

INVESTIGATION INTO RISK PERCEPTION OF MOTORCYCLISTS IN PENANG BY INTEGRATING A QUESTIONNAIRE SURVEY WITH COGNITIVE MAPPING

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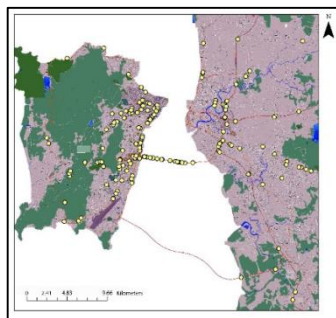
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Graphical abstract



Abstract

This study investigates the risk perception of motorcyclists based on two types of surveys, namely a questionnaire and cognitive mapping. The respondents comprised 138 motorcyclists who commute to work in Penang using the motorcycle as their main means of transportation. The main finding of this study is that different methods of survey will yield different results with regard to motorcyclists' risk perception of road accidents. According to the questionnaire survey, the motorcyclists perceived that the attitude of other road users was the main contributor to motorcycle accidents, while the cognitive mapping revealed that the condition of the roads was the cause of accidents. This study also suggests that by analysing the motorcyclists' risk perception, potential accident locations can be detected earlier and countermeasures can be taken to prevent accidents.

Keywords: Motorcyclists, risk perception, cognitive mapping, questionnaire survey, motorcycle accidents

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1.0 INTRODUCTION

Malaysia is among those countries with a high number of fatal injuries in traffic accidents. In 2012, the Malaysian Institute of Road Safety Malaysia (MIROS) revealed that 18 people are killed on Malaysian roads on a daily basis. This figure is estimated to rise to 29 people by 2020, and would account for 10,000 deaths in 2020. Amongst the fatality cases, 60% was reported to involve motorcyclists [1]. To date, the number of motorcycle accidents is still increasing. One of the reasons why motorcyclists contribute to the high number of road accident fatalities is because they are vulnerable road users with very limited protection [2]. They also tend to experience tiredness while riding, especially those who commute to work and work on

shifts [3]. Meanwhile, Penang is a state that has a high percentage of motorcyclists. George Town, the capital city of Penang, is located in the Greater Penang Conurbation, which is also referred as the George Town Conurbation. Due to the execrable traffic congestion on Penang Island, 33% of road users prefer to use motorcycles during the morning peak hours. Penang is divided into two parts, namely Penang Island and Seberang Perai. Both parts are linked by two bridges, the Penang Bridge (Penang First Bridge) and the Sultan Abdul Halim Muadzam Shah Bridge (Penang Second Bridge) (see Figure 1). A proportion of motorcyclists use both bridges are high. The Penang Second Bridge was officially opened in 2014 and provides a segregated motorcycle lane for motorcyclists.

The number of road crashes and fatalities in Penang continues to increase year by year. In 2012, the Road and Transport Department reported that as many as 37,851 road crashes occurred in Penang. Even though the statistics did not list Penang among the states that ranked high with regard to road accidents in Malaysia, yet the increasing number of road accident fatalities alarmed the Penang State Government. Therefore, in April 2015, Penang launched the Penang Road Safety Strategic Plan 2014-2020 to correspond with the Malaysia Road Safety Plan 2014-2020 and the Decade of Action for Road Safety. One important element that needs to be tackled in the strategic plan is motorcycle safety.

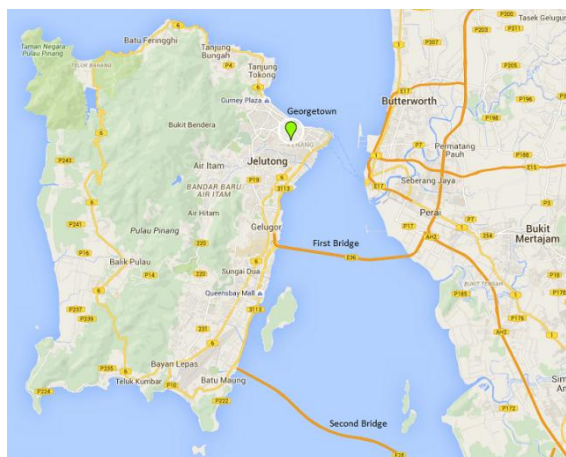


Figure 1 Penang First Bridge and Penang Second Bridgeling the peninsular to Penang Island

