lee, S.E., Antin, J.F., Perez, M., Buchanan-King, M., Hankey, J.M., 2016. Driver crash risk factors and prevalence evaluation using naturalistic driving data. Proc. Natl. Acad. Sci. 113 (10), 2636– 2641.
- Dong, G., Jia, H., Dong, X., & Xia, H. (2020, October). Analysis of Influencing Factors in Traffic Accidents of Road Passenger Transport Vehicles. In IOP Conference Series: Earth and Environmental Science (Vol. 587, No. 1, p. 012011). IOP Publishing.
- Drummer, O. H. (2009). Epidemiology and traffic safety: culpability studies. In Drugs, Driving and Traffic Safety (pp. 93-106). Birkhäuser Basel.
- Drummer, O. H., Gerostamoulos, D., Di Rago, M., Woodford, N. W., Morris, C., Frederiksen, T., ... & Wolfe, R. (2020). Odds of culpability associated with the use of impairing drugs in injured drivers in Victoria, Australia. Accident Analysis & Prevention, 135, 105389.

- Drummer, O. H., Gerostamoulos, J., Batziris, H., Chu, M., Caplehorn, J., Robertson, M. D., & Swann, P. (2004). The involvement of drugs in drivers of motor vehicles killed in Australian road traffic crashes. Accident Analysis & Prevention, 36(2), 239-248.
- Duijm, N. J. (2015). Recommendations on the use and design of risk matrices. Safety science, 76, 21-31.
- Eboli, L., Forciniti, C., & Mazzulla, G. (2020). Factors influencing accident severity: an analysis by road accident type. Transportation research procedia, 47, 449-456.
- Elander, J., West, R., & French, D. (1993). Behavioral correlates of individual differences in road-traffic crash risk: an examination of methods and findings. Psychological bulletin, 113(2), 279.
- Ellen, R., Marshall, S. C., Palayew, M., Molnar, F. J., Wilson, K. G., & Man-Son-Hing, M. (2006). Systematic review of motor vehicle crash risk in persons with sleep apnea. J Clin Sleep Med, 2(2), 193-200.
- Elmontsri, M. (2013). Review of the strengths and weaknesses of risk matrices. Journal of Risk Analysis and Crisis Response, 4(1), 49-57.
- Gadegbeku, B., Amoros, E., & Laumon, B. (2011, October). Responsibility study: main illicit psychoactive substances among car drivers involved in fatal road crashes. In Annals of Advances in Automotive Medicine/Annual Scientific Conference (Vol. 55, p. 293). Association for the Advancement of Automotive Medicine.
- Gao, J., Bai, X., Tsai, W.-T., and Uehara, T. (2014). Mobile Application Testing: A Tutorial. Computer (Long. Beach. Calif). 2, pp. 46–55.
- Gicquel, L., Ordonneau, P., Blot, E., Toillon, C., Ingrand, P., & Romo, L. (2017). Description of various factors contributing to traffic accidents in youth and measures proposed to alleviate recurrence. Frontiers in psychiatry, 8, 94.
- Golob, T. F., & Recker, W. W. (2003). Relationships among urban freeway accidents, traffic flow, weather, and lighting conditions. Journal of transportation engineering, 129(4), 342-353.
- Gothié, M. (2006, June). Heavy vehicle accident factors. In Proceedings of the 9th International Symposium on Heavy Vehicle Weights and Dimensions, Pennsylvania State University, University Park, Pennsylvania, USA.
- Guo, F., Klauer, S.G., Fang, Y., Hankey, J.M., Antin, J.F., Perez, M.A., Lee, S.E., Dingus, T.A., 2017. The effects of age on crash risk associated with driver distraction. Int. J. Epidemiol. 46 (1), 258–265.
- Hakamies-Blomqvist, L., Sirén, A., & Davidse, R. (2004). Older drivers-a review. Statens väg-och transportforskningsinstitut., VTI rapport 497A.

