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Effectiveness of Traffic Management at Kajang SILK Highway

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ABSTRACT

The traffic management centre is a place of operational monitoring and supervision activities at all highways under the Malaysian Highway Authority. The purpose of this centre is to help gather and disseminate information related to traffic to the users. The information presented by them is accurate and constantly updated from time to time. However, are highway users in Malaysia aware of the existence of this traffic management centre? How can traffic management centre help them to determine their travel times and fast routes especially during the festive seasons? Therefore, researchers have outlined some of the objectives to assist in obtaining information about this study. The main objective of this study is to measure the level of consumer awareness of the highway traffic management centre. In addition, the second objective of this study is to examine the factors causing traffic congestion. Besides, researchers also want to investigate the drivers' attitudes during the congestion which will lead to an accident and congestion and thus propose measures to raise the level of awareness and measures that can be taken to reduce traffic congestion. The technique used to carry out this study is a fuzzy conjoint model. The questionnaire distributed will be administered by the researcher himself. The level of consumer awareness will be measured through the likert scale which uses fuzzy linguistic variables such as one to five scale (never, sometimes, uncertain, ever, always). This study is conducted on users who use the Kajang SILK highway through the Toll Plaza Sg. Ramal. At the end of the study, the researcher hoped that this study would help the authorities, especially the Malaysian Highway Authority and other management in improving the traffic management centre.

Keywords: Traffic management; awareness; congestion; highway; fuzzy conjoint model

INTRODUCTION

Traffic congestion issues are always a hot issue every year, especially during festive seasons and peak times. Traffic congestion refers to the state of the road where the number of vehicles is at a time. Traffic management is a technique in engineering that aims to reduce vehicle movement conflict, increase traffic flow and safety for road users. Traffic management is usually done in urban areas where severe traffic congestion occurs. Yet in Malaysia today, there is a traffic management centre regulated by local authorities (PBT) namely the Kuala Lumpur City Hall a statutory body of the Malaysian Highway Authority (LLM). Each highway in Malaysia has been equipped with high security features including the use of integrated traffic information system (ITIS). In addition, monitoring of centralized traffic flow using a closed-circuit monitoring system (CCTV) is also practiced. Thus, the traffic management centre controls the flow of traffic through the CCTV.

The traffic management centre is established to link all highway traffic control centres throughout Malaysia. Through the establishment of this centre, the operation and smoothness of traffic on all highway networks can be adjusted to enable a comprehensive and efficient highway management system. In other words, this centre is a base that collects and delivers information on traffic related status and smooth traffic on the highways can be obtained by all users to facilitate users to plan their journey.

The traffic congestion not only affects a person's emotions, but it can affect the environment and socio-economic development. Pollution can occur due to increased vehicle emissions and degrades air quality, and noise from vehicles in traffic congestion (Guofa et al. 2020) and large resulting in time delays and fuel wastage (Agyapong & Ojo 2018). Therefore, traffic congestion is closely related to one's emotions. Based on Olga et al. (2019) studies, aggressive driving behaviour and attitude that related to driver stress level are found in high congestion areas and it may increase risks of accidents and decreasing driving performance.

This study was motivated to measure level of consumer awareness about highway traffic management centre as guidance in spreading traffic information, to examine factors causing congestion from consumers' perspective, and to investigate the drivers' attitude when facing traffic congestion. The method in this study is expected to define the effectiveness of traffic management in controlling and handling traffic congestion. The information was collected by spreading questionnaires to Kajang SILK highway users.

METHODOLOGY

RESEARCH DESIGN

The data source is from the primary data obtained from questionnaires to highway users. It is information obtained directly from the data sources formed by researchers. The questionnaire provided by the researcher has 6 parts which consist of 36 questions and the structure of questionnaire as shown in Figure 1.