Many policies, researches and countermeasures have been implemented in an effort to understand the causes of motorcycle accidents. The first era of motorcycle safety research was initiated in the 1970s focused on whether accidents occurred because motorcyclists were young, neglected to use helmets, failed to switch on their headlamps or were under the influence of alcohol or drugs. During the second period in the 1980s, the focus shifted to investigate why motorcyclists wore or did not wear helmets, and how training affected their behaviour. In the early 1990s, the studies shifted to the beliefs and attitude of motorcyclists concerning road safety and safe riding [4]. Nowadays, studies regarding the perceived risks or perceived hazards to motorcyclists are becoming more important as researchers are beginning to realize that road hazards and risks to motorcyclists are dissimilar to those of other road users [5, 6, 7].

The questionnaire survey is among the typical methods that are being used by researchers to comprehend the motorcyclists' risk perception. The questionnaire survey is an entrenched tool for acquiring information on attitudes, beliefs and reasons for actions [8]. Many studies regarding motorcycle safety have used questionnaires to understand the psychological attributes of motorcyclists that

contribute to risky behaviours and road accidents [9, 10, 11, 12]. Cognitive mapping or mental mapping is the process of encoding, storing, and manipulating experienced and sensed information that can be spatially referenced [13]. In transportation studies, the cognitive mapping technique is usually used to identify locations, route choices and any related studies regarding travel behaviour. However, it can also be used to identify risky locations or black spot areas that can lead to road accidents [14]. The differences between the two methods have been discussed. The cognitive mapping refers to high mental processes that include thoughts, memories, judgements and decision making, while the questionnaire survey is about obtaining thoughts, beliefs and constructs [15].

The questionnaire survey is very common and is widely used in risk perception research. Nevertheless, the practice of cognitive mapping to identify risk perception is rarely explored. Therefore, the aim of this study is to integrate the risk perception questionnaire survey with the cognitive mapping technique to identify risky locations based on the motorcyclists' perception of risk in Penang. The perceived risk that is recorded through the cognitive mapping will be analysed and visualized through spatial maps. The rest of this paper is organized as follows. First, the methodology used in this study is presented in the next section. This is followed by the results and discussion. Finally, the conclusion is presented in the last section to close the paper.

2.0 METHODOLOGY

In order to achieve the objective of this study, a set of questionnaires, consisting of Part A and Part B, was prepared for the survey. Part A of the questionnaire was comprised of questions regarding the socio-demographic factors, the particulars of the respondents with regard to the usage of their motorcycles, and the motorcyclists' perceived risk of accidents. For the socio-demographic factors, the motorcyclists were required to state their age, gender and monthly income, as well as details concerning their motorcycle, such as the brand and capacity. They also had to provide information regarding the motorcycle usage such as the distance travelled per day, the desired speed while riding and the minutes travelled per day. In terms of their perception towards the risk of accidents, the motorcyclists were asked to select the factors that could cause motorcycle accidents based on their perception of several attributes such as the attitude of other road users, the attitude of the motorcyclist, faulty motorcycles, condition of the road surface, road design and road infrastructure.

