

HIGHWAY MAINTENANCE MANAGEMENT: A REVIEW OF SOME PRACTICES IN MALAYSIA

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ABSTRACT

Highway maintenance is becoming a very popular topic in recent years. The relationship between the growth of the nation and welfare of the society has highlighted the importance of the subject. Without the proper maintenance system, highways can rapidly tumble into depreciation which in the end will affect the highways patron in term of vehicle operation, time, reliability and safety. With the alarming number of accidents happened due to highway condition, the effectiveness of the highway maintenance management system in Malaysia has raised a concerned. A study conducted to address this issue with related government agencies, highway operators and highway personnel using qualitative approach.

Keywords: *Highway maintenance management, qualitative approach*

INTRODUCTION

Practical and effective highways have known to enhance the movement of people as well as products to boost the economy of the country. Maw, Nakamura, & Okamura (2007) stated that highway is the foundation of the transport system to a country. Due to that, ensuring the safety of the highway patrons and the wellbeing of the nation via the top notch of highway maintenance practice should be one of the main priorities for the Malaysian government. In Malaysia, the highway operators are responsible for maintaining over 2,232 kilometers of highways. The highway operators are not there just to provide good and safe road for transportation purpose, they are also required to maintain all the roadside and highway assets in functioning condition. These roadside fixings include signs, barriers, drainage structures, traffic lights, illumination fixtures, and rest areas (PLUS, 2014). The effectiveness of the implementation of the highway maintenance management system (MMS) is a major concerned. Currently 19 people died on Malaysian road on daily basis and 45,000 of accidents happened between 2007 – 2011 on the highways were caused by the highway's condition (Ministry of Transport, 2014). That is why the maintenance management has become an important issue for parties involved.

LITERATURE REVIEW

History of maintenance management

Maintenance probably was first defined in 1964 by the British Standard in 1964 or known as BS 3811:1964 as “work undertaken in order to keep or restore every facility to an acceptable standard”. Geraerds (1985), Dekker (1996), Dhillon (2002), Pintelon & Parodi-Herz (2008) concluded that maintenance as the required actions performed in keeping or restoring a system or part or equipment to its original functionality state. In general, the maintenance management is equivalent to terms for example: maintenance models; maintenance methods; maintenance techniques; maintenance systems; maintenance types; maintenance philosophies; and maintenance strategies regularly used by many scholars to describe to describe the same concept of maintenance (Fraser, Hvobly, & Tseng, 2015). Performing an appropriate maintenance require techniques, technical skills, methods to use assets such as equipment, vehicles, equipment, machinery, materials, plants and systems in the right way (Velmurugan & Dhingra, 2015). The main objectives for maintenance is to ensure system function, system life and system safety (Khaira & Jain, 2012; Velmurugan & Dhingra, 2015). In the highway perspective, according to Al-Mansour, Sinha, & Thomas, (1993); Gandhare & Akarte, (2012) and Velmurugan & Dhingra, (2015), the two main approaches of maintenance were Corrective Maintenance (CM) and Preventive Maintenance (PM). CM and PM are classified as Planned Maintenance whereas Unplanned Maintenance is classified for Emergency Maintenance only (Institute of Maintenance Management Education, 2013). CM, also known as breakdown maintenance is regarded as the earliest model in the industry by the researchers where the maintenance is done after system failure meanwhile the PM is performed before system failure (Zaim, Turkyilmaz, Acar, Al-Turki, & Demirel, 2013). Wang, Chu, & Wu (2007) further explained that PM in practice is subdivided into periodic maintenance and predictive maintenance.

Periodic maintenance, also known as “time-based maintenance” is performed periodically to prevent sudden breakdown (Wang, Chu, & Wu, 2007). Whereas in predictive maintenance, also known as “condition-based maintenance”, maintenance activities performed grounded on inputs obtained from dedicated measurement instruments such as ultrasonic testing, techniques of monitoring, sensor systems and vibration monitoring (Wang, Chu, & Wu, 2007). Conversely, the current practices of most highway operators in Malaysia gives more focus on the corrective maintenance, while preventive maintenance has been given a minor attention due to the lack of awareness and also regulation enforcement (Harun, 2009).