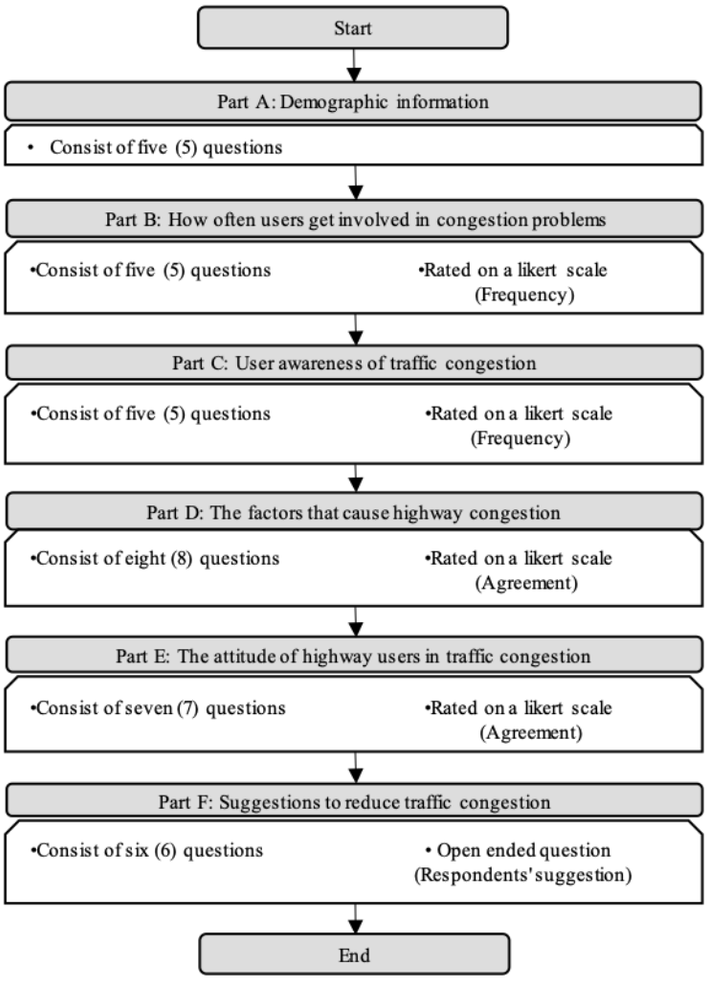

FIGURE 1. Structure of questionnaires

In part A, it concerns demographic information involving sex, age, race, education level and occupation type. While in section B, it aims to evaluate how often users are involved in congestion problems that occur. It is rated on a Likert scale never, occasionally, sometimes, often, and always. There are 5 questions in this section.

The first objective of this study can be evaluated by question in section C, which is about user awareness of the traffic info announced by the traffic management centre. It has 5 questions answered based on scale never, occasionally, sometimes, often and always. The next section, section D, examines the factors that cause highway congestion. In this section, respondents should respond according to the scale of 1 to 5 which is most disagreeing, disagreeing, uncertain, agreeing and agreeing most on the 8 questions provided.

While in section E, the researchers provided 7 questions to study the attitude of highway users when they were in traffic congestion. It should also be answered based on the Likert scale provided. Respondents will also be asked questions about suggestions to reduce the congestion in the last part of which is part F. The researcher provides 6 questions to determine the improvement to reduce traffic congestion.

Through a study written by Wan Rosmanira et al. (2004), a fuzzy conjugate theory to produce a group selection from a number of individual choices over a set of finite criteria and alternatives. The resulting results in the survey involve subjective, inaccurate and vague opinions. As such, the fuzzy set theory is used to generate the exact analysis based on Likert scale. This theory was used first by Nadzri and Abu Osman (2002) to determine the career choice by form five students. In addition, it has also been used in determine the priority level of an attribute that affects respondents who can illustrate the extent of respondents' priorities using non-motorized vehicles in Kota Bharu (Razuhanafi et al. 2015). There are also other studies that optimum aggregation methods need to be based on the idea that an expert's opinion should be greater if the distance between his or her opinion and the other is smaller (Lu et al. 2006).

This theory has been published by Zadeh (1965) to assess the priorities of the respondents to the study. This blurred conjugate theory may represent the uncertainty or confusion inherent in the definition of linguistic variables (Zadeh 1975). In this study, the researcher will refer to the fuzzy conjugate theory produced by Turksen (1992). Decisions are taken into account on a scale of 1 to 5 where the maximum priority is on the scale of five. According to Razuhanafi et al. (2015), this theory is a chain of classical theory sets and probability theory. The set of fuzzy theories takes off between 0 to 1 which is [0,1] [5,8] while the classical set on the previous one takes only 0 and 1 values of [0,1].

