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An Overview of Pavement Maintenance Management Strategies in Malaysia

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Abstract. Pavement damages are always associated with its optimum function and considered among the main contributing factors to fatal accident. With significance growth of vehicular road traffic and of accompanying problems of overloading vehicles in Malaysia will indirectly contributed to worsen the condition. Unceasingly, road pavement will experience failures more rapidly than expected hence lead to negative socioeconomic effects. A proper and timely maintenance by road authorities must be made in order to sustain and maintain the roadway condition to keep them serviceable so that it will benefit not only safety but also improve economic growth and social development. Hence, this study was carried out to explore current practise of pavement maintenance strategies in Malaysia. To achieve that objective, a qualitative data of questionnaires distribution to industry practitioners that are involved in managing roads are analyzed to indicate the viability and practicability of pavement maintenance strategies in Malaysia. Other than that, specifics issue pertinent to pavement management also identified. The findings of this study are valuable in developing the realistic performance criteria for seamless road pavement maintenance strategies.

Keywords: Pavement Maintenance, Pavement Management,

1. INTRODUCTION

Transportation systems continues to evolve over time to meet the challenges towards fulfilling the aspirations of the people. It plays a significant role to enhance the mobility and accessibility of the people and boost up the economy activities of every nation [1]. The rapid developments of the transport systems are of concern due to its significant effects on the safety of the highway patrons and also the quality of the environment. Road life span has a limitation and it is not eternal because of the load and impact that comes from vehicles and also environment. This is supported by [2] that highlighted that it is important to ensure that pavement strengthening is carried out at or before the critical/intervention level in order to maintained in its original condition and hence will extend their working life. With the continuous growth of economy activities and transportation system, there will be more private and commercial vehicles will be generated on road. This will cause the physical and internal harm to the road and it may also



affect the safety of road users. As mentioned by [3] and [4] increasing in vehicular traffic especially heavier vehicles and also traffic loading was among the risky factors influencing pavement damage. Pavement damages comes in several types such as cracking, distortion, disintegration, polished aggregate, bleeding or flushing and edge defect. [5] claimed that pavement damages will cause a danger situation for road user that lead to road crashes. For example, if there is a large pothole on the roadway, can cause a driver hit the potholes. This situation could burst the tire of the vehicles causing the driver to lose control and colliding with another vehicle. Moreover, a research done by [6] and [7] mentioned that pavement damage of high rut depth will increase high rates of crashes. In addition, Highway Safety Manual published by American Association of State highway and Transportation (AASHTO) (2008) as cited in [8] also pointed out about 34% of road crashes are a combination of roadway condition and other factors. Roadway conditions itself covers many aspects of the physical elements of the road system which includes roadside conditions and road surface conditions. Thus in order to ensure safety, and to maintain and hold the pavement life span, the pavement maintenance is vitally important. Accordingly, it is known that pavement maintenance should be viewed as an important national asset and must be carried out at regular intervals to keep its serviceability. Prior to that, this study was conducted to explore better on some pavement maintenance management strategies in Malaysia.

2. LITERATURE REVIEW

Pavement maintenance is a renovation in repairing or upgrading the existing road. It includes adjustment of road alignment, subgrade widening, repair or restoration of stream crossings and drainage structure, reconstruct or upgrade of road surfacing, remarking the road sign on road or signage and repair or removal of unstable material. By doing so, it helps to reduce the rate of damage and road failure by extending the road age and will encourage safety and comfort of the road users. Other than that, it will also help to minimise road agency and user cost as pavement damage not only considered as contributing factor of road crashes but it also incurred an additional cost of responsive maintenance of repairing requirements [9].

Pavement maintenance management have to be handled properly and systematically so that the authorities doesn't have to facing a high loss later and at the same time can ensure user satisfaction through safe, efficient and comfort level. Studies have determined few challenges are facing in the implementation of pavement maintenance management strategies that needs to be investigated comprehensively. Among others, are the strategies and practices in application of maintenance management, available resource, budget and others. In addition, lack of proper maintenance management also brings poor maintenance activities carried out that can be seen through the financial performance and lead to safety hazard and loss of human lives [10].

