

Survey on Road Maintenance along PLUS Expressway for Mobile Application Development

^[1] Nurul Husna Mohd Jamail, ^[2] Abd Halim A G, ^[3] Sulzakimin Mohamed

^[1] Department of Civil Engineering & Built Environment, Universiti Tun Hussein Onn Malaysia (UTHM),

^[2] Department of Civil Engineering & Built Environment, Universiti Tun Hussein Onn Malaysia (UTHM),

^[3] Department of Technology Management & Business, Universiti Tun Hussein Onn Malaysia (UTHM)

^[1] nurulhusnamj@yahoo.com, ^[2] abdulhalim@uthm.edu.my, ^[3] zakimin@uthm.edu.my

Article Info

Volume 83

Page Number: 1573 - 1580

Publication Issue:

May - June 2020

Abstract:

At every nook and corner of the globe, roads happen to be one of the biggest assets in every country at every corner of the globe whereby the network infrastructure presenting economic and social benefits for individuals, groups of person, companies and industries. Maintaining the road system has been known generally to give significant improvement to the growth of economic and social benefits; meanwhile, inadequate road system maintenance could give a bad impact to mobility, the increasing rate of accidents, aggravates isolation, poverty and could eventually cause the rise of vehicle operating cost. A survey was conducted to elicit and evoke information on all sorts and factors of road imperfection and the present road maintenance rehearsed along PLUS expressway. Regardless to that, in most countries in the world today the management of road maintenance has been a big challenge. Unidentified road environment covers many aspects. Thus, based on those matters, it is vital to improve the quality of inspection reports whereby the efficiencies by mobile application shall be utilized. The developed system mobile application was found to be efficient and it can be used at anywhere and anytime which makes it flexible and convenient. Thus, the aim of this study is to identify types of defect, problems or issues and shortcomings of current road maintenance practice and subsequently develop a computerized road maintenance management system for PLUS Expressway. All the information gathered were examined, abridged and portrayed by utilizing Statistical Package for Social Science (SPSS) programming. The data analysis result of the survey will be utilized as the input for the mobile applications development, focusing on road maintenance along the PLUS Expressway.

Keywords: Mobile application, road maintenance, statistical package for social science (SPSS), expressway

Article History

Article Received: 11August 2019

Revised: 18November 2019

Accepted: 23January 2020

Publication: 10 May2020

I. INTRODUCTION

In every country, roads are one of the significant resources. Economic as well as social advantages to people, gatherings of individuals, organizations and enterprises can be provided by road network framework [1]. It empowers goods and services to be conveyed opportune and adequately, just as improving free development of individuals. In appropriate settings and areas, new roads may advance substantial economic and social advantages [2]. There are many creating nations obtaining from worldwide moneylenders or arranging access to their characteristic assets to expand their transportation framework. For these advantages to be continued, the expressway upgrades must be trailed by an all-around

arranged observed program of upkeep. In the absence of ordinary upkeep, roads can quickly fall into deterioration which might keep the acknowledgment of longer-term effects of street enhancements for improvement as much as the nation's development in social and economy [3]. Street upkeep is a procedure that is profoundly influenced by the wild factors of nature, for example, atmosphere, landscape, area, and so forth and in addition the wild factors speaking to the operational troubles, for example, traffic, load, traffic accidents and so forth [4].

Road maintenance involves the activities to keep pavement, drainage facilities, road shoulders and slopes as well as all other structures and properties within the road margins as near as possible to their as constructed or renewed condition. This includes

minor repairs and improvements to stamp out the cause of defects and to prevent excessive repetition of maintenance efforts. For proper management and operational convenience, road maintenance is categorized as routine, periodic, and urgent [5]. In addition to enhancing the quality of inspection reports, the efficiencies created by the mobile application will allow the expressways or highways management to lower the rate that it charges for inspections and pass along over their savings for their management asset maintenance. The mobile application utilization will further shorten the time span of project delivery and engage users directly in shaping the application to provide topmost and maximum business value.

