THE MAJOR FACTORS CONTRIBUTING TO ROAD DAMAGES OF FEDERAL ROADS IN MALAYSIA

***Kordi, N. E., *Endut, I. R., *Tarudin, N. F.**
* Malaysia Institute of Transport (MITRANS),
Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia
nurulelma@yahoo.com

Abstract
High quality roads are among the most important public assets that contribute to economic growth in many countries. However, road damages are challenges that seek to inhibit the function of the roads; hence, it constitutes a concern to the authorities and road users. The clarification on the main factors contributing to road damages is essential to understanding the remedial measures and lasting solutions. In identifying the criticality of the factors responsible for road damages, careful triangulation and review of extended literature and questionnaire survey is done on the road users in Malaysia. The findings in this research are based on data analysis of 500 useable questionnaires received. According to the results based on the questionnaires, roads users establish that overloading of vehicles is the major cause of road damages.

Keywords:- federal roads; overloading; questionnaire; road damages; road users

Introduction

The causes of roads damages in Malaysia are still not properly identified and the actual factors of damages are yet to be fully explored and analyzed. The lack of certainty of the causes of road damages adds a great loss to the country as the research for the main cause of road damages lingers on.

Most of the comments from road users are associated with the damages that occur on the roads due to the overloading and heavy vehicles using these roads (Bavani, 2010; Kordi *et al.,* 2012). However, contrary to the prevalent literature and the other road users' speculations, the Pan Malaysia Lorry Owners Association (PMLOA) objects to the fact that trucks do not pose any risk to other road users or damage to the roads (Bavani, 2010).

To explore, assess, analyze and confirm the claims, this study conducted a questionnaire to explore the opinions of the road users regarding the performance of the roads in Malaysia and the main factor that influences roads damage.

Research Methodology

This research employs post positivist paradigm (Goodier *et al.,* 2010); hence, uses a questionnaire survey to conduct systematic data collection method from the appropriate population (Stockton *et al.*, 1999). The purpose of the questionnaire survey is to collect the quantitative information through the structured and standardized questionnaire (Stockton *et al.,* 1999).

The population for the study consists of all the roads users who have used federal roads and highways in Malaysia. The respondents have been selected randomly to avoid bias an opinions (Denscombe, 2010) from the maintenance companies, heavy vehicle agencies, Ministry of Public Works and the normal roads users.

The Design of Questionnaire

The questionnaire was formulated from critical review of extant literature to address the objectives of this research, which is to abtain the data which can be used to statistically test the hyphotheses in the structural equation modelling (SEM) – (the model is not included in this research). However, this research presents only the descriptive data analysis from the 500 responses received from the questionnaire survey. Pilot study has been done to varify of the content (Fellows and Liu, 2008), format and question sequence of the questionnaire through face-to-face interviews with ten (10) experts from various backgrounds of road users (pavement specialist, statistic lecturer, researcher). The experts were also asked to review the quality of the questionnaire. All the comments received were reviewed and considered to develop the finalized questionnaire.

The questionnaire is divided into nine (9) sections. The first section (demography) contains the background of the respondents; such as gender, age, driving experience and type of vehicle they use. The demographic information is important to get an idea about the experience the respondent on the roads condition (Stockton *et al.*, 1999). The rest of questionnaire consists of 37 variables on the factors responsible for causing road damages. The road users perceptions were measured on a five-point Likert scale where 1 represents 'strongly disagree' and 5 for 'strongly agree'. The questionnaire required the respondents to rate the major factors that contribute to road damages in the areas such as traffic volume, loading and climatic effect. This questionnaire also needed respondents to rate the effect of an accident due to roads damage in term of waste. The last part of the questionnaire asks their level of satisfaction of the road infrastructure and their overall feeling when using the federal roads.

Data Collection

The data was collected using the combination of electronic (Flintsch and McGhee, 2009) and face-to-face surveys (Sproull, 1986). However, the main method for this survey is electronic method. The electronic method was via e-mail and they will answer the questionnaire through web-based questionnaires (Denscombe, 2010; Griffis *et al.,* 2003). There are several advantages of using the web-based rather than postal questionnaire such as it can reduce the cost of postal questionnaire, more attractive design and the result are collected and downloaded straight into the database in Microsoft Excel without entering wrong details at the data entry stage into SPSS18 (Denscombe, 2010; Shehu and Akintoye, 2010).