In Malaysia the road network is classified under three main categories which are federal roads, state roads and toll highways with the total length of the road network at more than 100000 km. With this large road network, it brings key challenges to the maintaining authorities in implementing an effective pavement maintenance management. Due to the limited financial provided in road improvement, the authorities need to identify which road need to be maintained first within the given budget. Authorities that involve in this part of road maintenance have to plan the strategies that use while making a decision in order to spend the annual budget wisely and in a minimal cost.

Another challenges in pavement maintenance phenomenon is that not only financial and high cost for maintenance works but also can affect the traffic flow condition and subsequently resulted in complaints from the road users. In order to undertake such task in efficient manner,

an appropriate maintenance management strategies need to be implemented to assist decision makers to ensure the pavement maintenance works are well managed and the traffic flow are not interrupted.

Malaysia as a developing country is currently facing an increase of vehicle growth together with accompanying problems with the overloading vehicles. Unceasingly, road facilities reach the terminal ends more rapidly than expected due to the increases in traffic volume and insufficient degree of maintenance. Therefore, it will be desirable to increase the competencies and efficiency of pavement maintenance management so that it will benefit not only safety and comfort of the road users but other disciplines as well such as road inventory and asset management, traffic operations and also the growth of economy.

3. METHODOLOGY

The data collection involves acquiring qualitative data by means of questionnaire distributions. The questionnaire is distributed to engineers and technicians who are practicing under department of road maintenance facilities of road agencies in Malaysia as to obtain professional view on the pavement maintenance management strategies. These groups of people deemed to be the most suitable population that equipped with the information, making findings reliable, and valid for this study. The questionnaires consist of two parts which were Part A and Part B. In Part A, the questions were related to respondent's background while in Part B, it consists of implementations elements on pavement maintenance management strategies for examples types of maintenance strategy been used, types of equipment or machine available to monitor road condition, types of roads condition data available in their organization and so on. It was made up of likert scale questions to indicate professional perception with the statement in the questionnaire ranging from 1 (most disagree) to 5 (most agree). The qualitative data are analysed using average index analysis as to understand better on the strategies and practices being applied in the pavement maintenance management in Malaysia. Average index scale has been proposed by [11] based on agreement attributes and frequent index as shown in Table 1 below.

Table 1: The index attributes

5 points Likert Scale	Attributes of Indexes	Average Index
5	Extremely Agree	$4.5 < \text{Average index} < 5.0$
4	Agree	$3.5 < \text{Average index} < 4.5$
3	Fairly Agree	$2.5 < \text{Average index} < 3.5$
2	Less Agree	$1.5 < \text{Average index} < 2.5$
1	Least Agree	$1.0 < \text{Average index} < 1.5$

4.0 DATA ANALYSIS

The focus of this study was to obtain an overview on some strategies on pavement maintenances management in Malaysia. This is done by using questionnaire distributions to the engineers and technician from the related parties that involved in pavement maintenance management.

As shown in the Figure1 and 2 below was the testing techniques and types of road conditions data that they currently have in their organization. These testing techniques is carried out to determine the functional and structural condition of existing pavements or known as Pavement

condition assessment (PCA). Functional condition is undertaken based on field measurements that relate to riding comfort and safety meanwhile for structural condition is based on structural capacity of pavement to support traffic load. Pavement condition assessment can be applied at network level and project level investigation. The network level focus on pavement assessment on the entire network to create most effective use of budgetary resources. On the other hand, the project level provides development and selection on cost effective rehabilitation techniques to a given sections of poor pavements which require rehabilitation.

Based on Figure 1, it shows that the Falling Weight Deflectometer (FWD) and Axle Load Test were the most type of test conducted by highway operators in Malaysia to monitor road condition under their jurisdiction at about 56.3% and 48.4%. The FWD test is conducted to determine the pavement structural condition by applying a moving wheel load of 700 kPa (flexible pavement) and measuring the deflection of the pavement structure. On the other hand, the Axle Load Test is conducted to determine the equivalence factor of commercial vehicles which it can provide assistance for for cost effective pavement design and materials [12]. Afterward in Figure 2 indicates the types of road condition data that available in their organization. It is found that potholes were the most types of road condition data that available in their organization (65.6 %) and followed by cracking and road roughness data at about 62.5 % and 48.4 %.