- Hakkanen, H., & Summala, H. (2001). Fatal traffic accidents among trailer truck drivers and accident causes as viewed by other truck drivers. Accident Analysis & Prevention, 33(2), 187-196.
- Hassan, K. H., Rahim, R. A., Ahmad, F., Zainuddin, T. N. A. T., Merican, R. R., & Bahari, S. K. (2016). Retirement planning behaviour of working individuals and legal proposition for new pension system in Malaysia. J. Pol. & L., 9, 43.
- Hasselberg, M., & Laflamme, L. (2008). Road traffic injuries among young car drivers by country of origin and socioeconomic position. International journal of public health, 53(1), 40-45.
- Health Informatics Centre, Planning Division, Ministry of Health Malaysia (2017). Health Facts. Putrajaya, Malaysia.
- Higgins, J. S., Michael, J., Austin, R., Åkerstedt, T., Van Dongen, H. P., Watson, N., ... & Rosekind, M. R. (2017). Asleep at the wheel—The road to addressing drowsy driving. Sleep, 40(2), zsx001.
- Horne, J., & Reyner, L. (1999). Vehicle accidents related to sleep: a review. Occupational and environmental medicine, 56(5), 289-294.
- Hossain, S., Maggi, E., Vezzulli, A., & Mahmud, K. T. (2021). Determinants of awareness about road accidents and knowledge of traffic rules: Empirical evidence from Khulna City in Bangladesh. Theoretical Economics Letters, 11(6), 1247-1272.
- ILO. (2010). World Social Security Report 2010-2011.
- ILO. World Social Security Report 2010/11. http://www.ilo.org/wcmsp5/groups/public/\_\_dgreports/\_\_dcomm/\_\_\_\_ publ/documents/publication/wcms\_146566.pdf.
- International Organization for Standardization, ISO 45001, 1st Edition, 2018, Occupational health and safety management system – Requirements with guidance for use.
- Islam, R., Khan, M. A., Nath, K. D., Hossain, M., Mustagir, G., & Taneepanichskul, S. (2018). Determinants of Road Traffic Injury at Khulna Division in Bangladesh: A Cross-Sectional Study of Road Traffic Incidents. F1000Research, 7, 1238.
- Ismail, A., Razelan, I. S. M., Yusof, L. M., Zulkiple, A., & Masri, K. A. (2021, February). An Overview of Pavement Maintenance Management Strategies in Malaysia. In IOP Conference Series: Earth and Environmental Science (Vol. 682, No. 1, p. 012042). IOP Publishing.
- Jabatan Kerja Raya Malaysia (2016). Guidelines for the selection of speed limit. pp. 1-27, Jabatan Kerja Raya, Malaysia.

- Jais, A. S., & Marzuki, A. (2020). E-hailing services in Malaysia: current practices and future outlook. Planning Malaysia, 18(13).
- Jamaluddin, N., Ho, J. S., Shabadin, A., Megat Johari, N., & Ameer Batcha, W. (2013). Exposure work commuting: case study among commuting accident in Klang Valley, Malaysia. In 16th International Conference Road Safety on Four Continents. Beijing, China (RS4C 2013). 15-17 May 2013.
- Jamaludin M.I., Dahlan N.D., Mohd Elias S., Baharudin M.R. (2017), —Plantation safety: A Conceptual paper on factors that affect safety and health risk assessment in oil palm plantation, Journal of Occupational Safety and Health, 14(2), 33-37.
- John, N. A. (2013). Sharing, Collaborative Consumption and Web 2.0. Media@Lse, Retrieved (26), 17 July 2014.
- Jung, S., Qin, X., & Noyce, D. A. (2010). Rainfall effect on single-vehicle crash severities using polychotomous response models. Accident Analysis & Prevention, 42(1), 213-224.
- Kadilar, G. O. (2016). Effect of driver, roadway, collision, and vehicle characteristics on crash severity: a conditional logistic regression approach. International journal of injury control and safety promotion, 23(2), 135-144.