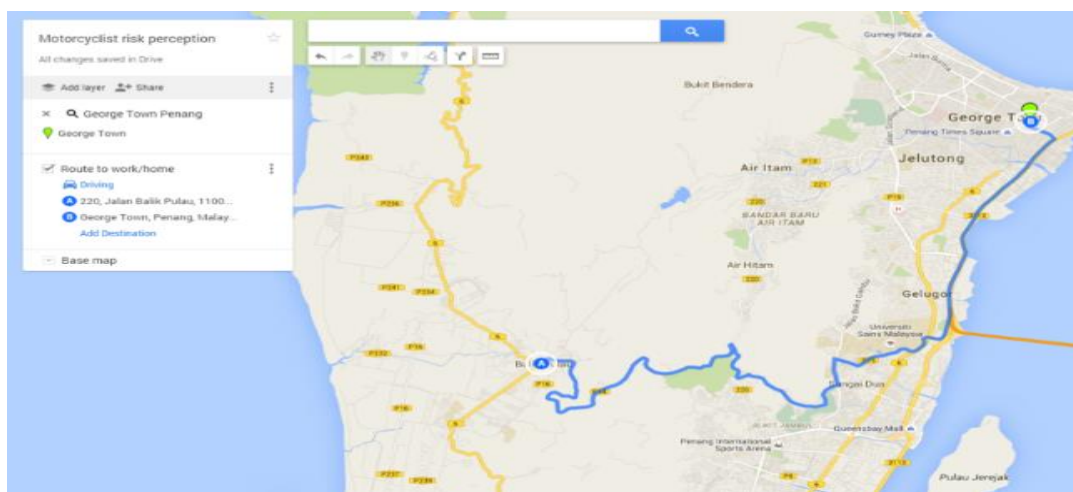
Part B of the survey was a mapping task that required online internet access. The respondents had to select their daily routes to work on the online map at the Google Maps Engine Lite. They were asked to locate and point out the location at the selected

route that they perceived had potential for the occurrence of road accidents. In this task, known as cognitive or mental mapping, they were required to recall the entire route and the locations. They were also asked to rate the level of risk of the locations from 10 to 100 %, and to categorize the risk according to 3 different categories, either being due to the road environment, the attitude of other road users, or their own attitude. They were also asked to rate the percentage of risk for those locations based on their perception (see Figure 2). The data obtained from Parts A and B was then synchronized for further analysis.

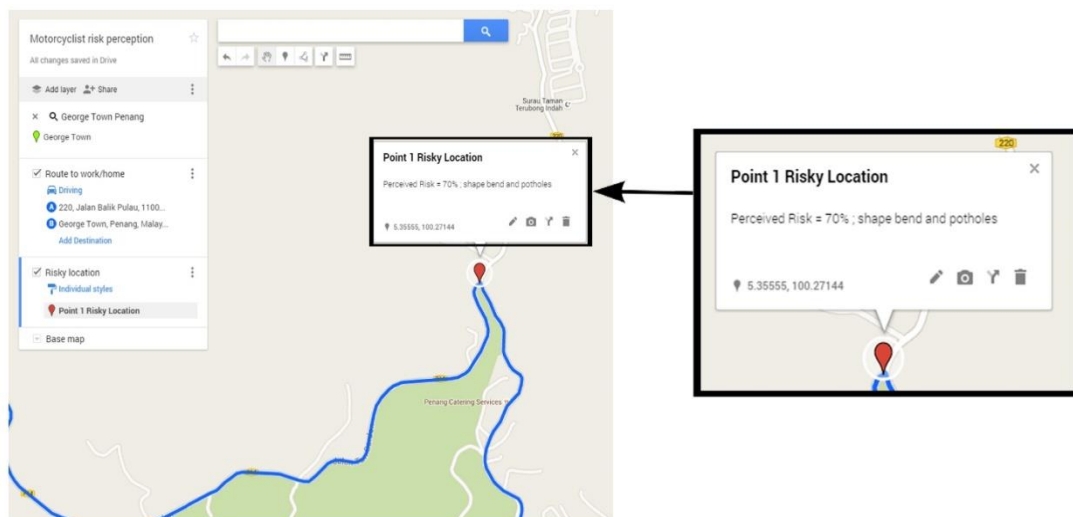
In this study, the targeted respondents were motorcyclists who travelled to/from work place using the motorcycle as their main means of transportation. The questionnaire survey was conducted at several

government agencies in Georgetown, Penang. The respondents for this study were approached randomly those individuals who came to work on motorcycles and invited them to join the survey at a special kiosk. It took about 20 minutes per respondent to finish one set of the survey.

The respondents were given a token of appreciation once they completed the survey. Only 200 respondents were able to join the survey for 3 days during working hours. After considering the flaws and technical errors, only 138 respondents' data were suitable for further analysis. Even though this study only involved with the small numbers of the respondents, outcomes from the cognitive mapping are exploratory results. Therefore, it can be a pilot study for the future study.