Total Responses Received

A total of 500 useable questionnaires were received and analyzed. According to Hair *et al.* (2011) and Nunnaly (1978) cited by Lee and Yu (2012), in structural equation modeling, the sample size should at least 10 times the number of variables. However, many researchers (Field, 2009; Pallant, 2010) advocated that the higher the response rate in surveys, the better the results. In this study, the sample size is larger than 10 times of number variables, thus it was sufficient for factor analysis (Ling and Ng, 2011; Lee and Yu, 2012).

From the 1202 questionnaires distributed by email, a total of 30.8% of the questionnaires sent were completed, returned and received. Face-to-face questionnaires were also distributed to reach the road users that do not have access to Internet. The whole 100% of face-to-face questionnaires were completed and returned. It appears that for the online survey, the respondents are more comfortable answering the online questionnaires during office hour, as they respond to the e-mail immediately. If the e-mail is sent during weekends (Saturday and Sunday), it is found that the number of questionnaires returned is low because normally the respondents are not on the internet. For the face-to-face questionnaires, the respondents completed the questionnaire on the spot, therefore, there was no problems associated with loss or unreturned questionnaires.

Results And Discussion

Data Sample Characteristics

From the demographic information, the composition of the gender of the respondents was 250 males and females (50% each). A total of 53.6% of respondents are 21-30 years old of age and the majorities (42.2%) of respondents have more than 10 years driving experience. The respondents' year of experience in driving is an essential determinant of their level of knowledge and experience of road condition. Furthermore, most of them are working as professionals, engineers, academicians, logisticians and executives. Therefore, their opinions and knowledge can be applied. Among the respondents, 84.4% use car or taxi as their transport. The descriptive statistics relating to the respondents' profiles are shown in Table 1.

Variable	Frequency	%	Variable	Frequency	%
1. Gender			*3. Driving experience (years)*		
Male	250	50	<1	24	4.8
Female	250	50	2 – 4	84	16.8
2. Age (years)			5 - 7	102	20.4
<20	8	1.6	8 – 10	79	15.8
21 – 30	268	53.6	>10	211	42.2
31 – 40	122	24.4	*4. Type of vehicle used*		
41 – 50	64	12.8	Motorcycle	62	12.4
51 – 60	38	7.6	Car or taxi	422	84.4
>61	0	0	Van or utilities	7	1.4
			Bus	4	0.8
			Medium lorry	4	0.8
			Heavy lorry	1	0.2

Table 1: Profile of Respondents (N=500)

Reliability And Normality Tests

Prior to any statistical analysis, reliability of the data was checked to determine the reliability, where a reliability test was conducted. In the reliability analysis, the Cronbach alpha value is used as the indicator for the internal consistency to check whether the scales used for data collection are reliable or not (Pallant, 2010). The coefficient of Cronbach alpha is between 0 and 1. However, the reliable value is above 0.7 (Aripin, 2009; Pallant, 2010). In this test, the Cronbach alpha value is ***p = 0.806***, which is considered sufficient (Field, 2009) and preferable (Pallant, 2010). Therefore, the 37 questions are consistent and thus, reliable for measuring the factors influenced in the damages and satisfaction of roads users.

Having been successful in the reliability analysis, normality test is subsequently conducted to determine the characteristics of the data (whether parametric or non-parametric) (Field, 2009). Test of normality is used to determine the scores distribution on the dependent variable is 'normal' (Pallant, 2010). If the data distribution is normal, parametric tests are applicable (Aripin, 2009). In this study, the normality test has been conduct using Explore option technique of the Descriptive menu. The normality value of non-significant result achieved when a 'sig. value' in the table labeled 'Test of Normality' is more than 0.05. However, in this study the result of sig. value is 0.000. This means that the distribution is non-normal (hence, non-parametric) because the majority of the respondents answer of low (1=strongly disagree) or high (5=strongly agree) in the Likert scale. However, according to Pallant (2010), this is quite common in larger samples.