- Kalra, Gursev. (2009) "Mobile Application Security Testing. "Found stone Professional Services, a division of McAfee, http://www.foundstone.com.
- Khamis, N. K., Deros, B. M., Nuawi, M. Z., & Omar, R. B. (2014). Driving Fatigue among Long Distance Heavy Vehicle Drivers in Klang Valley, Malaysia. Applied Mechanics and Materials, 663, 567.
- Klauer, S.G., Guo, F., Simons-Morton, B.G., Ouimet, M.C., Lee, S.E., Dingus, T.A., 2014. Distracted driving and risk of road crashes among novice and experienced drivers. N. Engl. J. Med. 46 (4), 600–601.
- Kubba, A. E., & Jiang, K. (2014). A comprehensive study on technologies of tyre monitoring systems and possible energy solutions. Sensors, 14(6), 10306-10345.
- Kunji, A. K. (2018). Characteristic of Safety Recovery Zone and Roadside Hazard Cases in Malaysia Road: A Review. International Journal of Engineering Technology and Sciences, 5(3), 90-104.
- Kweon, Y. J. (2011). Crash data sets and analysis. In Handbook of traffic psychology (pp. 97-105). Academic Press.

- Lee, J., Chae, J., Yoon, T., & Yang, H. (2018). Traffic accident severity analysis with rain-related factors using structural equation modeling–A case study of Seoul City. Accident Analysis & Prevention, 112, 1-10.
- Legrand, S. A., Gjerde, H., Isalberti, C., Van der Linden, T., Lillsunde, P., Dias, M. J., ... & Verstraete, A. G. (2014). Prevalence of alcohol, illicit drugs and psychoactive medicines in killed drivers in four European countries. International journal of injury control and safety promotion, 21(1), 17-28.
- Legrand, S. A., Isalberti, C., der Linden, T. V., Bernhoft, I. M., Hels, T., Simonsen, K. W., ... & Verstraete, A. G. (2013). Alcohol and drugs in seriously injured drivers in six European countries. Drug testing and analysis, 5(3), 156-165.
- Li, G., Braver, E. R., & Chen, L. H. (2003). Fragility versus excessive crash involvement as determinants of high death rates per vehicle-mile of travel among older drivers. Accident Analysis & Prevention, 35(2), 227-235.
- Li, G., Keyl, P. M., Smith, G. S., & Baker, S. P. (1997). Alcohol and injury severity: reappraisal of the continuing controversy. Journal of Trauma and Acute Care Surgery, 42(3), 562-569.
- Liew, S., Hamidun, R., & Soid, N. F. M. (2017). Differences of driving experience and gender on traffic offences among Malaysian motorists. In MATEC Web of Conferences (Vol. 103, p. 08016). EDP Sciences.
- Lin, L. J., & Cohen, H. H. (1997). Accidents in the trucking industry. International Journal of Industrial Ergonomics, 20(4), 287-300.
- Liu, J., Li, J., Wang, K., Zhao, J., Cong, H., & He, P. (2019). Exploring factors affecting the severity of night-time vehicle accidents under low illumination conditions. Advances in Mechanical Engineering, 11(4), 1687814019840940.
- Liu, Z., Li, Z., Wu, K., & Li, M. (2018). Urban traffic prediction from mobility data using deep learning. Ieee network, 32(4), 40-46.
- Low, W. Y., Lee, Y. K., & Samy, A. L. (2014). Non-communicable diseases in the Asia-Pacific region: Prevalence, risk factors and community-based prevention. International journal of occupational medicine and environmental health, 1-7.
- Machado-León, J. L., de Oña, J., de Oña, R., Eboli, L., & Mazzulla, G. (2016). Socio-economic and driving experience factors affecting drivers' perceptions of traffic crash risk. Transportation research part F: traffic psychology and behaviour, 37, 41-51.