(a)



(b)

Figure 2(a) Selected routes for commuting to work/home on Google Maps Engine Lite; (b) Installation of perceived risk location at the selected route

3.0 RESULTS AND DISCUSSION

3.1 Descriptive Statistics

Table 1 presents the descriptive statistics of the respondents in this study that were obtained from Part A of the questionnaire survey. The ages of the respondents ranged between 21 to 59 years. The average age of the respondents was 36 years. The majority of the respondents in the survey were males, who comprised 86% of the total number of respondents compared to only 14% of female respondents. In terms of income, the results showed

that most of the motorcyclists earned around RM 1,501 – RM 3,000 (USD 338 – USD 676) per month. Honda motorcycles were the preferred choice of most of the motorcyclists (56%) compared to other brands. Most of the respondents (41%) preferred motorcycles with an engine capacity of 100 – 125 cc. As for the daily distance travelled, the results showed that the average distance travelled by the respondents was 43 km per day, inclusive of the return trip from the workplace. Most of them (44%) reported that they were likely to ride at a speed of 61 – 80 km/h, and 38% of them reported that they rode on their motorcycle at least 2 hours every day.

Table 1 Descriptive statistics of the respondents

Variable	N (%)	Mean/ Standard deviation
Age	-	36.14/10.57
Gender		
1 - Male	119 (86.2)	1.14/0.346
2 - Female	19 (13.8)	
Income		
1 - < RM 1500 (USD 338)	37 (26.8)	2.03/0.854
2 - RM 1501 - RM 3000 (USD 339 – 675)	69 (50)	
3 - RM 3001 – RM 5000 (USD 676 – 1125)	25 (18.1)	
4 - RM 5001 – RM 7000 (USD 1126 – 1,575)	5 (3.6)	
5 - > RM 7000 (USD 1575)	2 (1.4)	
Motorcycle brand		
1 - Yamaha	37 (26.8)	2.09/1.104
2 - Honda	77 (55.8)	
3 - Modenas	11 (8)	
4 - Kawasaki	5 (3.6)	
5 - SYM	4 (2.9)	
6 - Others	4 (2.9)	
Engine capacity		
1 - < 70	2 (1.4)	2.99/0.912
2 - 71-100	43 (31.2)	
3 - 101-125	57 (41.3)	
4 - 126-150	27 (19.6)	
5 - >151	9 (6.5)	
Distance travelled per day (km)		
1 - <10	41 (29.7)	2.36/1.139
2 - 11-30	34 (24.6)	
3 - 31-60	41 (29.7)	
4 - 61-100	17 (12.3)	
5 - >101	5 (3.6)	
Desired speed		
1 - < 60 km/h	12 (8.7)	2.46/0.746
2 - 61-80 km/h	60 (43.5)	
3 - 81-110 km/h	57 (41.3)	
4 - > 111 km/h	9 (6.5)	
Minutes per day (riding)		
1 - < 60	26 (18.8)	2.49/1.204
2 - 61-120	52 (37.7)	
3 - 121-360	43 (31.2)	
4 - 361-480	5 (3.6)	
5 - 481-600	7 (5.1)	
6 - >600	5 (3.6)	

3.2 Factors Affecting Road Accidents Based on Motorcyclists' Risk Perception

The results from Part A of the questionnaire regarding the perception of motorcyclists towards the factors that affect road accidents are explained in this

section. The respondents in this study were allowed to choose more than one category, and also to mention any factors (other than what had been given) that contributed to road accidents.

A total of 1,875 risk factors were obtained from the 138 respondents. Table 2 shows the six categories of

factors that affect motorcycle accidents and the types of reasons based on the motorcyclists' perception. The results showed that most of the motorcyclists reported that the attitude of other road users is a factor that causes motorcycle accidents to occur, with $n = 425$ (22.7%) out of the total of 1,875 reasons reported. In this category, most of them listed the main reason as other road users not paying attention to motorcyclists (26%), followed by reckless driving (25%), aggressive behaviour (25%) and violation of traffic rules (24%).