II. LITERATURE REVIEW

A. Highway in Malaysia

In general, it has been found out that maintenance of roads enhances economic growth and social benefits whilst poorly maintained road system destructs mobility, increases the rate of accidents, and aggravates isolation, poverty and vehicle operating cost [2]. [6] Believes that, road maintenance is essential short-term transport policy that policy makers need to pay attention to because it helps to enhance road safety and improves social welfare of the citizenry. This also includes the maintenance of highways. Highways infrastructure and its provision have a significant impact on economic prosperity and its development is reflected in the economic well-being of the country as well as bringing important social benefits. Thus, the goal of maintenance is to preserve and sustains the asset and the maintenance must be done regularly. Road maintenance requires tasks to maintain the roads, slopes, drainage systems and all other buildings and assets as similar as possible to their built or renovated condition. [5] Claims that road maintenance must be classified as routine, periodic and urgent for proper management and operational convenience. Therefore, the road infrastructure must be monitored systematically and in consistent intervals to recognize damaged road fragments and road hazards which is labour intensive and require extensive manual paper processes. In improving the quality of road maintenance, the mobile application implementation is expected to overcome the usual paper-based road survey reports which were manually entered into a system, a process that was both laborious and prone to errors. In the advent of

technology, smartphones have played a vital role in mens' 24/7 many activities. To be in line with Malaysia government strategic goals of increasing efficiency through modernization and making more effective use of its complement, the toll expressway should be aggressively pursued the adoption of innovative mobile technologies to transform the existing toll expressway maintenance as well as its business processes.

The toll turnpikes or thruways in Malaysia are controlled by a statutory body known as Malaysian Highway Authority (MHA) (Highway Authority Malaysia (consolidation) Act 1980. These parkways are privatized and managed by the MHA. The foundation of MHA is among all to concentrate on executing the plan, development, direction, activity and support of parkways, to enhance and gather tolls, to go into contracts and to accommodate any issues associated therewith. The MHA is controlled by a Board delegated by the Minister of Works regulated the MHA. The MHA is additionally dedicated in utilizing top of the line innovation for the maintainability of the nation's expressway. The MHA business is working intimately with college to join green and manageability innovation in the parkway (LLM, Annual Report 2014). The MHA or Lembaga Lebuhraya Malaysia (LLM) has its official entrance which can be reach at (<http://www.llm.gov.my/>). The entry gives helpful data and reports on its motivation of foundation. With the coming of media period, the MHA have fundamentally affected its clients through Facebook, Twitter and portable application, featuring the administrations they bring to the table. The Authority has additionally propelled a Tollroads Evaluation and Monitoring System Version 2 (TEAMSv2) which fundamental purposes will go about as an administration apparatus for execution and support pointers (<http://teams.llm.gov.my/site/login>). Both advancements are critical key in accomplishing a proficient expressway the executive's upkeep which is the focal point of this exploration proposition.

B. PLUS EXPRESSWAY

The PLUS Expressway or PLUS Malaysia Berhad (PMB) is the acronym of Projek Lebuhraya Usaha Sama Berhad (PLUS) formerly Projek Lebuhraya Utara Selatan Berhad and by far the most substantial highway concessionaries company in Malaysia. PLUS Expressways covers Federal Highway Route 2, New Klang Valley Expressway, Seremban-Port

Dickson Highway, Malaysia- Singapore Second Crossing, Butterworth-Kulim Expressway as well as the North-South Expressway Central Line. This research proposal will highlight PLUS expressway to study its maintenance management system.

The significance of aligning Information Technology (IT) with corporate strategy in road maintenance highway organizations is extensively acknowledged. The PLUS Highway of Malaysia, as for example has launched the PLUS Traffic Monitoring Centre (TMC) in providing a secure, smooth and comfortable journey for its users. The PLUS Traffic Monitoring Centre (TMC) plays a vital role as the traffic management hub for the PLUS expressways by monitoring daily; approximately 1.5 million vehicles using the PLUS expressways, comprising the North-South Expressway (NSE), the New Klang Valley Expressway (NKVE), the Federal Highway Route 2 (FHR2), the ELITE highway, the Secondlink, the Seremban-Port Dickson Highway (SPDH), the Butterworth-Kulim Expressway (BKE) and the Penang Bridge.