- Mahat, N., Jamil, N., & Raseli, S. S. (2020). Analysing Road Accident Triggers In Malaysia By Using Analytical Hierarchy Process. Gading Journal of Science and Technology (e-ISSN: 2637-0018), 3(02), 118-125.

- Malavolta, I., Ruberto, S., Soru, T., and Terragni, V., (2015). End Users' Perception of Hybrid Mobile Apps in the Google Play Store, in: Proceedings – 2015 in: IEEE 3rd International Conference on Mobile Services, MS 2015. New York, NY, USA.
- Malaysian Institute of Road Safety Research (2016). Using mobile phone while driving as a contributing factor to road crashes among motorist in Klang Valley: a self-reported study. pp. 12-19, Bangi, Malaysia
- Malin, F., Norros, I., & Innamaa, S. (2019). Accident risk of road and weather conditions on different road types. Accident Analysis & Prevention, 122, 181-188.
- Manan, M. M. A., Várhelyi, A., Çelik, A. K., & Hashim, H. H. (2018). Road characteristics and environment factors associated with motorcycle fatal crashes in Malaysia. IATSS research, 42(4), 207-220.
- Manghani, K. (2011). Quality assurance: Importance of systems and standard operating procedures. Perspectives in clinical research, 2(1), 34.
- Mao, H., Deng, X., Jiang, H., Shi, L., Li, H., Tuo, L., ... & Guo, F. (2021). Driving safety assessment for ride-hailing drivers. Accident Analysis & Prevention, 149, 105574.
- Markowski, A. S., & Mannan, M. S. (2008). Fuzzy risk matrix. Journal of hazardous materials, 159(1), 152-157.
- Marques, A. P., Ramke, J., Cairns, J., Butt, T., Zhang, J. H., Muirhead, D., ... & Burton, M. J. (2021). Global economic productivity losses from vision impairment and blindness. EClinicalMedicine, 35, 100852.
- Martin, J. L., Gadegbeku, B., Wu, D., Viallon, V., & Laumon, B. (2017). Cannabis, alcohol and fatal road accidents. PLoS one, 12(11), e0187320.
- Martin, J.-L., 2002. Relationship between crash rate and hourly traffic flow on interurban motorways. Accident Analysis and Prevention 34,619–629.
- Martinussen, L. M., Møller, M., Prato, C. G., & Haustein, S. (2017). How indicative is a self-reported driving behaviour profile of police registered traffic law offences?. Accident Analysis & Prevention, 99, 1-5.
- McCartt, A. T., Shabanova, V. I., & Leaf, W. A. (2003). Driving experience, crashes and traffic citations of teenage beginning drivers. Accident Analysis & Prevention, 35(3), 311-320.

- McKenna, F. P., & Horswill, M. S. (2006). Risk taking from the participant's perspective: The case of driving and accident risk. Health Psychology, 25(2), 163.
- Meso, J. (2019). Identification Of Potential Road Accident Hot Spots Using Geospatial Techniques A Case Study Of Thika Superhighway (Doctoral dissertation, UoN).
- Miller, T. R., & Galbraith, M. (1995). Estimating the costs of occupational injury in the United States. Accident Analysis & Prevention, 27(6), 741-747.
- Ministry of Health Malaysia. The Truth Behind Road Traffic Crash. Malaysia [8 September 2015]; Available from: http://www.myhealth.gov.my/en/truthbehind-road-traffic-crash/
- Ministry of Women, Family and Community Development. Statistic On Women, Family and Community Malaysia (2016). pp.94-100, 2013, Putrajaya, Malaysia
- Mokhtar, Z. R, Hang, T. B., Muhammad, R. M., Rafee, B. (2019). Developing a Construction Occupational Safety and Health Risk Assessment Matrix (COSHRAM) with Modifying Risk Factors. International Journal of Recent Technology and Engineering (IJRTE).