The second category that was highlighted as a factor that contributes to motorcycle accidents was the condition of the road surface, with $n = 386$ (20.6%). Most of the motorcyclists, who chose this category reported that potholes are the main

contributor to risky road surfaces (31%), followed by unmaintained road surfaces (27%), slippery road surfaces (23%) and no appropriate pavement markings (19%).

The attitude of the motorcyclists themselves was reported as the third factor that contributes to motorcycle accidents, with $n = 362$, which is 19.3 % of the total number of reasons reported. 28% of the reasons in this category pointed to the aggressive behaviour of the motorcyclists as a factor for the occurrence of motorcycle accidents, while another 27% was due to violation of the rules and regulations, such as not using a helmet or beating the traffic lights, followed by 24% attributed to not paying attention to other road users, and 21% to reckless driving.

Table 2 Results of questionnaire survey on factors affecting road accidents

Category	Reasons	Item count (n)	Percentage of item count (%)
Attitude of other road users (22.7%)	▪ Reckless driving	106	25
	▪ Not paying attention to motorcyclists	109	26
	▪ Aggressive behaviour	107	25
	▪ Violation of traffic rules	103	24
	Total item count	425	
Attitude of motorcyclists (19.3%)	▪ Reckless riding	78	21
	▪ Not paying attention to other vehicles	89	24
	▪ Aggressive behaviour	97	28
	▪ Violation of traffic rules	98	27
	Total item count	362	
Safety aspects (motorcycle) (11%)	▪ Motorcycle design (less visibility)	36	17
	▪ Not checking mirrors, lights, and tires before riding	85	41
	▪ The motorcyclist has to share the same road with other road users	86	42
	Total item count	207	
Condition of the road surface (20.6%)	▪ Unmaintained road surfaces	105	27
	▪ Potholes	120	31
	▪ Slippery road surface	87	23
	▪ No pavement markings	74	19
	Total item count	386	
Condition of the road design (10.7%)	▪ Road design does not follow specifications	62	31
	▪ Unsafe road design	74	37
	▪ Unsuitable road design	65	32
	Total item count	201	
Condition of the road infrastructure (15.7%)	▪ Road infrastructure does not follow specifications	100	34
	▪ Unmaintained road infrastructure	74	25
	▪ Unsafe road infrastructure	65	22
	▪ Unsuitable road infrastructure	55	19
	Total item count	294	

The condition of the road infrastructure was reported as the next factor that contributes to motorcycle accidents, with $n = 294$ (15.7%). It was found that the poor road infrastructure was mainly due to not following the appropriate specifications, including roads being blocked by trees or being vandalised (34%). The other reasons are unmaintained road infrastructure (25%), unsafe road infrastructure (22%) and unsuitable road infrastructure (19%). A total of 207 reasons or 15.7% of the total

categories fell under the category of safety aspects for motorcyclists. 48% of the reasons were attributed to the risk of sharing the lane with other road users. This was followed by the motorcyclists' negligence in not checking the side mirrors, lights or tires before riding (41%), and the design of the motorcycle that made it difficult to be noticed (17%). The least selected category was the condition of the road design, which was only stated as 10.7% of all the reported reasons. 74 points were recorded for unsafe

road design, which was 37% of the total of 201 points that were reported in this category. This was followed by unsuitable road design (32%), and not following the road design specifications (31%).

3.3 Spatial Analysis from Cognitive Mapping

Based on the data obtained from Part B of the survey, a spatial analysis was carried out in order to identify the high risk locations based on the motorcyclists' risk perception. From the respondents' cognitive mapping, the results showed that 349 locations were pointed out as risky locations in Penang. The risky locations were based on the

respondents' perception of the routes travelled by them to their workplace every day. Figure 3 below shows the risky points that have been identified based on three categories, namely road environment, other road users' attitude, and the respondents' attitude. For the road environment category, 202 points were reported as potential locations for road accidents, 95 points were reported for the category of other road users' attitude, and 52 points for the category of the respondents' attitude. The findings showed that the road environment is perceived as a crucial factor that causes road accidents compared to the attitude of road users.