Maintenance optimization and strategy

The best maintenance strategy to be selected is actually depends on several factors such as maintenance approach chosen must be able to resolve the problem, delivering within a budget and lastly minimal disruption to the public (Ansell, Holmes, Evans, Pasquie, & Price, 2009). General maintenance management models such as Total Productive Maintenance (TPM), Condition-Based Maintenance (CBM), Corrective Maintenance (CM), Preventive Maintenance (PM) and Predictive Maintenance (PDM) were evaluated to suite a particular asset/system in any organization as well as any industry. Many models proposed to improve operational performance and optimize the

cost such as maintenance decision support system (DSS) (Lin, Ambani, & Jun, 2009; Mahdi, Hossein, & Taha, 2010); Expert systems (Chang Albrites, Krugler, & Smith, 2005); Analytical modeling (Gendreau & Soriano, 1998); and System Dynamics (SD) (Fallah, Rahmandad, Triantis, & De-la-garza, 2010).

The critical issues in discussing the optimization of maintenance model are related to the identified key indicators for measuring the efficiency of maintenance, which are viability, reliability, accessibility, safety, and maintainability (Qingfeng, L.Wenbin, Z.Xin, Y.Jianfeng, & Y.Qingbin, 2011). Apart from the mentioned models, many other models are being developed and practiced all over the world as the optimization models are originally being introduced to assist managers and practitioners in production related industry. Therefore, further research is needed in covering this area and identifying the best method in Malaysia context.

The central aim of maintenance management is “total asset life cycle optimization” i.e., maximization of availability and the reliability of assets in attaining the operational or business goals. On that note, the maintenance is not only needed to deal with the issues of technology but a mix of issues pertaining technology, management, business and operation strategies (Pintelon & Parodi-Herz, 2008). According to Schokry (2010), maximizing the productivity at the lowest cost possible without compromising the quality and the safety standard is the main objective of maintenance. Therefore, the maintenance commitment is constantly about optimizing productivity, minimizing cost and maximizing quality and safety of product, system or infrastructure.

Maintenance management problems

The highway operators are the parties responsible for maintaining of highways. These infrastructure providers always have limitation in terms of the available resources. As a result, highway operators or more precisely, the highway maintenance department face problems in their efforts to optimize the allocation of resources between different competing objectives in terms of increasing capacity, maintain and improve highway safety (Chassiakos, Panagolia, & Theodorakopoulos, 2005). Lack of effective maintenance management can be seen through financial performance of the company and lead to safety hazard and loss of human lives (Sinha, 2015).

Miles and Syagga (1987) concluded that there are three main problems associated with maintenance management, insufficient financial; poor design; and bad management. The first problem of maintenance management is always being associated with financial. The lower appreciation for maintenance, coupled with increasing maintenance cost has made the maintenance task become increasingly difficult. (Sharaf & Youssef, 2001). Highway need for maintenance keep increasing every year due to the assets deterioration factor and at the same time the fund allocated for this function are not adequate to satisfy all activity. Generally, the money increase for maintenance function, is related to the increase of maintenance activity cost and not for the betterment of maintenance works (Sharaf & Youssef, 2001).

The second drawback correlated to highway maintenance is poor design (Miles & Syagga, 1987). Each year many accidents happened as a result of improper maintained highway and poor design roads (The World Bank, 2013). According to The Levin

Firm (2014), some of the more common accident-causing conditions that result from negligent road maintenance or design including potholes; lack of signage; poor road drainage system; faulty traffic signals; faded or missing lane markers; burned-out streetlights; uneven pavement; debris on road; poorly maintained bridges; and lack of warning regarding hazards.