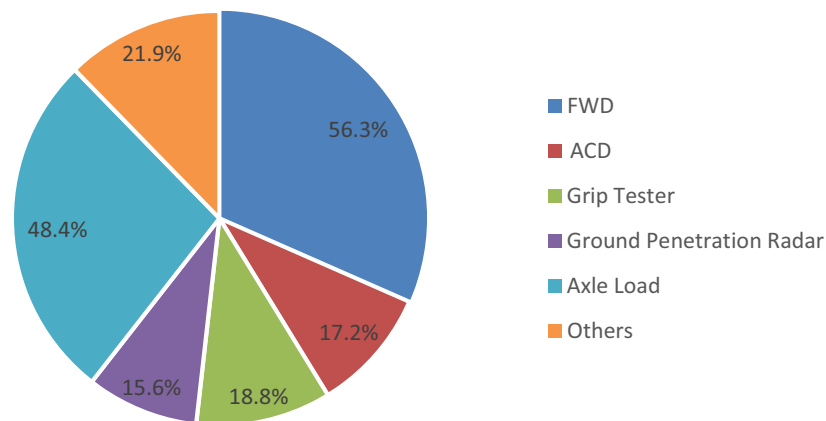


Figure 1: Testing techniques

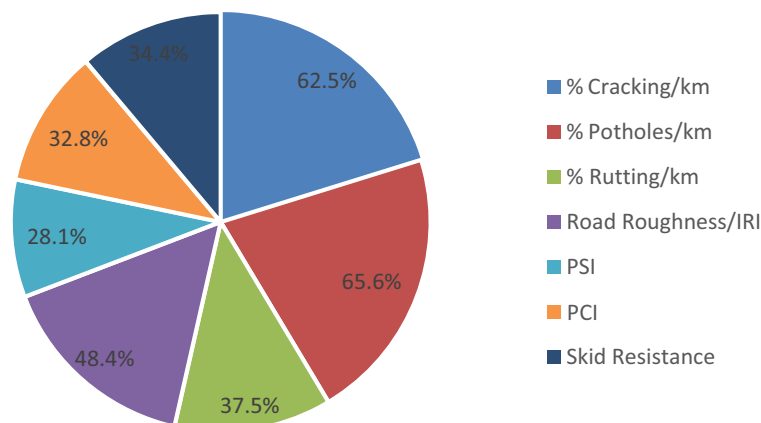


Figure 2: Availability of road condition data

This study was further explored on the approach used in conducting pavement maintenance management. According to [13] the objective of the maintenance work is about maximizing the productivity at the lowest cost possible without compromising the quality and safety standard. Therefore, road authorities in the world have been actively seeking for more innovative ways to manage and maintain their road network in order to achieve cost saving and/or ‘value for money’ when it is linked to innovations and users’ satisfaction. Among the most common approaches used in maintenance of road is conducted using in-house resources of the road authorities and latter using method-based contracting where the contractors conduct the work based on predefined volume and work method and then paid using unit prices [14] [15].

Based on Figure 3, it shows that more than 50% of the respondents claimed that their organizations implemented the conventional method in conducting road maintenance. In conventional method, normally the consultant will be engaged to design and evaluate maintenance needs and then appoint a contractor to do the work through tender or other method. Other than conventional method the performance based contract also been applied in conducting road maintenance eventhough it can be considered new in Malaysia. In the performance based contract, a two types approaches, termed as the pure and hybrid is considered [15]. Performance based contract hybrid still uses unit price as payment criteria in some part, combined with performance criteria. Pure performance based contract counts totally on the performance criteria which to some extend part of it are difficult to be quantified.