- Mphela, T. (2020). Causes of road accidents in Botswana: An econometric model. Journal of Transport and Supply Chain Management, 14(1), 1-8.
- Murphy, L. R., DuBois, D., & Hurrell, J. J. (1986). Accident reduction through stress management. Journal of Business and Psychology, 1(1), 5-18.
- Nagata, T., Takamori, A., Berg, H. Y., & Hasselberg, M. (2012). Comparing the impact of socio-demographic factors associated with traffic injury among older road users and the general population in Japan. BMC Public Health, 12(1), 887.
- National Highway Traffic Safety Administration (2015). Critical reasons for crashes investigated in the national motor vehicle crash causation survey.
- National Traffic Law Centre. Investigation and prosecution of distracted driving cases. pp. 1-27, National Highway Traffic Safety Administration, Washington.
- Odeyinka, O. T., & Ajayi, I. O. (2017). Prevalence of hypertension and diabetes and their determinants among commercial drivers in Ibadan metropolis, South-Western Nigeria. Nigerian Journal of Cardiology, 14(2), 75.

- Ogunbodede, E. F., Olurankinse, F., Olabode, A. D., & Ale, A. S. (2018). Accident Black Spots In Ondo State, Nigeria: Implications For Transportation Planning. Journal of Geography and Planning Sciences Volume 3, Number 2, 2018, ISSN 2006 – 1226.
- Orriols, L., Delorme, B., Gadegbeku, B., Tricotel, A., Contrand, B., Laumon, B., ... & CESIR research group. (2010). Prescription medicines and the risk of road traffic crashes: a French registry-based study. PLoS medicine, 7(11), e1000366.
- Ostapczuk, M., Joseph, R., Pufal, J., & Musch, J. (2017). Validation of the German version of the driver skill inventory (DSI) and the driver social desirability scales (DSDS). Transportation research part F: traffic psychology and behaviour, 45, 169-182.
- Owsley, C. (2016). Vision and aging.
- Oxley, J., Corben, B., Fildes, B., O'Hare, M., & Rothengatter, T. (2004). Older vulnerable road users- measures to reduce crash and injury risk. In Monash University Accident Research Centre Reports (Vol. 218, p. 162).
- Pakgohar, A., Tabrizi, R. S., Khalili, M., & Esmaeili, A. (2011). The role of human factor in incidence and severity of road crashes based on the CART and LR regression: a data mining approach. Proceedia Computer Science, 3, 764-769.
- Paleti, R., Eluru, N., & Bhat, C. R. (2010). Examining the influence of aggressive driving behavior on driver injury severity in traffic crashes. Accident Analysis & Prevention, 42(6), 1839-1854.
- Parker, D., West, R., Stradling, S., & Manstead, A. S. (1995). Behavioural characteristics and involvement in different types of traffic accident. Accident Analysis & Prevention, 27(4), 571-581.
- Peden, M., Scurfield, R., Sleet, D., Hyder, A. A., Mathers, C., Jarawan, E., ... & Jarawan, E. (2004). World report on road traffic injury prevention. World Health Organization.
- Peden, M., Scurfield, R., Sleet, D., Hyder, A. A., Mathers, C., Jarawan, E., ... & Jarawan, E. (2004). World report on road traffic injury prevention. World Health Organization.
- Petrova, E. G., & Shiryaeva, A. V. (2019). Road accidents in Moscow: weather impact. Advances in Environmental Sciences, 11(1), 19-30.
- Quddus, M.A., Wang, C., Ison, S.G., 2009. The impact of road traffic congestion on crash severity using ordered response models. In: TRB 2009 Annual Meeting CD-ROM.

- Ravera, S., van Rein, N., de Gier, J. J., & de Jong-van den Berg, L. T. W. (2011). Road traffic accidents and psychotropic medication use in the Netherlands: a case-control study. British Journal of Clinical Pharmacology, 72(3), 505–513. doi:10.1111/j.1365-2125.2011.03994.