C. Factor Contributing to Road Defect

A lot of factors are necessary to take into cogitation when making a road safe for traffic. When any of these factors are lacking, this can cause menace to the travelers and commuter using these roads. Road defect can be one the factors, making the road or highway risky for travelers. Road defects may lead to road users encountering a sudden unwanted driving experience while cruising the highway as vehicles are completely vulnerable to road defects [7]. Small light vehicles, predominantly motorcycles may require more careful balance as they have fewer points of contact with the road. Road defects such as potholes, a missing sign, a poorly designed curve or any of these factors, caused by negligence, can lead to severe consequences and result in a serious, life-changing injury or wrongful death [8].

From this observation, in general we can categorize the road defects into design and maintenance defects. The design defects as mentioned earlier in the former paragraph include defects such as missing or inadequate signage, blind curves and intersections, no shoulder or soft shoulder, narrow lanes and missing guardrails. On the other hand, maintenance defects can include issues such as potholes, cracks, broken traffic signals and to the extent of overgrown

vegetation or trees on the side roads.

There are many more other details factors that may contribute to the road defects. A study from [9], mentioned some other factors that contribute to the defect of the roads such as heavy traffic, natural catastrophes (heavy rain and flood), improper maintenance, imperfection in construction, road design problems, low quality in materials used in road construction and inefficiency of controlling and monitoring are some examples of other factors. A questionnaire study depicts that heavy traffic and act of god such as heavy rain and flood are the factors that mostly often affect the road condition.

A paper written by [10] described on the Road Infrastructure as a vital role player in road safety. The road infrastructure among all, as discussed by [10], emphasized on the geometry of the roadway which plays a significant role in road crash frequencies as well as the crash severity level. Subsequently, he listed out four different elements of the road design that are more prominent. These parameters are the Cross-section of the Roadway, Roadside Condition Curvature of the Roadway and Sight Distance. He named these parameters as the Negative Road engineering factors of which a road defect directly triggers a crash, whereby some elements of the road environment mislead a road user and thereby creates human errors.

D. Highway Assets and Typical Defect

Highway asset needs maintenance from time to time in order to sustain its usability and practicality. Nevertheless, the road defects commonly occurred due to many reasons e.g. heavy rains, human error etc. Lembaga Lebu Raya (LLM) has categorized various natures of defects identified according to the functional category of the expressway, namely road surface, drainage structure, structures, earthwork and road safety furniture. For an optimum asset preservation, PLUS has undertaken asset management activities that are being centered on a structured maintenance organization. This approach is mainly focusing on preventive maintenance to identify and capture defects for early intervention. The structured organization involves integration of activities such as network planning, network asset, condition assessment, investigation of defects, detailed inspections and investigations by specialists, design and procurement, works implementation, information management as well as technical

development and research. Expressway maintenance is conducted to conserve the road function and structural characteristics in providing a safe, comfortable and reliable passage for all traffics. Subsequently, it can be defined as a program to preserve, repair and restore the expressways' asset condition as well as enhancing the performance of the assets. Its system elements include pavement, slopes, drainage, structures, road furniture etc.

The Concession Company should ensure that maintenance activities are planned and controlled in a well-organized manner. Planning is the process to develop a course of action. Scheduling is the activity that coordinates manpower, materials, tools, equipment and work methods. Proper management will give rise in productivity from available manpower and funds while effective solutions and well-organized priorities shall be yielded by a better definition of problems.

E. Mobile Application

Nowadays, there has been a remarkable rise in the number of people utilizing mobile application in their daily walk of life. The latest information appears to be that the technology is more popular than home phones and computers combined. Mobile applications which universally referred to as Mobile Apps, are software applications that are usually designed to be run on smart phones and tablet computers system [11]. These Mobile Apps are normally run on the Google Android and Macintosh iPhone system. Since it is mobile yet convenient in nature, Mobile Apps have made it easy for users to take their website, blog or online store anywhere and anytime. The emergence of mobile devices which is wireless in communication has given impetus to the implementation of ubiquitous mobile usage in supporting many aspects of human activities.

The Mobile Apps had started with many leading app categories mainly on mobile gaming and social networking. Nevertheless, later business apps growth expands with practical utility has increased. Mobile Apps developers had catered users by creating apps to handle things such as time management and multitasking. Nonetheless, the selection of the right platform to suit the business customers' needs has been a hitch correlated with the development of business apps. Developers must determine the most popular platforms used by businesses and executives in order to maximize profits. Latterly, we have

witnessed the number of business apps downloaded have risen significantly, but in terms of the overall market there appears to be even greater potential for growth.