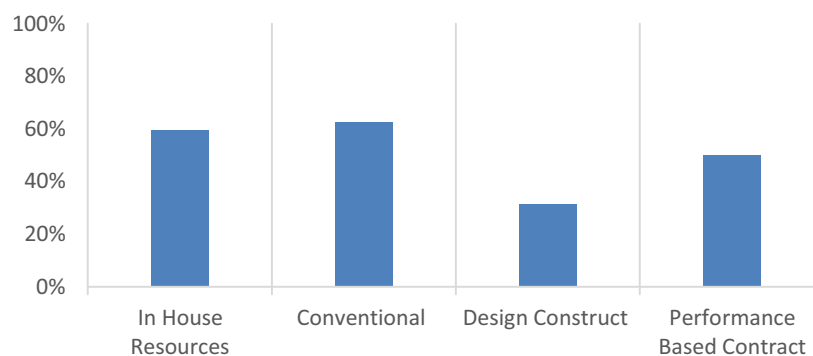


Figure 3: Approach in conducting road maintenance

Next this study explored on the factors that influenced the road agencies to conduct maintenance intervention. As tabulated in Figure 4, it shows that the road conditions and users complaint is extremely important factors that need to be considered in order to conduct maintenance intervention with average index of 4.68 and 4.52. [16] reported that PWD receives many road user’s complaints especially on the case of pavement failure. This is also in line with the study conducted by [17] that road users’ seemed to be very sensitive to road environments at which all groups of driver at different ages were consistently agree that potholes, ruts and irregularities seems to be the critical attributes that affect overall perception on roadway inventory elements. From the view of road users, road asset must be well maintained by the authority as to provide safety and comfort. Meanwhile budget, availability, age of road, emergency conditions, repeated accident and long term planning falls under important with the average index score of more than 3.5.

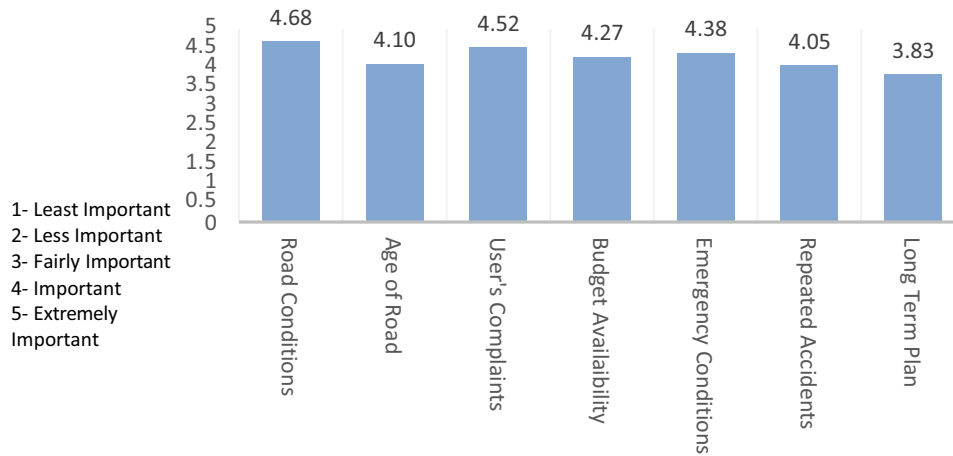


Figure 4: Decision to conduct maintenance intervention

In Figure 5 indicates the type of road surface condition which requires greater attention to the highway operators involved in this study. It can be concluded that almost all types of surface condition stated in this question falls into a consistent agreement with average index between to 4.5. Meaning to say that these types of road surface condition is being important types of road surface condition that require greater attention in pavement maintenance activities.