- Redelmeier, D.A., Tibshirani, R.J., 1997. Association between cellular-telephone calls and motor vehicle collisions. N. Engl. J. Med. 336 (7), 453–458.
- Repin, S., Evtiukov, S., & Maksimov, S. (2018). A method for quantitative assessment of vehicle reliability impact on road safety. Transportation Research Procedia, 36, 661-668.
- Rivas-Ruiz, F., Perea-Milla, E., & Jimenez-Puente, A. (2007). Geographic variability of fatal road traffic injuries in Spain during the period 2002–2004: an ecological study. BMC Public Health, 7(1), 266.
- Rohayu, S., Sharifah Allyana, S. M., Jamilah, M. M., & Wong, S. V. (2012). Predicting Malaysian Road fatalities for the year 2020.
- Rolison, J. J., Regev, S., Moutari, S., & Feeney, A. (2018). What are the factors that contribute to road accidents? An assessment of law enforcement views, ordinary drivers' opinions, and road accident records. Accident Analysis & Prevention, 115, 11-24
- Rosner, B. (2011). Fundamentals of Biostatistics (The 7th edition). Boston, MA: Brooks/Cole.
- Rotenberg, L., Silva-Costa, A., Diniz, T. B., & Griep, R. H. (2011). Long-term deleterious effects of night work on sleep. Sleep Science, 4(1), 13-20.
- Rusli Bin, N. (2014). Rising trend of work-related commuting accidents, deaths, injuries and disabilities in developing countries: A case study of Malaysia. Industrial Health, 52(4), 275-277.
- Sabir, M. (2011). Weather and travel behavior (Ph.D. thesis). VU University, Amsterdam.
- Salminen, S. (2000). Traffic accidents during work and work commuting. International Journal of Industrial Ergonomics, 26(1), 75-85.
- Schnabel, E., Hargutt, V., & Krüger, H. P. (2010). Meta-analysis of empirical studies concerning the effects of alcohol on safe driving. Druid 6th European Framework Programme. Consulted at< http://www. druid-project. eu/Druid/EN/deliverales-list/downloads/Deliverable\_1\_1\_2. html.
- Sehat, M., Naieni, K. H., Asadi-Lari, M., Foroushani, A. R., & Malek-Afzali, H. (2012). Socioeconomic status and incidence of traffic accidents in metropolitan Tehran: a population-based study. International journal of preventive medicine, 3(3), 181.

- Selamat, M. N., & Surienty, L. (2014). An examination of Commuting Accident In Malaysia. In 3rd Scientific Conference on Occupational Safety and Health: Sci-Cosh (Vol. 12, No. 1)
- Shah, S. A. R., Ahmad, N., Shen, Y., Pirdavani, A., Basheer, M. A., & Brijs, T. (2018). Road safety risk assessment: An analysis of transport policy and management for low-, middle-, and high-income Asian countries. Sustainability, 10(2), 389.
- Shen, S., Benedetti, M. H., Zhao, S., Wei, L., & Zhu, M. (2020). Comparing distance and time as driving exposure measures to evaluate fatal crash risk ratios. Accident Analysis & Prevention, 142, 105576.
- Sinyai, C., & Choi, S. (2020). Fifteen years of American construction occupational safety and health research. Safety Science, 131, 104915.
- Soares, Y. and Fagundes, R. (2017). Software time estimation using regression methods, in IEEE Latin American Conference on Computational Intelligence (LA-CCI). Arequipa, pp. 1–6.
- Solah, M. S., Hamzah, A., Ariffin, A. H., Paiman, N. F., Hamid, I. A., Wahab, M. A., ... & Osman, M. R. (2017). Private vehicle roadworthiness in Malaysia from the vehicle inspection perspective. Journal of the Society of Automotive Engineers Malaysia, 1(3).