The last problematic issues with regard for highway maintenance is relates to bad management (Miles & Syagga, 1987). Highway maintenance has undergone many aspect of changes such as computerized highway maintenance system (PLUS, 2014), electronic reporting and communication (Lingkaran Trans Kota Sdn Bhd, 2014). However, the decision made for highway maintenance function is still at heart and this has not change by any mean (The Chartered Institution of Highways & Transportation, 2012). The effectiveness of maintenance management is relates to the highway maintenance manager and the ability of the maintenance personnel / workers (Mohamed, 2010).

METHODOLOGY

The objective of this study is to investigate the effectiveness of implementation of highway maintenance management system in Malaysia. The general research design and justification engaged as an outlines for the current study. It features an argument of the primary research design, data collection, sample selection and method of management, reliability and validity issues, principled considerations and data analysis strategy. The study understand the need for involvement of qualitative methods in the highway maintenance area as its will involve the collection of data and analysis from the related parties such as government agencies and highway operators. The qualitative research will explore issues and uncover major research arguments with regard to the highway maintenance management practice, before analyzing the data to measure the effectiveness of highway management system practices in Malaysia.

The research aims to address the concerns of parties involved in this problematic highway maintenance system area and in cooperation with the members of the system in transforming the system into a desired state. These objectives are deemed to suit the goal of an action research (AR) for the study. AR processes enable practitioners to justify and improved their practice (French, 2009). This principle of understanding a phenomenon are generally normal to the paradigm of qualitative research (O'Brien, 2001). Qualitatively based approaches effectively measuring a complex function such as maintenance compared to quantitative models (Cresswell, 2007; Kumar, Galar, Parida, Stenstro m, & Berges, 2013).

The study will employ interview method to obtain understanding of the maintenance personnel and will focus on unstructured interview which intended to put the interviewees at ease and unassessed and at the same time set the tone for the rest of the interview sessions as the researcher do not know in advance all the questions related (Douglas, 1985; Fontana & Frey, 1994; Hannabuss, 1996; Qu & Dumay, 2011). The interview conducted with standard procedure aims to ensure that all information data are consistent and reliable with the objective of the research studies (Mack, Woodsong, MacQueen, Guest, & Namey, 2005). The data gathered from the

interview will be reviewed and coded for emergent themes or categories, which then will form the basis of the research findings (Rowley, 2012).

The quality and the finding trustworthiness of qualitative study depends on the credibility of data gathered, the accuracy of the analyses conducted and research design employed (Margaret & Paul, 2015). According to Bhattacherjee (2012), disregarding of the research design utilized, the objective of researchers is to collect as many and as varied as possible data that can help you get the best view possible of the phenomenon of interest. In addition, the strength of qualitative research methods were located on their utility in understanding the meaning and context of the phenomenon being studied, and certain events that occurred and the procedures that make up this phenomenon from time to time, in real life and natural settings (Maxwell, 1996; Kaplan & Maxwell, 2006). The analysis strive for depth of understanding (Merriam, 2002).

Sample selection

The credible of qualitative research depends on adequate sample size (Marshall, Cardon, Poddar, & Fontenot, 2013). Accept generalization from logical reasoning enable the study as credential research due to the relevant respondents were selected for the study instead of statistical drawn samples (Yin, 1989). Interviews will be conducted with selected maintenance personnel in the Maintenance Management Department from government agencies and highway operators.

Data analysis

The qualitative research is represented by the search for meaning and agreement, researchers considered a major tool for data collection and analysis of data, an inductive strategy and the investigation and the final product rich descriptive (Merriam, 2002) . Dodge (2011) explained that the data analysis for qualitative study gives a meaning for first impression and final compilation. The data analysis will be presented in these three categories; the work process flow of maintenance department involving the maintenance work planning, the weaknesses in the implementing of maintenance management during the maintenance monitoring activities and the details of the report requirements needed by the top management. These three classifications will attempt to discover all the details that can be utilized to accomplish the objective of the research

CONCLUSION

This research seek to uncover the phenomenon in maintenance management system in Malaysia with the application of maintenance management, the strategy and practices, critical success factors, problems with the application of maintenance management. Irrespective of all issues recorded in the past, there is scope for maintenance management system, as a consequence of few fundamental explanations; the technological push, the economic necessity and safety aspect. MMS included in the decision support system allows quantitative and objective decision making. Firstly, the decision made is a decision that can be defended enable it to be very suitable for group

decision-making, mainly it allows parties responsible / operators to assess from an economic standpoint, satisfaction and safety resulted from the decision made.