Road Maintenance mobile devices are believed to have the potential to enable engineers and management teams to do their job more effectively and efficiently. The approach in developing an app for road maintenance management would help to improve service delivery on issues related to the highway asset maintenance. With this automated Mobile Apps system, delayed and postponement issues can possibly be overcoming. It will become more cost effective as maintenances activities will eventually become faster with Mobile Apps.

III. RESEARCH METHODOLOGY

This research engaged quantitative approach, whereas questionnaire survey acts as the best method in collecting the data vis-à-vis to attitude, orientation and preferences [12]. Quantitative approach aids to offer review information on several characteristics which become more useful for testing [13]. 400 respondents were addressed with self-administered questionnaires among the targeted respondents that are actively involved in road maintenance activities including PLUS Berhad, UEM EDGENTA PROPEL, Malaysian Highway Authority (MHA) and road users.

A face to face interaction with respected respondents was implemented during the distribution of questionnaire. The personally administered questionnaire is the most relevant instrument in line with the study as it consumed a brief period to gather data at a minimal cost. By applying this strategy, the researcher would be able to assist the respondents if they had any concerns or questions regarding the things in the questionnaire [14]. In order to validate the program with the relevant maintenance framework, further work has been done to define and understand the equipment, algorithm environment and resources required. Data obtained were analyzed using the Statistical Package for Social Science (SPSS) 21.0.

This research also involved archives data which have been obtained from the PLUS berhad, UEM EDGENTA PROPEL and Malaysian Highway Authority (MHA). These archives information will enable the identification of the area of study. The function of these data is to confirm all information

and other details to be used in the final analysis of this research. Aside from that, secondary data were also obtained through literature, references such as books, journals, conference papers, magazines, newspapers, reports, internet surfing and so on.

For the rating scale, Likert scale was applied since it is suitable to ration the attitude, behavior and preferences [15]. Multiple choice questions have also been used which would allow the respondents to select one of the response alternatives by using 5-point scale ranging from number 1 represents 'Strongly Disagree', number 2 represents 'Disagree', number 3 represents 'Moderate', number 4 represents 'Agree' and number 5 represents 'Strongly Agree'. Part A consisted of 6 questions which covered the respondents' demographic profile which include gender, age, respondent's transportation mode, frequency of highway usage and the purpose of using the highway. Part B comprised of 12 questions that includes type of defects while Part C consisted 11 questions that focusing on factors that influence the defects. For the fourth part of this questionnaire (Part D), there are 7 questions that have been developed to assess the suggestion for implementation of management system and 6 questions have been prepared for the fifth section (Part E) of the questionnaire to assess the enhancement of maintenance system while the final part of this questionnaire (Part F) consists of 11 questions regarding on the method of maintenance road effect. For these six sections, the respondents were requested to give a score by using the 5 points Likert Scale. The arrangements of the questionnaire can be summarized in the table 1 shown below:

Table 1. Arrangement of development questionnaire

Section	Description	Number of Question
Part A	Demographic profile	6
Part B	Type of Defect	12
Part C	Factors of defect	11
Part D	Suggestion for implementation of management system	7
Part E	Enhancement of maintenance system	6
Part F	Method of maintenance road effect	11
Total number of questions		53

A. Mobile Application Development

The application will be developed according to the normal software development cycle and system. A user interface design (UI) or user interface engineering will be designed for machines and software and application. The UI design focuses on

maximizing usability and the users' experience. The common and general Mobile Apps Development Process can be drawn as depicted in Figure 1.

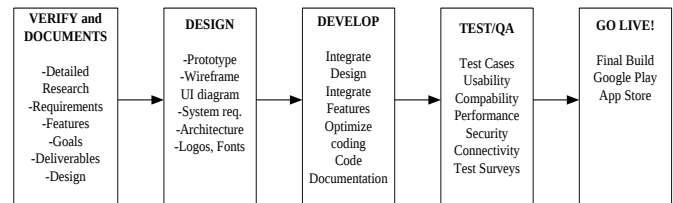


Figure 1: Mobile Apps Development Process

IV. RESULT AND ANALYSIS

The data presented and visualized were obtained from the Statistical Package for Social Science (SPSS) software. The discussions in data analysis are regarding the improvement on PLUS Highway Maintenance System. In this research, all the data were gathered from 400 respondents using questionnaire survey method.