- Sorock, G. S., Chen, L. H., Gonzalgo, S. R., & Baker, S. P. (2006). Alcoholdrinking history and fatal injury in older adults. Alcohol, 40(3), 193-199.
- Spielberger, C. D. (2021). Stress and anxiety in sports. In Anxiety in sports (pp. 3-17). Taylor & Francis.
- Sturm U, Luna S, Albert A, Schade S, Kasperowski D (Eds) (2017) Report of the workshop Defining principles and guidelines for mobile apps and platform development for best practice in citizen science. Berlin, December 13-14, 2016.
- Sullivan, J. M., & Flannagan, M. J. (2009). Relationships among driver age, vehicle cost, and fatal nighttime crashes. University of Michigan, Ann Arbor, Transportation Research Institute.
- The Malaysian Workforce 2018 http://www.krinstitute.org/assets/contentMS/img/template/editor/Part2\_K RI\_SOH\_2018.pdf
- The World Bank. (2015). Malaysia Economic Monitor, June 2015 Transforming Urban Transport.

- Tiruneh, B. T., Dachew, B. A., & Bifftu, B. B. (2014). Incidence of road traffic injury and associated factors among patients visiting the emergency department of Tikur Anbessa specialized teaching hospital, Addis Ababa, Ethiopia. Emergency medicine international.
- Todd, L., Amirullah, A., & Hui Xing, C. (2018). E-hailing regulations: striking the right balance. Institute for Democracy and Economic Affairs (IDEAS), Kuala Lumpur.
- Touahmia, M. (2018). Identification of risk factors influencing road traffic accidents. Engineering, Technology & Applied Science Research, 8(1), 2417-2421.
- Tzortzi, A., Kapetanstrataki, M., Evangelopoulou, V., & Behrakis, P. (2021). Driving behavior that limits concentration: a nationwide survey in Greece. International journal of environmental research and public health, 18(8), 4104.
- Ursano, R. J., Fullerton, C. S., Epstein, R. S., Crowley, B., Kao, T. C., Vance, K., ... & Baum, A. (1999). Acute and chronic posttraumatic stress disorder in motor vehicle accident victims. American Journal of Psychiatry, 156(4), 589-595.
- Uskov, V.L. (2013). "Mobile software engineering in mobile computing curriculum, "Interdisciplinary Engineering Design Education Conference (IEDEC), pp.93,99, 4-5 March 2013.
- Verster, J. C., Pandi-Perumal, S. R., Ramaekers, J. G., & de Gier, J. J. (Eds.). (2009). Drugs, driving and traffic safety. Springer Science & Business Media.
- Vingilis, E., & Wilk, P. (2008). The effects of health status, distress, alcohol and medicinal drug use on subsequent motor vehicle injuries. Accident Analysis & Prevention, 40(6), 1901-1907.
- Vlkovský, M., Šmerek, M., & Michálek, J. (2017, October). Cargo securing during transport depends on the type of road. In IOP Conference Series: Materials Science and Engineering (Vol. 245, No. 4, p. 042001). IOP Publishing.
- Vogel, L., & Bester, C. J. (2005). A relationship between accident types and causes. SATC 2005.
- Wall, K. D. (2011). The trouble with risk matrices. DRMI Working Papers Ongoing Research.
- Wang, Y. (2021, February). Research on full-cycle risk management of logistics real estate based on the risk matrix. In 6th International Conference on Economics, Management, Law, and Education (EMLE 2020) (pp. 498-501). Atlantis Press.

- Wasserman, A.I. (2010). Software engineering issues for mobile application development, in Proceedings of the FSE/SDP Workshop on Future of Software Engineering Research. ACM, 2010. pp. 397–400
- Williams, A. F. (2003). Views of US drivers about driving safety. Journal of Safety Research, 34(5), 491-494.
- Wisetjindawat, W., Wilson, R. E., Bullock, S., & de Villafranca, A. E. M. (2019). Modeling the impact of spatial correlations of road failures on travel times during adverse weather conditions. Transportation research record, 2673(7), 157-168.