The importance of highway maintenance needs to be raised at the broadest level of planning and prioritizing within a sector perspective, including the role of maintenance and its benefits to highway operators, users, and beneficiaries. At the same time, it is necessary to build a broader understanding of highway maintenance objectives and benefits, planning and prioritization processes, and an ability to explain these issues when necessary (Penang Monthly, 2014).

REFERENCES

Al-Mansour, A., Sinha, K., & Thomas, K. (1993). Effects of Routine Maintenance on Flexible Pavement Condition. *Journal of Transportation Engineering*, Vol. 220, No. 9, 65-73.

Ansell, M., Holmes, M., Evans, R., Pasquire, C., & Price, A. (2009). Delivering Best Value in Highway Major Maintenance Scheme: Case Study. *Construction Engineering and Management*, Vol. 135, No. 4, 235-245.

Bhattacherjee, A. (2012). *Social Science Research: Principles, Methods, and Practices*. University of South Florida.

British Standard (3811). (1964). Maintenance Management Terms in Terotechnology. United Kingdom.

Chang Albitres, C., Krugler, P., & Smith, R. (2005). A Knowledge Approach Oriented to Improve Strategic Decision in Pavement Management Practices. *1st Annual-university Symposium of Infrastructure Management*. Ontario, Canada: Waterloo.

Chassiakos, A. P., Panagolia, C., & Theodorakopoulos, D. D. (2005). Development of Decision-Support System for Managing Highway Safety. *Journal of Transportation Engineering* (Vol. 131, No. 5), 364-373.

Cresswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among 5 approaches* (2nd ed). Thousand Oaks, CA: Sage Publications Inc.

Dekker, R. (1996). Application of maintenance optimization model: a review. *Reliability Engineering and System Safety*, Vol. 51, 229-240.

Dhillon, B. (2002). *Engineering Maintenance: A Modern Approach*. New York, NY: CRC Press.

Dodge, P. R. (2011). Managing school behavior: a qualitative case study. *A dissertation submitted to the graduate faculty in partial fulfillment of the requirements for the degree of Doctor of Philosophy*. Graduate Theses and

Dissertations . Graduate School, Iowa State University: Digital Repository @ Iowa State University.

Douglas, J. D. (1985). *Creative Interviewing*. Beverly Hills, CA: Sage.

Fallah, S., Rahmandad, H., Triantis, K., & De-la-garza, J. (2010). Optimizing Highway Maintenance Operation: Dynamic Consideration. *System Dynamic Review*, Vol. 26, No. 3, 216-238.

Fontana, A., & Frey, J. H. (1994). Interviewing: The Art of Science. In N. K. Denzin, & Y. S. Lincoln, *The Handbook of Qualitative Research* (pp. 361-376). Thousand Oaks: Sage Publications.

Fraser, K., Hvolby, H.-H., & Tseng, T.-L. (2015). Maintenance management models: a study of the published literature to identify empirical evidence. *International Journal of Quality & Reliability Management*, Vol. 32 Iss 6, 635-664.

French, S. (2009). Action research for practising managers. *Journal of Management Development*, Vol. 28, No. 3, 187-204.

Gandhare, B. S., & Akarte, M. (2012). Maintenance Strategy Selection. *Ninth AIMS International Conference on Management*, 1330-1336.

Gendreau, M., & Soriano, P. (1998). Airport Pavement Management System: An Appraisal of Existing Methodologies. *Transportation Research Part A: Policy and Practice*, Vol. 32, No. 3, 197-214.

Geraerds, W. (1985). The cost of downtime for maintenance: preliminary considerations. *Maintenance Management International*, 5, 13-21.

Hannabuss, S. (1996). Research interviews. *New Library World*, Volume 97 · Number 1129, 22–30.