T-test Between Engineers And Others

To check the validity of data in term of bias between engineers and other road users that constitute invalid data, *t*-test has been conducted by independent samples to test whether the mean score between these two groups is equal to a predicted value (Pallant, 2010). Groups of engineers are selected because they are considered experts and have highly technical knowledge in relation to pavements, also as a part of a team involved in the program to maintain roads (Markow, 2007). In this test, all the values of significance level (2-tailed) were above 0.05 (see Appendix A). As the values were above the required cut-off of 0.05, this means that there was no statistically significant difference between the opinion of engineers and other road users.

Critically Index For Critical Factors

Having conducted the reliability and normality tests, the research proceeds with further analyses of the data using criticality index. The indexing ranks the major factors influence the roads damages. Therefore, to determine the relative critical index of the listed factors, this study uses formula developed by Odeh and Battaineh (2002), while the analysis uses the weighting scale uses by Cheng (2002). Cheng uses the weighting of the importance index from 0.00, 0.25, 0.50, 0.75 and 1 (Shehu and Akintoye, 2010). In this approach, the weighting substitutes the position of the Likert scale. The maximum criticality index is 1,

therefore, any factor with the highest value between 0 ≥ 1 are considered critical. Equation (1) shows the formula for calculating relative criticality index.

$$C_{rd} = \frac{\sum_{i=1}^{5} W_i X_i}{\sum_{i=1}^{5} X_i} \qquad (1)$$

Where:
C_{rd} = Criticality Index for major factor of roads damage.
i = responses category index = 1,2,3,4 and 5 (position on the Likert scale).
W_i = is the weight assigned to *i*th response = 0, 0.25, 0.5, 0.75 and 1 respectively (Cheng, 2002)
X_i = frequency of the *i*th response given as percentage of the total responses for each cause (Odeh and Battaineh, 2002)

By evaluating the data collected using Equation 1; the respective criticality indices are calculated. Table 2 presents the exploratory and descriptive data for the criticality index and mean. Given that the questionnaire ranged from 1 (strongly disagree) to 5 (strongly agree), higher mean scores reflect responses that indicate higher criticality for the major factor of roads damages. The interpretation of the criticality indices is as follows (Shehu, 2008):

1. 0.00 – 0.25 Weak
2. 0.26 – 0.50 Moderate
3. 0.56 – 0.75 High
4. 0.76 – 1.00 Very high

Assessment items	Variables	Critically index	Rank
Loading			
Overloading vehicles is a major cause of road damage.	L2	0.821	1
Heavy vehicles are driven slowly because they carry heavier loads.	L3	0.820	2
Increasing the load limit will reduce the life span of the roads.	L4	0.769	3
Heavy vehicles that use the roads are always overloaded.	L1	0.759	4
Traffic volume			
Federal roads in Malaysia are no longer capable of withstanding additional traffic volume.	TV2	0.725	1
Traffic volume on federal roads is higher than tolled roads.	TV3	0.716	2
High traffic volume of vehicles contributes to damage.	TV1	0.699	3
Road users prefer to use federal roads compared to tolled roads.	TV4	0.617	4
Climatic effect			
The type of soil used in construction of the road may affect the strength of that road.	CE4	0.800	1
The road materials used in Malaysia can be easily damaged when continually exposed to water and flooding.	CE2	0.794	2
Alternating weather conditions (heavy rain followed by heat and vice versa) cause damage to the roads.	CE3	0.762	3
Heavy rainfall weakens the road structure.	CE1	0.717	4
Roads damages			
Cracking on the road surface increases uncomfortable feelings during driving.	RD2	0.927	1

Damaged roads can cause accidents.	RD3	0.911	2
Damage roads can cause traffic jams as drivers need to drive slowly.	RD4	0.900	3
Heavy vehicle on the road induced the road damages.	RD5	0.881	4
Low vehicle speed increases the longitudinal deformation (rutting) of road surface.	RD1	0.542	5
Accident			
Accidents cause damage to vehicles.	ACC4	0.943	1
Accidents cause delays to other road users.	ACC1	0.936	2
Accidents cause injuries to drivers and passengers.	ACC5	0.919	3
Accidents cause injuries to victims.	ACC6	0.918	4
Accidents cause trauma to victims.	ACC3	0.906	5
Accidents cause damage to road facilities.	ACC2	0.827	6

Table 2: Major Factors of Roads Damages

The major categories of factors that contribute to road damages are divided into three, which are (i) loading, (ii) traffic volume and (iii) climatic effect (Saraf *et al.*, 1995; Wong and Ruban, 2010; Kordi *et al.*, 2011; Shahid, 2011). To look at the most critical factor of each category, the criticality index and mean ranking have been conducted separately.