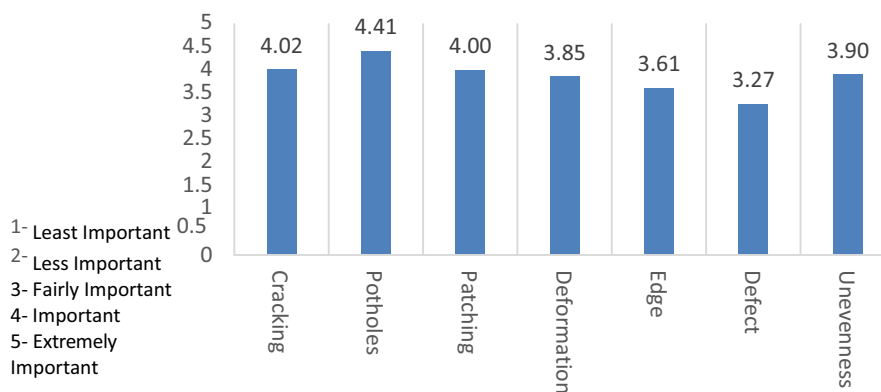


Figure 5: Road surface condition that require attention

Other than that, this study also explored on the preference of the roles as parties involved in road maintenance activities as depicted in Figure 6 below. Most of the respondents have a consistent agreement at all the preferences given in the question. As a developing country, it indicates that road agencies in Malaysia has developed well and have flexibility in handling the strategies and practices in delivering road maintenance in line with the rapid development that has been taken so far especially in pavement maintenance management system. This phenomenon has urge the road agencies to actively seeking for optimization of maintenance

practices and strategies not only issues on technology but also other issues such as management, business and operation strategies in attaining the operational goals.

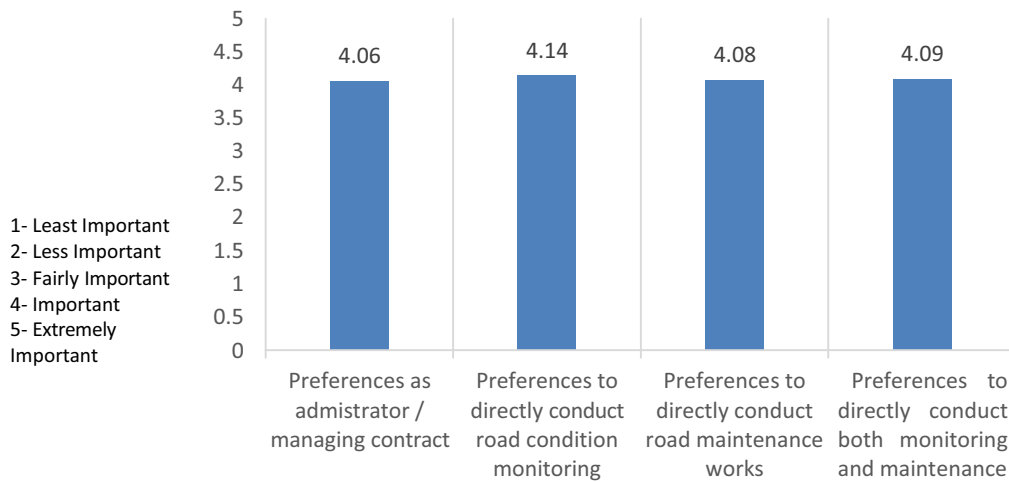


Figure 6: Roles preference

Figure 7 shows the rate given by the respondents on their perception towards the implementation of maintenances strategy approaches using ranking criteria, decision tree and also software. Both approaches have a consistent agreement by the respondents specifies that both ranking criteria/decision tree and software was successful in implementing pavement maintenances. In the limitation of human experts, technology has come and receiving greater attention from road agencies because of their ability to enhance productivity and to aid in the decision making process such as diagnosis, design, repair and rehabilitation [18].