A. Types of Defect

Table below indicates the findings on the types of defects happened at the highway pavement based on the respondents' perceptions and thoughts. According to the items categorized in Table 1, the most agreed types of defect and supported by the respondents is cracks due to pressure from vehicle loads with the mean value of 3.92. Highest mean value has proven that most respondents agreed that crack due to pressure from vehicles loads always happen at the highway. All items in Table 2 will be classified as harm categories based on the rating criteria. The highest mean would need urgent attention due to traffic safety needs as a means of high priority repairs. High means will be graded as high priority repairs. For the meantime, the lowest mean would categorize as less priority repairs. Figure 2 shows the overall result using bar chart.

Table 2. Descriptive analysis for types of defect

Items	Types of Defect	
	Mean	Std. Dev
Cracks due to pressure from vehicle loads	3.92	0.724
Indentation due to poor road construction work	3.32	0.992
Potholes	3.50	0.907
Bumpy or uneven road surface	3.66	0.771
Blocked drainage system	3.24	0.772
Broken edge of the road due to the road shoulder settlement	3.40	0.756
Premix deprived as a result of the pavement work done during rain	3.37	0.774
Dividers damaged due to vehicles collisions	3.61	0.790
Landslides or erosion	3.56	0.776

Ground settlement	3.58	0.778
Damage highway signage	3.27	0.897
Road lighting does not work	3.41	0.907
Overall Mean	3.49	0.496

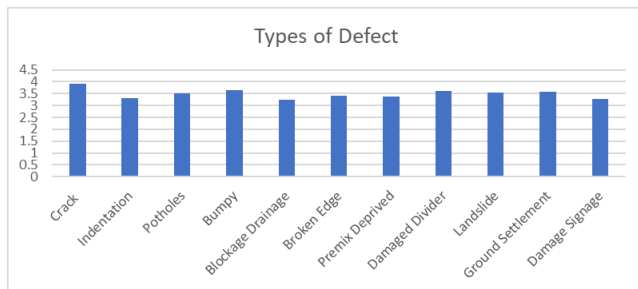


Figure 2: Types of defect

B. Factor Contribute to Road Defect

The second variable for this research which is factors contributing to the road defect have been analysed according to the mean on Table 3. According to the bar chart in figure 3, the factor of overload vehicles gave the outcome of the highest computed mean score with the value of 4.14 compared to other items. On the other hand, the lowest mean score which is 3.11 refers to items of imperfect road construction which contributed to the road defect.

Table 3: Factors contributing road defect

Items	Types of Factor	
	Mean	Std. Deviation
Overload vehicles	4.15	0.726
Poor road design	3.20	1.027
Accident	3.56	0.924
Usage of non-quality materials	3.19	1.062
Inefficiency of control and monitoring by authorities	3.15	1.026
Imperfect road construction	3.11	1.042
Improper maintenance	3.12	1.075
Heavy traffic	3.54	0.834
Exposed to water and flood	3.73	0.802
Imperfect drainage structure	3.58	0.831
Heavy rain	3.73	0.717
Overall Mean	3.46	0.577

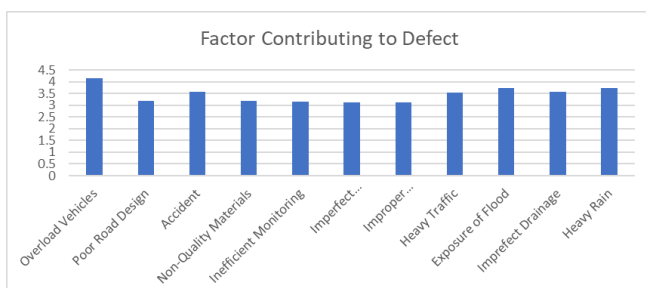


Figure 3: Factor contributing road defect

C. Implementation of Management System

The third variable for this research is the implementation of management system for

concession company such as PLUS. By referring to the seven items below, the mean has been computed. As referring to the table 4, the suggestion of road management should often meet or discuss with the road operator has obtained the highest computed mean score with the value of 4.23, while the lowest computed mean score of 4.03 was obtained by the suggestion of providing road maintenance financial reports as one of the implementations of management system. Figure 4 shows the overall result using bar chart.