Main factors of road damages

According the questionnaire responses based on the category of **'loading'**, *'overloading vehicles is a major cause of road damage'* and *'heavy vehicle are driven slowly because they carry more loads'* were the most loading with same the criticality index of 0.82. From these results, road users believe that loading is the major factor contributing to the damages because normally the damages occurred on the left lane in which heavy vehicle use this lane due to carrying more load and driving at a low speed; thus, distribution or spreading of load become greater (Marshek *et al.*, 1986; Gillespie and Karamihas, 1994; Kordi *et al.*, 2012).

In the category of **'traffic volume'**, respondents believe *'federal roads in Malaysia are no longer capable of withstanding additional traffic volume'* with 0.73 critically index as a highest ranked in this category. The lower loading is on *'road users prefer to use federal roads compared to tolled roads'*. This result is not surprising because tolled expressway are better maintained and well performed than federal roads (Mansor, 2010). Road users do not mind paying tolls as long as they feel comfortable while driving.

The highest factor that affects road conditions is under **'climatic effect'** is *'the type of soil used in construction of the road may affect the strength of that road'* (*Crd* = 0.80); followed by *'the road materials used in Malaysia can be easily damaged when continually exposed to water and flooding'* with 0.79 critically index. In nature, roads performance can be affected by climatic change. Therefore, it is important to construct and use high quality materials to ensure the roads can withstand the effects of the climate. According to Carrera *et al.* (2009), climatic change influences the performance of roads because the current design theory and construction techniques are based on the current climate. Therefore, if the future climate changes, the design and construction method also needs to be amended to suit the climate.

Road damages effect to accident and waste

The main priority for drivers when driving is the road condition because the result shows the highest factor in the category of road damages is *'cracking on the road surface increases uncomfortable feelings during driving'* which has 0.92 criticality index. Drivers have to slow down their vehicle to avoid damaged roads; hence, causes traffic congestion.

In this research, it has been hypothesized that damage to roads can lead to accidents, and respondents believe that *'accidents cause damage to vehicles'* and *'accidents cause delays to other road users'* which has the same result of criticality index of 0.94 in category of accident. According to Ramli (2012) and

Yaacob (2010), normally victims do not notice road damaged (pot holes) especially during heavy rain and at night; thus, causing injuries and trauma to victims.

Road damages also cause waste in term of time and financial as respondents state *'severe road damages take some time to be repaired by maintenance company'* when this factor was ranked first in the category of waste with critically index of 0.83 whereas *'government spends a lot of money for maintaining/repairing the damaged roads'* to improve the roads performance in Malaysia is the lowest factor of waste with 0.72 critically index. These results indicate that respondents feel maintenance company are slow to take action to repair damaged roads and the lack of assistance from the government for maintaining roads in term of financial. However, this contradicts with the reports from Hamzah (2011); Hasam *et al.* (2010); Yusuf (2011) which stated the government has invested a lot of money to ensure the quality of roads in Malaysia is at a satisfactory level.

Maintenance
Water can weaken the road structure. Proper drainage system is very important to ensure water can flow quickly into the drain to prevent water being absorbed into the road structure (Dawson *et al.*, 2009). Therefore, 54% of respondents strongly agree and 39.8% of respondents agree that *'proper maintenance of drainage system may reduce the problem of roads damages'* which has the highest loading in the category of maintenance with 0.87 critically index. The second highest loading under this category is *'regularly maintenance increase roads life span'* (*Crd*=0.87). Burningham and Stankevich (2005) indicate that regular roads maintenance is important to prevent roads rapidly falling into disrepair and avoiding high cost for rehabilitation. Poor roads maintenance may increase accident rates and property cost; therefore, to sustain good performance of roads, a schedule of road maintenance must be well-planned and organized (Burningham and Stankevich, 2005).