POPULATION AND SAMPLING OF STUDIES

The population of the study is based on road traffic volume 2015 which is 87,573 total traffic passed through Plaza Tol Sg. Ramal. Based on the road traffic volume, the sample of the study consists of 383 respondents determined by Krejcie and Morgan (1970). Figure 2 shows the determination of sample size of Krejcie and Morgan (1970).

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	246
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	351
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	181	1200	291	6000	361
45	40	180	118	400	196	1300	297	7000	364
50	44	190	123	420	201	1400	302	8000	367
55	48	200	127	440	205	1500	306	9000	368
60	52	210	132	460	210	1600	310	10000	373
65	56	220	136	480	214	1700	313	15000	375
70	59	230	140	500	217	1800	317	20000	377
75	63	240	144	550	225	1900	320	30000	379
80	66	250	148	600	234	2000	322	40000	380
85	70	260	152	650	242	2200	327	50000	381
90	73	270	155	700	248	2400	331	75000	382
95	76	270	159	750	256	2600	335	100000	384

FIGURE 2. Determination of sample sizes
Note: N is population size and S is sample size
Souce: Krejcie and Morgan (1970)

FUZZY SET PROCEDURE

Based on the theory developed by Turksen (1992), the resulting conjugated model is based on the following:

1. Obtain the priority of respondents based on five linguistic values.
2. Determine the five scales measured to achieve satisfaction in the blurred set.
3. Obtain the weight by dividing the respondents' measurements with the number of respondents.
4. Obtain the degree of value for each respondent by multiplying the weight and each set of blurred set sets.
5. Obtain the overall degree of expertise by summing up the skill level of each of these linguistic values.

$$u_R(y_1, A) = \sum_{i=1}^{T} \frac{W_i}{\sum_{k=1}^{T} Wk} \, u_{Bi}\,(x_1, A) \qquad (1)$$

Where, W_i is weights that illustrate the level of respondents' priorities, A is criteria used, $u_R(y_1, A)$ is overall membership degree for linguistic value denoted by R for all respondents on item A based on linguistic value y_1 is 1,2,3,4,…, $u_{Bi}(x_1, A)$ is degree of expertise for linguistic value for criteria B, and K is number of linguistic values used.

In order to determine the fuzzy similarity degree between two fuzzy sets there are few formulas that can be used. This study will use formula based on Euclidean Inner Product which was introduced by Biswas (1995). The fuzzy similarity degree between fuzzy set R and M is defined by:

$$S(R \cdot M) = \frac{R \cdot M}{\max\,(R \cdot R, M \cdot M)} \qquad (2)$$

where, R is $\mu_R(x_1)$, $\mu_R(x_2)$, ... , M is $\mu_M(x_1)$, $\mu_M(x_2)$ which R and M are vectors, and X is x_1, x_2, ...

The theory that represents the uncertainty/ ambiguity that exists in the definition of linguistic variables.

[least important, not main, uncertain, major, most important]

Lk = {least major, not main, uncertain, major, most}

Lk = (k = 1, 2, 3, 4, 5)

L_1: linguistic value, least important

$$L_1 = \{\frac{1}{1}, \frac{0.75}{2}, \frac{0.5}{3}, \frac{0}{4}, \frac{0}{5}\}$$

L_2: linguistic value, not main

$$L_2 = \{\frac{0.5}{1}, \frac{1}{2}, \frac{0.75}{3}, \frac{0.25}{4}, \frac{0}{5}\}$$

L_3: linguistic value, uncertain

$$L_3 = \{\frac{0}{1}, \frac{0.5}{2}, \frac{1}{3}, \frac{0.5}{4}, \frac{0}{5}\}$$

L_4: linguistic value, major

$$L_4 = \{\frac{0}{1}, \frac{0.25}{2}, \frac{0.75}{3}, \frac{1}{4}, \frac{0.5}{5}\}$$