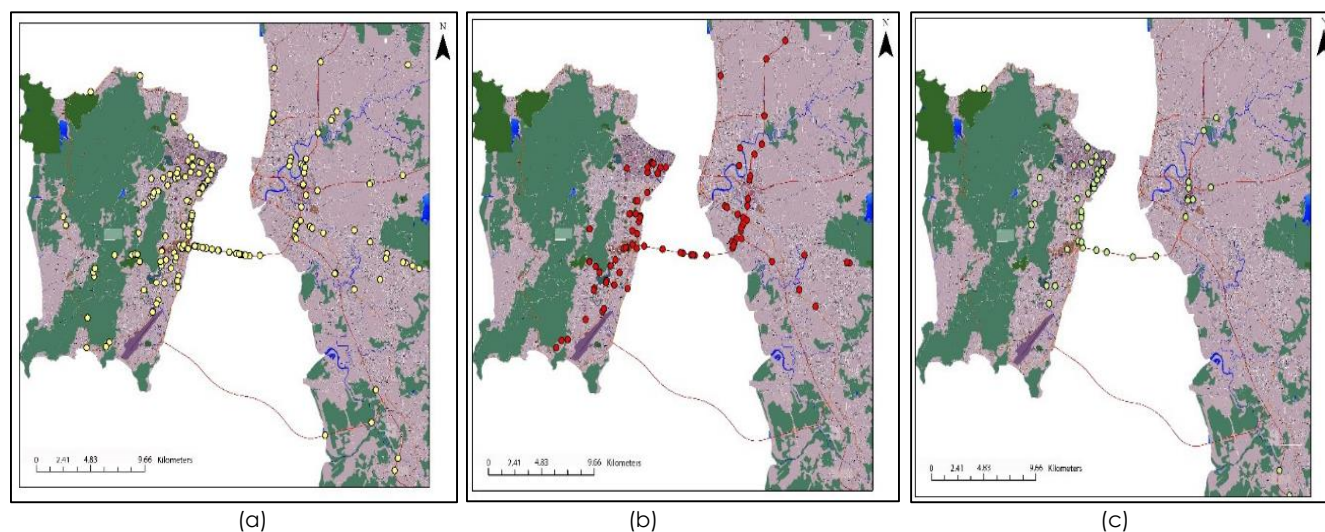


Figure 3 (a) Points of risky locations based on road environment category; (b) Points of risky locations based on other road users' attitude; and (c) Points of risky locations based on motorcyclists' attitude

4.0 CONCLUSIONS

In this study, the motorcyclist's risk perception towards road accidents was successfully analysed through a two-fold survey comprised of a questionnaire and cognitive mapping. For the same sample of respondents, it was found that different methods of survey will obtain different risk perceptions of road accidents. It is interesting to highlight that in answering the questionnaire the motorcyclists tended to refer to psychological attributes such as attitude. At the same time, while the motorcyclists were involved in the cognitive tasks, they tended to focus on the overall perspective of their daily route and focused less on the psychological attributes.

This study revealed that in the questionnaire, the motorcyclists tended to report that other road users' attitude towards motorcyclists, such as reckless driving or paying less attention to the presence of motorcyclists, would likely contribute to accidents. It is because the motorcyclists were claimed to have the tendency to report unrealistic optimism, as if their safety is being threatened by users of other motor vehicles [16]. The findings were different for the online

cognitive mapping, where the motorcyclists had a high risk perception of road accidents based on the road environment category. For example, the results showed that the first Penang Bridge is perceived as a high risk location from the aspect of road environment and the road users' behaviour. This might be because many heavy vehicles tend to travel at high speeds, especially during the evening hours. Furthermore, the design of the motorcycle lane is not favoured by motorcyclists, who usually leave at the end of the lane to weave between other vehicles.

This study also found that motorcyclists are a potential medium for identifying risky locations, the behaviour of traffic offenders, and defects in the road environment. Currently, black spot areas are identified only after several fatalities have occurred at the same location. Most of these black spot areas involve motorcycle accidents. Therefore, this study suggests that by analysing the motorcyclists' risk perception, the black spot areas can perhaps be detected earlier. Subsequently, this information can be used to reduce the occurrence of road accidents at the determined risky locations.

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