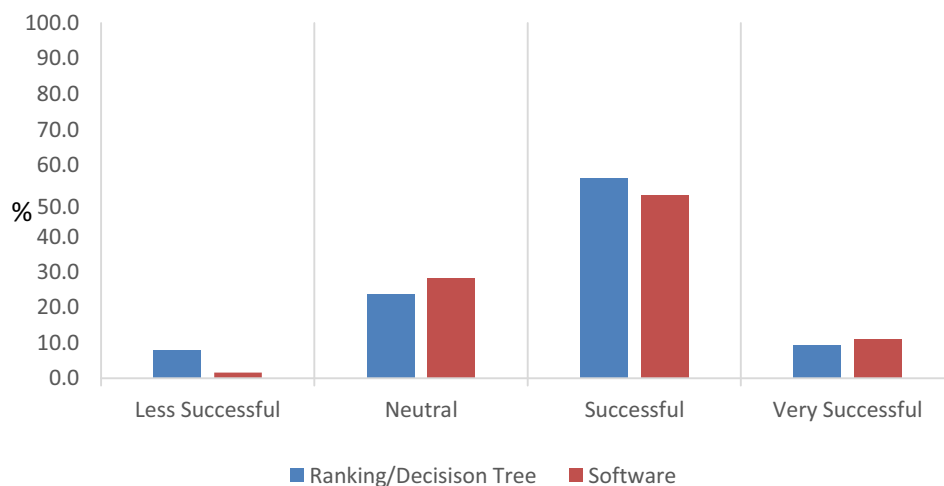


Figure 7: Successful level of Ranking/ Decision Tree and Software

Last but not least, this study also seek to derive the factors that influencing the optimazation of pavement maintenance management system through the perception of the players in road agencies. Based on finding in Figure 7 it shows that the respondents have a consistent agreement

in all ten major problems that specifies in the questions. Most respondents agreed that fund on the pavement maintenance was the main factors that influencing the optimization. This is supported by [19] in implementing effective maintenance fund is the main factor that limiting the aspirations. Meanwhile the least perception that influence optimization were the factors of communications/skills of the staff and standardization specification and manual procedure which they ranked ‘fairly agree’.

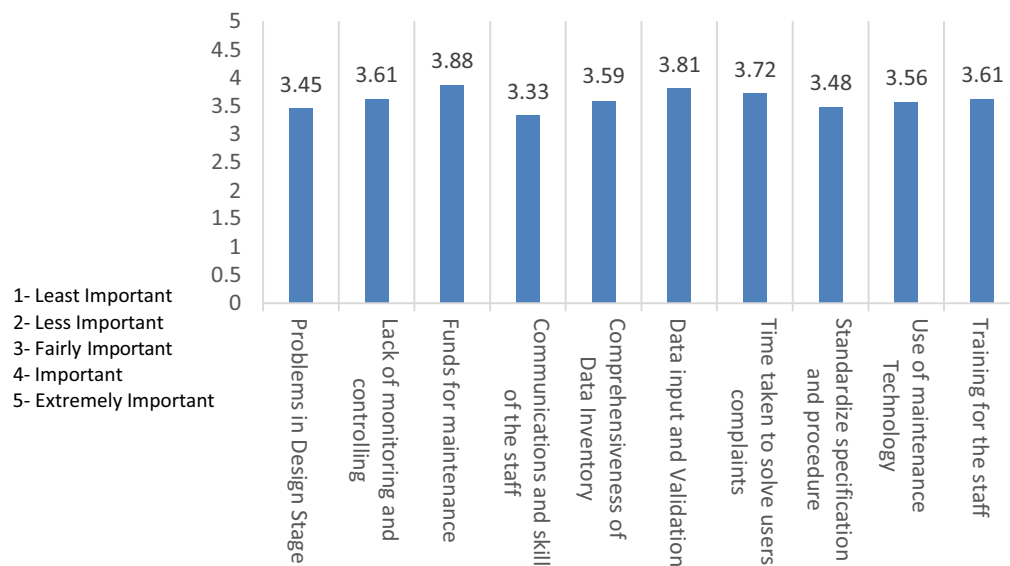


Figure 8: Factors influenced the optimization of pavement maintenance

5.0 CONCLUSION

In recent decades, the approach of pavement maintenance management has been widely developing in line with the rapid upturn in technology, critical success factor, management, strategies and practices and many more. Road agencies have to be kept up in pace with the related indicators in order to ensure efficiency of maintenance management. The data analysed in this study provide insight on the strategies of pavement maintenance management in Malaysia in which it can be concluded as encouraging, viable and practical. Other than that fund for pavement maintenance was highlighted to be vital element in influencing the optimization of pavement maintenance. It is widely known that road will reach their design life after a few years of operation. Therefore, the good condition of road must be maintained not only to encourage safety but also to helps in minimising the maintenance cost before the serviceability of the pavement further deteriorate and worsen. This paper has explored perception and challenges that are affecting some strategies on pavement maintenance management system in Malaysia. It is suggested to study on the broadest level of the key indicators in optimizing the success of the system.

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