Road users satisfaction
Overall, roads users feel that it is *'interesting to drive on the federal roads'* with 0.50 critically index. The factor ranked high in the critically assessment, however it scored low under the satisfaction factor. Roads users still have unsatisfied feelings with the performance of federal roads in Malaysia when the factor is located at a low rank of 0.40 critically index. The result indicates that, road conditions in Malaysia are at worrying stage when the majority of road users are unhappy with the quality of the roads. Therefore, the responsible authorities should seek alternatives to amend this problem before the situation became worse.

Conclusion
There are three categories of factors contributing to road damages, which are loading, traffic volume and climatic effect. However, respondents believe that loading is the main factor influencing the road damages in Malaysia, as two of the criticality indices are 0.82. It has also been established that the roads users agree that proper and regular maintenance can mitigate the damaging effect on the roads. It has also been inferred that the type of soil, materials used in road construction, alternating weather conditions and rainfall are critical factors that contribute to road damages. Subsequently, in analyzing the effect of road damages, it has been established that the respondents did not only indicated that the roads are uncomfortable to drive on, but also cause traffic jams or even accidents.

A careful consideration of the responses also reveals that bad road conditions can cause accidents on those roads. If occurred, accidents can cause delays to other road users, damage vehicles, injuries to parties (drivers and passengers) and damage road facilities. To confirm if road damages or accidents cause any waste, the respondents voted strongly that not only drivers spend a lot of money to fix their vehicles, but also severe road damages take long time to be fixed, they (damages) cost a lot of money to fix and it opens an avenue for misappropriation by the maintenance companies (by doing substandard work).

In a bid to assess the satisfaction of the road users with the current state of the federal road, it has been confirmed that the level of satisfaction is relatively low; thus, improvement is not only necessary, but should be done immediately to make the roads enjoyable and safer. This development is also detrimental to the country which has invested a lot of money to ensure perfect road conditions.

Acknowledgement
The authors would like to express their gratitude for receiving the greatest support from Malaysia Institute of Transport (MITRANS) and Universiti Teknologi MARA (UiTM).

References

- Aripin, R. (2009). A guide to data management and analysis using SPSS for windows. Shah Alam, Selangor: Universiti Teknologi MARA.
- Bavani, M. (2010, August 18). Raise lorry load limit for all, argues association, *The Star,* p. 13.
- Burningham, S., & Stankevich, N. (2005). Why road maintenance is important and how to get it done *Transport Notes*. Washington D.C.: The World Bank.
- Carrera, A., Dawson, A., & Stegar, J. (2009). State of the art of likely effect of climate on current roads (1st ed.). Europe: University of Nottingham, UK.
- Cheng, J. (2002). Discussion of importance index in technology foresight. Tokyo, Japan: National Institute of Science and Technology Policy (NISTEP).
- Dawson, A., Kringos, N., Scarpas, T., & Pavšič, P. (2009). Water in the Pavement Surfacing. In A. Dawson (Ed.), *Water in Road Structures* (1st ed., Vol. 5, pp. 81-105): Springer Netherlands.
- Denscombe, M. (2010). *The good research guide for small-scale social research projects* (4th ed.). England: McGraw Hill.
- Fan, W., & Yan, Z. (2010). Factors affecting response rates of the web survey: A systematic review. *Computers in Human Behavior, 26*(2), 132-139. doi: 10.1016/j.chb.2009.10.015
- Fellows, R., & Liu, A. (2008). *Research methods for construction* (2nd ed.). United Kingdom: Blackwell Publishing.
- Field, A. P. (2009). *Discovering statistics using SPSS* (3rd ed.). London: SAGE Publication Ltd.
- Flintsch, G. W., & McGhee, K. K. (2009). *Quality management of pavement condition data collection*. Washington D.C: Transportation Research Board.
- Gillespie, T. D., & Karamihas, S. M. (1994). *Heavy truck properties significant to pavement damage.* Paper presented at the Vehicle-Road Interaction II Conference, Santa Barbara, CA, USA.
- Goodier, C., Austin, S., Soetanto, R., & Dainty, A. (2010). Causal mapping and scenario building with multiple organisations. *Futures, 42*(3), 219-229. doi: 10.1016/j.futures.2009.11.007
- Griffis, S. E., Goldsby, T. J., & Cooper, M. (2003). Web-based and mail surveys: A comparison of response, data and cost. *Journal of Business Logistics, 24*(2), 237-258. doi: 10.1002/j.2158-1592.2003.tb00053.x
- Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *Journal of Marketing Theory and Practice, 19*(2), 139-151. doi: 10.2753/MPT1069-6679190202
- Hamzah, N. A. (2011, 9 February). Lebih RM180 juta baiki kerosakan, *Sinar Harian,* p. 9.
- Hasam, S. H., Bakar, R. S. A., & Isa, M. S. M. (2010, December 10). RM1.156b selenggara jalan raya di Selangor, *Utusan Malaysia,* p. 15.
- Kordi, N. E., Endut, I. R., Baharom, B., & Wahab, M. Y. (2011). *Investigation of types of damages occurred on Malaysian Federal Road Route One (FT01) at Selangor.* Paper presented at the International Transport Research Conference 2011 (ITRC2011), Universiti Sains Malaysia.
- Kordi, N. E., Endut, I. R., Baharom, B., & Wahab, M. Y. A. (2012). *The relationship between traffic volume of heavy vehicles and the performance of Malaysian Federal*