L_5: linguistic value, most important

$$L_5 = \{\frac{0}{1}, \frac{0}{2}, \frac{0.5}{3}, \frac{0.75}{4}, \frac{1}{5}\}$$

RESULTS

Here are the procedures and results of the fuzzy and conjoint model analysis used:

1. Determine the question that can affect the respondent to choose to answer the objective. The question is shown in Appendix.
2. Determine the priority based on Likert scale to determine respondent's selection. The set of respondents is denoted as R= (R1, R2, Rn, …, R383). While the set of priority levels for questions 1 to 36 for 383 respondents is 1= (5,5, …, 5) as shown in Table 1.

TABLE 1. Respondents' opinions on priority suggestions

	R_1	R_2	R_n	R_{383}	$\sum_{i=1}^{s} R_i$
1	5	5	.	5	1834
2	4	4	.	5	1711
n	.	.	.	.	.
36	5	5	.	5	1673

3. Table 2 below shows the calculation of weights for the level assessment of each of the respondents by dividing each respondent with total respondents. Weights describe the level of priority of the respondents compared with other respondents.

TABLE 2. Weighting level assessment

	W_1	W_2	W_n	W_{383}
1	5/1834	5/1834	.	5/1834
2	4/1711	4/1711	.	5/1711
n	.	.	.	.
32	5/1673	5/1673	.	5/1673

4. To derive the calculation of fuzzy set membership degrees of linguistic value of each respondent, the value needs to multiply by the definition of fuzzy set. The linguistic values as shown in Table 3. The overall degree of membership can be obtained by summing the degree of membership of each of the linguistic values.

$$\mathrm{R}_1 = (5/1834)(\mathrm{L}_1) = \{\frac{1}{1}, \frac{0.75}{2}, \frac{0.5}{3}, \frac{0}{4}, \frac{0}{5}\}$$

$$\mathrm{R}_{383} = (5/1834)(\mathrm{L}_1) = \{\frac{1}{1}, \frac{0.75}{2}, \frac{0.5}{3}, \frac{0}{4}, \frac{0}{5}\}$$

TABLE 3. Overall degree in linguistic values

	L_1	L_2	L_3	L_4	L_5
R_1	0	0	0.001363	0.002045	0.002726
R_2	0	0	0.001363	0.002045	0.002726
R_n	.	.	.	.	.
R_{383}	0	0	0.001363	0.002045	0.002726

5. Total degrees of membership of each domain separately value set is the calculation of the overall set of fuzzy linguistic value, namely Li respondents as Table 4 and the level of priority with the weightage point of every question is shown in Table 5. The highest linguistic value or approaching to 1.000 showing the priority to the question and the tendency of respondents to select the answer. For example, question number 1 (n=1), L5 shows the highest linguistic value with a value of 0.9552. Thus, for (n=1), L5 is the priority.