Table 4: Implementation of Management System

Items	Types of Implementation	
	Mean	Std. Deviation
Provides comprehensive maintenance schedule	4.17	0.589
Conduct regular inspections	4.20	0.572
Prepare reports after the inspections	4.22	0.598
Carry out technical assessments based on the degree of damage	4.21	0.573
Provides road maintenance financial reports	4.03	0.691
Road management should often meet or discuss with the road operator	4.23	0.604
Conduct road safety campaigns to the road users	4.06	0.702
Overall Mean	3.46	0.476

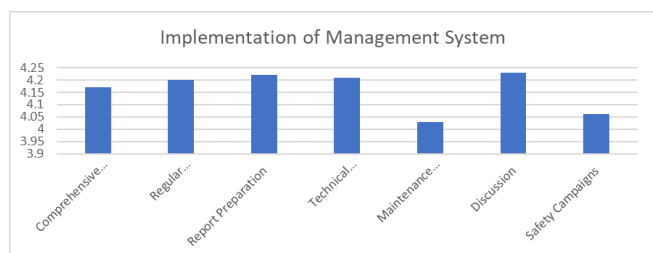


Figure 4: Implementation of management system

D. Suggestion for Improvement of Maintenance System

Based on the table 5, it can be concluded that creating an effective and comprehensive mobile application ranks at the top of respondents' suggestion with the computed mean of 4.33. It shows that mobile application road maintenance is important to supersede the usual paper-based road survey reports which were manually keyed-in into a system. Meanwhile, tolled highway system needs to be maintained to cover the cost of maintaining the highway obtained the lowest computed mean with the score of 3.31. It means that the responses agree mobile apps development will improve the road maintenance system. This is because mobile Apps such as LLM traffic and PLUS app just focusing on traffic information, emergency hotline, toll fare etc. Figure 5 shows the overall result using bar chart.

Table 5: Suggestion for Improvement of Maintenance System

Items	Types of Suggestion	
	Mean	Std. Deviation
Perform road enhancements quickly and continuously	4.22	0.606
Improve service against complaints received from highway users	4.23	0.597
Create an organized planned work schedule	4.28	0.550
Must be committed and quick to perform maintenance work if asset damage complaint is received	4.26	0.610
Tolled highway system needs to be maintained to cover the cost of maintaining the highway	3.31	1.099
Create an effective and comprehensive mobile application	4.33	0.780
Overall Mean	4.08	0.464



Figure 5: Suggestion for improvement of maintenance system

E. Maintenance Method for Road Defect

Table below indicates the findings of the suggestions of various maintenance methods for road defect in Malaysia. According to the items, controlling surface erosion is the most suggested method by the research respondents. This can be proven by the highest value of computed mean portrayed in the bar chart on figure 6 which is 4.01 compared to other items which averagely scored below 4.00. Meanwhile, the lowest value for most suggested method by the research respondents is patching by scoring 2.98 for the computed mean.

Table 6: Maintenance Method for Road Defect

Items	Types of Method	
	Mean	Std. Deviation
Rejuvenating	3.94	0.598
Crack sealing and filing	3.09	0.998
Patching	2.98	1.071
Thin bituminous overlays	3.30	0.853
Resurfacing	3.38	0.816
Re-tread	3.64	0.833
Repave and re-mix	3.45	0.778
Reconstruction	3.86	0.656
Maintaining	3.75	0.650
Creating, restoring or improving soil structure	4.00	0.487
Controlling surface erosion	4.01	0.432
Overall Mean	3.48	0.461