Roads Route One (FT01) in Selangor: A case study. Paper presented at the 2012 IEEE Business, Engineering and Industrial Application Colloqium Seri Pacific Hotel, Kuala Lumpur.

- Lee, S. K., & Yu, J. H. (2012). Success model of project management information system in construction. *Automation in Construction, 25*(0), 82-93. doi: 10.1016/j.autcon.2012.04.015
- Leeuw, E. D. D., & Hox, J. J. (1988). The effects of response-stimulating factors on response rates and data quality in mail survey: A test of Dillman's total design method. *Journal of Official Statistics, 4*(3), 241-249.
- Ling, F. Y. Y., & Ng, W. T. (2011). Boosting performance of road infrastructure: A case study based on motorist satisfaction in Singapore. *Journal of Built Environment Project and Asset Management, 1*(2), 211-225.
- Mansor, S. A. (2010, May 5). Tolled roads are better maintained, *The Star,* p. 19.
- Marshek, K. M., Chen, H. H., Connell, R. B., & Saraf, C. L. (1986). Effect of truck tire inflation pressure and axle load on flexible and rigid pavement performance. *Transportation Research Record*, 14-21.
- Odeh, A. M., & Battaineh, H. T. (2002). Causes of construction delay: Traditional contracts. *International Journal of Project Management, 20*(1), 67-73.
- Pallant, J. (2010). *SPSS Survival Manual* (4th ed.). New York: McGraw-Hill.
- Ramli, A. (2012, 17 January). Longkang bocor punca jalan raya berlubang, *Kosmo,* p. 10.
- Saraf, C. L., Ilves, G. J., & Majidzaded, K. (1995). *Effect of heavy vehicle weights on pavement performance.* Paper presented at the Road Transport Technology, USA.
- Shahid, A. (2011). *Issue and challenges in sustainable roads and highways in Malaysia*, Malaysia Institute of Transport.
- Shehu, Z. (2008). *The Framework for effective adoption and implementation of programme management within the UK constructions industry.* Doctor of Philosophy, Glasgow Caledonian University, Glasgow.
- Shehu, Z., & Akintoye, A. (2010). Major challenges to the successful implementation and practice of programme management in the construction environment: A critical analysis. *International Journal of Project Management, 28*(1), 26-39. doi: 10.1016/j.ijproman.2009.02.004
- Sproull, L. S. (1986). Using electronic mail for data collection in organizational research. *The Academy of Management Journal, 29*(1), 159-169.
- Stockton, L., Maris, B. V., & King, B. (1999). Conducting research survey (2nd ed.). Toronto, Ontario: The Banting Institute.
- Walston, J. T., Lissitz, R. W., & Rudner, L. M. (2006). The influence of Web-based questionnaire presentation variations on survey cooperation and perceptions of survey quality. *Journal of Official Statistics, 22*(2), 271-291.
- Wong, P. M., & Ruban, A. (2010, July 27). Heavy vehicle banned, *The Star,* p. 12.
- Yaacob, M. Z. (2010, October 22). Angkara lubang, *Harian Metro,* p. 4.
- Yusuf, R. (2011, October 25). Kerajaan belanja RM747j selenggara Jalan Persekutuan, *Utusan Malaysia*, p. 5.