TABLE 4. The overall set of fuzzy linguistic value

	L_1	L_2	L_3	L_4	L_5
1	0.0060	0.0255	0.5194	0.7448	**0.9552**
2	0.0171	0.0858	0.5618	0.7690	**0.8583**
3	0.0181	0.0849	0.5617	0.7687	**0.8586**
4	0.0185	0.2658	0.7421	**0.8850**	0.4973
5	0.5229	0.5458	**0.6095**	0.3497	0.2582
6	0.0157	0.0812	0.5616	0.7763	**0.8612**
7	0.0155	0.1030	0.5855	0.7790	**0.8135**
8	0.4331	0.5701	**0.6701**	0.3794	0.2267
9	0.0060	0.0255	0.5194	0.7448	**0.9553**
10	0.6828	**0.7224**	0.6248	0.1900	0.0677
11	0.0062	0.0638	0.5574	0.7820	**0.8790**
12	0.0062	0.0638	0.5574	0.7820	**0.8790**
13	0.0153	0.0909	0.5720	0.7713	**0.8408**
14	0.0159	0.0909	0.5711	0.7722	**0.8420**
15	0.0125	0.1092	0.5945	**0.8111**	0.7986
16	0.1603	0.6061	**0.8861**	0.4534	0.0675
17	0.0215	0.0954	0.5681	0.7357	**0.8423**
18	0.0189	0.2064	0.6815	**0.8598**	0.6181
19	0.0185	0.2658	0.7421	**0.8850**	0.4973
20	0.5229	0.5458	**0.6095**	0.3497	0.2582
21	0.1603	0.6061	**0.8861**	0.4534	0.0675
22	0.0185	0.2658	0.7421	**0.8850**	0.4973
23	0.5278	0.4591	**0.5866**	0.3930	0.4127
24	0.1603	0.6061	**0.8861**	0.4534	0.0676
25	0.0215	0.0954	0.5681	0.7357	**0.8423**
26	0.0137	0.1029	0.5864	0.7812	**0.8135**
27	0.0137	0.1029	0.5864	0.7812	**0.8136**
28	0.0060	0.0255	0.5194	0.7448	**0.9553**
29	0.1603	0.6061	**0.8861**	0.4534	0.0675
30	0.0060	0.0255	0.5194	0.7448	**0.9553**
31	0.0155	0.1030	0.5855	0.7790	**0.8135**

TABLE 5. Weightage table

No	Item	Level of priority	Weights
	How often users are involved in congestion problems that occur		
1	Have you ever experienced traffic congestion?	Strongly priority	0.9552
2	How often you be into traffic congestion during festive season?	Strongly priority	0.8583
3	How often you be into traffic congestion during peak hours?	Strongly priority	0.8586
4	How often you are in distress due to accident?	Priority	0.8850
5	Have you ever involved into accident because of traffic congestion?	Undecided	0.6095

continue ...

... continued

	User awareness of the traffic info announced by the traffic management centre		
6	How often you hear / read announcements traffic info?	Strongly priority	0.8612
7	Have you ever heard the announcement over the radio traffic info?	Strongly priority	0.8135
8	Have you ever read the traffic data in social media such as Facebook, Twitter?	Undecided	0.6701
9	Do you use the Waze app to know the current situation of traffic?	Strongly priority	0.9553
10	Have you ever contacted the Traffic Management Centre's hotlines to find out the current situation of traffic?	Not priority	0.7224
	Factors that cause highway congestion		
11	Congestion often occurs due to the increase in number of vehicles.	Strongly priority	0.8790
12	Congestion occurs due to the ratio between the number of vehicles and the area of the road is not balanced	Strongly priority	0.8790
13	Congestion occurs due to the attitude of motorists using the emergency lane	Strongly priority	0.8408
14	Congestion occurs due to a change in the number of lanes of the road. (example: change from three lanes to two lanes)	Strongly priority	0.8420
15	Congestion occurs because motorists are choosing to take their own car rather than using public transport.	Priority	0.8111
16	Congestion is caused by the problem of damaged vehicles not resolved immediately	Strongly priority	0.8861
17	Congestion occurs because the driver slows down the vehicle when passing through a damaged road.	Undecided	0.8423
18	Congestion is occurring due to the construction being done on the roadside.	Priority	0.8598
	The attitude of highway users when they were in traffic congestion		
19	I decided to switch lanes if the traffic on the lanes were moving smoothly	Strongly priority	0.8850
20	I chose to use an emergency lane in case of congestion.	Undecided	0.6095
21	I often do not comply with the rules of the road	Undecided	0.8861
22	I often change the lane without giving a signal	Priority	0.8850
23	I do not follow red light signal.	Undecided	0.5866
24	I often cut off the line to enter the intersection	Undecided	0.8861
25	I often slow down the vehicle when passing through a damaged road.	Strongly priority	0.8423
	To determine the improvement to reduce traffic congestion.		
26	Improving existing roads were damaged.	Strongly priority	0.8135
27	Tightening road laws	Strongly priority	0.8136
28	Improve the quality of public transport	Strongly priority	0.9553
29	Use another alternative path	Undecided	0.8861
30	Construction should begin taking place outside peak hours	Strongly priority	0.9553
31	Suggest that traffic officers are more sensitive and quicker to any accidents	Strongly priority	0.8135

DISCUSSION

This study was conducted to measure the level of user awareness during traffic congestion. This issue arises due to complaints received by the Traffic Management on congestion occurring at main highways.