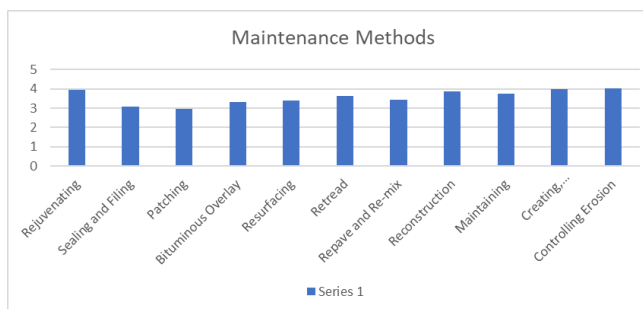


Figure 6: Maintenance methods for road defect

CONCLUSION

Highway maintenance management is truly vital in order to ensure the expressway is safe to be used by the road users and hence, optimizing maintenance expenditure. With the survey result of identification of types of road defect, factor contributing road defect and maintenance method of road defect, the maintenance team can find the solution to enhance the maintenance works by utilizing the user-friendly mobile application.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the Universiti Tun Hussein Onn Malaysia especially to Department of Civil Engineering and Built Environment.

REFERENCES

- [1] A.I. Setianingsih, S. Sangaji, A. Setyawan, Road Maintenance and Rehabilitation Program Using Functional and Structural Assessment, IOP Conference Series Material Science and Engineering 176 pp. 12030 (2017). doi:10.1088/1757-899X/176/1/012030.
- [2] U. R. B. Emeasoba, "Sustainable Socio-Economic Development in Nigeria: A Case for Road Infrastructure Maintenance," vol. 3, no. 5, pp. 129–137, 2013.
- [3] Levik, K. How to sell the message "Road maintenance is necessary" to decision makers. First Road Transportation Technology Transfer Conference in Africa, 2001.
- [4] S. Fallah-fini, K. Triantis, V. Tech, F. Church, and J. M. De Garza, "Performance Measurement of Highway Maintenance Operation Using Data Envelopment Analysis: Environmental Considerations," Ind. Eng. Res. Conf., pp. 6–11, 2009.
- [5] Adebayo O.H A (2015) GIS-Based Model for Road Maintenance in Nigeria: A Case Study of Ikeja Road

- Network, Lagos, Nigera. IOSR Journal of Humanities and Social Science. Volume 20, Issue 5, Ver.IV (May 2015), PP 16-26
- [6] A. Forster and C. A. Mensah, “Enhancing Urban Roads Maintenance in Ghana: Implications for Sustainable Urban Development,” vol. 3, no. 12, pp. 63–76, 2013.
- [7] H.H. Hizal and S.A.R. Sharifah Allyana, “The construction of road accident analysis and database system in Malaysia,” in 4th IRTAD Conference, Seoul, 2009, pp. 235-241.
- [8] P. Kumar and A. Gupta, “Cases studies of bituminous pavementsCases studies of bituminous pavements,” Compend. Pap. from First Int. Conf. Pavement Preserv., vol. 7, no. 0, pp. 505–518, 2010.
- [9] A. Dulrhman Abushnaf, “The Study of Highway Maintenance Works in Selangor,” Int. J. Innov. Res. Sci. Eng. Technol., vol. 4, no. 12, pp. 11712–11719, 2015, doi: 10.15680/ijirset.2015.0412008.
- [10] I. Ahmed, “Road infrastructure and road safety,” Transp. Commun. Bull. Asia Pacific, no. 83, pp. 19–25, 2013.
- [11] Treeratanapon T. Design of the usability measurement framework for mobile applications. International Conference on Computer and Information Technology ICCIT’, Bangkok; 2012. pp71–75.
- [12] D. T. Robinson et al., “Comparison of empirical methods for building agent-based models in land use science,” J. Land Use Sci., vol. 2, no. 1, pp. 31–55, 2007, doi: 10.1080/17474230701201349.
- [13] Hair, J.F., Black, B., Babin, B., Anderson, R. & Tatham, R.L. Multivariate data analysis, 6th edition. Englewood Cliffs, NJ: Prentice Hall, 2007.
- [14] Sekaran, U. & Bougie, Roger. Research Methods for Business: A Skill Building Approach (5th Edition). International Journal of Information Technology and Management- IJITM, 2009.
- [15] Malhotra, N., & Mukherjee, A. (2004). The relative influence of organisational commitment and job satisfaction on service quality of customer-contact employees in banking call centres. *Journal of services Marketing*, 18(3), 162-174