- Wong, K., Chan, A. H., & Ngan, S. C. (2019). The effect of long working hours and overtime on occupational health: a meta-analysis of evidence from 1998 to 2018. International journal of environmental research and public health, 16(12), 2102.
- Wood, J. M. (2002). Aging, driving and vision. Clinical and experimental optometry, 85(4), 214-220.
- Wooldridge, Dave, and Michael Schneider (2010). The business of app development: Making and marketing apps that succeed. A press.
- World Health Organization. (2006). Risk factors for road traffic injuries. Road Safety Training Manual. http://www. who. int/violence\_injury\_prevention/publications/road\_traffic/world\_report/en Profili territoriali dell'incidentalità in Piemonte.
- World Health Organization. (2015). Global status report on road safety 2015. World Health Organization.
- Xing, Y., Lv, C., Wang, H., Cao, D., & Velenis, E. (2020). An ensemble deep learning approach for driver lane change intention inference. Transportation Research Part C: Emerging Technologies, 115, 102615.
- Xu, J., Liu, J., Sun, X., Zhang, K., Qu, W., & Ge, Y. (2018). The relationship between driving skill and driving behavior: Psychometric adaptation of the Driver Skill Inventory in China. Accident Analysis & Prevention, 120, 92-100.
- Xu, M., David, J. M., & Kim, S. H. (2018). The fourth industrial revolution: opportunities and challenges. International journal of financial research, 9(2), 90-95.
- Xu, Y., Ye, Z., Wang, Y., Wang, C., & Sun, C. (2018). Evaluating the influence of road lighting on traffic safety at accesses using an artificial neural network. Traffic injury prevention, 19(6), 601-606.

- Yaacob, S. S., Ismail, K. I., Shaarial, S. Z. M., Noor, N. M., Selvaraju, R., & Ab Ghani, H. (2018). Commuting Accidents among Health Care Workers Working in Malaysia Government Hospitals. KnE Life Sciences, 79-87.
- Yahia, H. A., FARAG, S. G., MANCHIRYAL, R. K., & OMAN, S. O. (2016). Antecedents and Consequences of Car Driver Behaviours towards RTA Involvement using Structural Equation Models (SEM). International Journal of Transportation Systems.
- Yang, W. D., & Wang, T. (2012). The fusion model of intelligent transportation systems based on the urban traffic ontology. Physics Procedia, 25, 917-923.
- Yannis, G., Papadimitriou, E., & Papantoniou, P. (2014). Distracted driving and mobile phone use: Overview of impacts and countermeasures. In Proceedings of the Communication Technologies and Road Safety Conference, Abu Dhabi.
- Yunin, N. A. M., & Manan, M. M. A. (2020). Causation of Road Traffic Crash Severity on Malaysian Expressways. International Journal of Road Safety, 1(2), 49-52.
- Zakaria, N. H., Mansor, N., & Abdullah, Z. (2012). Workplace accident in Malaysia: most common causes and solutions. Business and Management Review, 2(5), 75-88.
- Zeigler, D. W., Wang, C. C., Yoast, R. A., Dickinson, B. D., McCaffree, M. A., Robinowitz, C. B., & Sterling, M. L. (2005). The neurocognitive effects of alcohol on adolescents and college students. Preventive medicine, 40(1), 23-32.
- Zhang, L., Cui, B., Yang, M., Guo, F., & Wang, J. (2019). Effect of using mobile phones on driver's control behavior based on naturalistic driving data. International journal of environmental research and public health, 16(8), 1464.
- Zuwairy, M. S., Harith, A. A., Nobuyaki, H., Naim, N. M., & Yon, R. (2020). Road Traffic Accidents: A Descriptive Study Of Commuting Injury Among Healthcare Workers In Malaysia 2014-2016. International Journal of Public Health and Clinical Sciences,7(1),58-71.