This study has achieved the four objectives set out to measure the level of highway users awareness of traffic management centres, to study the factors that cause accidents, the attitude of the user to deal with the congestion and the latter is to suggest traffic management measures that can be taken to reduce congestion.

1. Measuring the user awareness about traffic management centre.

Researchers can conclude here that users are aware of the traffic information, but they are less likely to receive information than social media. This can be solved by traffic management centre to create an apps that can provide updated traffic info and besides it can also be a navigation to road users. With such an application, it is expected to reduce traffic congestion as road users can plan their trips with their accurate and fast traffic info.

2. Currently Factors Ability.

There are some factors most agreed upon by respondents who contribute to congestion such as due to the increase in number of vehicles, the driver's attitude using the emergency lane during the festive season and also congestion occurs as drivers slow down the vehicle when passing through a damaged road. These factors can be overcome by the mitigation proposed by the researcher.

3. Introducing Road Consumer Action When Applicable in Failure.

Most road users choose to switch lanes when the traffic on the aisle is smooth and they do not give a signal. This can increase traffic congestion due to sudden vehicle slowing. The vehicles behind will also stop the vehicle unintentionally and indirectly can cause traffic congestion to road users. In addition, road users also often cut lines to enter the intersection. This is a negative attitude that degrades the congestion.

4. Provides mitigation to reduce traffic congestion.

Almost all respondents agreed with the proposals listed. Among them is improving existing roads, tightening the law by installing AES cameras, improving the quality of public transport by providing more MRT and KTM routes in Kajang, Bangi and Putrajaya areas, suggesting that construction times be tightened for heavy vehicles coming in from construction areas and to suggest that patrol officers and traffic be more sensitive to any accidents that occur.

CONCLUSION

In conclusion, this study has fulfilled all the objectives of the study and answers the questions of the study. Researchers hope that in the future, traffic management, especially the Malaysian Highway Authority, will reduce the congestion rate. Proposed improvements for this study in the future are to conduct traffic assessment in the area and to study the highways relating to the Kajang SILK Highway.

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DECLARATION OF COMPETING INTEREST

None

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APPENDIX

The questionnaires as shown below.

No	Item
1	Have you ever experienced traffic congestion?
2	How often you be into traffic congestion during festive season?
3	How often you be into traffic congestion during peak hours?
4	How often you are in distress due to accident?
5	Have you ever involved into accident because of traffic congestion?
6	How often you hear / read announcements traffic info?
7	Have you ever heard the announcement over the radio traffic info?
8	Have you ever read the traffic data in social media such as facebook, twitter?
9	Do you use the waze app to know the current situation of traffic?
10	Have you ever contacted the Traffic Management Centre's hotlines to find out the current situation of traffic?
11	Congestion often occurs due to the increase in number of vehicles.
12	Congestion occurs due to the ratio between the number of vehicles and the area of the road is not balanced
13	Congestion occurs due to the attitude of motorists using the emergency lane
14	Congestion occurs due to a change in the number of lanes of the road. (example: change from three lanes to two lanes)
15	Congestion occurs because motorists are choosing to take their own car rather than using public transport.
16	Congestion is caused by the problem of damaged vehicles not resolved immediately
17	Congestion occurs because the driver slows down the vehicle when passing through a damaged road.
18	Congestion is occurring due to the construction being done on the roadside.
19	I decided to switch lanes if the traffic on the lanes were moving smoothly
20	I chose to use an emergency lane in case of congestion.
21	I often do not comply with the rules of the road
22	I often change the lane without giving a signal
23	I do not follow red light signal.
24	I often cut off the line to enter the intersection
25	I often slow down the vehicle when passing through a damaged road.
26	Improving existing roads were damaged.
27	Tightening road laws
28	Improve the quality of public transport
29	Use another alternative path
30	Construction should begin taking place outside peak hours
31	Suggest that traffic officers are more sensitive and quicker to any accidents