Harun, M. H. (2009). Highway Maintenance Management: A Case Study at Projek Lebuhraya Utara Selatan.

Institute of Maintenance Management Education. (2013, July 21). Definition and Types of Maintenance. Delhi, India.

Kaplan, B., & Maxwell, J. A. (2006). Qualitative Research Methods for Evaluating Computer Information Systems. In J. G. Anderson, & C. Aydin, *Evaluating the Organizational Impact of Health Care Information Systems* (pp. 30-55). Springer Science & Business .

Khaira, A., & Jain, A. K. (2012). An Optimized Decision for Opportunistic Maintenance or Event-Driven Maintenance of Industrial System. *International Journal of Scientific & Engineering Research*, Volume 3, Issue 6, June-2012, 1-5.

Kumar, U., Galar, D., Parida, A., Stenstrom, C., & Berges, L. (2013). Maintenance performance metrics: a state-of-the-art review. *Journal of Quality in Maintenance Engineering, Vol. 19 No. 3*, 233-277.

Lin, L., Ambani, S., & Jun, N. (2009). Plant-level maintenance decision support system for throughput improvement. *International Journal of Production Research, Vol. 47 No. 4*, 7047-7061.

Lingkaran Trans Kota Sdn Bhd. (2014). <http://www.litrak.com.my/>. Retrieved January 1, 2016, from http://www.litrak.com.my/?page_id=312

Mack, N., Woodsong, C., MacQueen, K. M., Guest, G., & Namey, E. (2005). *Qualitative Research Methods: A Data Collector's Field Guide*. North Carolina: Family Health International.

Mahdi, B., Hossein, B., & Taha, H. (2010). Selecting optimum maintenance strategy by fuzzy interactive linear assignment method. *International Journal of Quality and Reliability Management*, 991-1016.

Margaret, R. R., & Paul, J. L. (2015). *Applied Qualitative Research Design*. New York: The Guilford Press.

Marshall, B., Cardon, P., Poddar, A., & Fontenot, R. (2013). Does Sample Size Matter In Qualitative Research?: A Review of Qualitative Interviews. *The Journal of Computer Information Systems; Fall 2013; 54, 1*, 11-22.

Maw, A. A., Nakamura, F., & Okamura, T. (2007). A Study on Highway Project Procurement Through Evaluation of Alternative Public-Private Partnership Approaches . *Proceedings of the Eastern Asia Society for Transportation Studies, Vol.6*. Japan: Eastern Asia Society for Transportation Studies.

Maxwell, J. (1996). *Qualitative Research Design:An Interactive Approach*. Thousand Oaks, CA: Sage Publications.

Merriam, S. B. (2002). *Qualitative research in practice - examples for discussion and analysis*. San Francisco, CA: Jossey-Bass.

Merriam, S. B. (2002). *Qualitative research in practice - examples for discussion and analysis*. San Francisco, CA: Jossey-Bass.

Miles, D., & Syagga, P. (1987). *Building Maintenance: A Management Manual*. Intermediate Technology Publications.

Ministry of Transport. (2014). *Pelan Keselamatan Jalan Raya Malaysia 2014-2020*. Putrajaya: Jabatan Keselamatan Jalan Raya.

Mohamed, N. W. (2010). Road Maintenance Management System: A Study at Public Work Department. *A project report submitted in fulfilment of the requirement for the award of the degree of Master of Science Master of Science*

(*Construction Management*) . Faculty of Civil Engineering, University of Technology Malaysia .

O'Brien, R. (2001). *An Overview of the Methodological Approach of Action Research*. Retrieved from <http://www.web.ca/~robrien/papers/arfina.html>

Pintelon, L., & Parodi-Herz, A. (2008). Maintenance: An Evolutionary Perspective. In K. A. Kobbacy, & D. N. Murthy, *Complex System Maintenance Handbook* (pp. 21-48). London: Springer.

PLUS. (2014). *PLUS - A Member of UEM*. Retrieved January 10, 2015, from <http://www.plus.com.my/>
http://www.plus.com.my/index.php?option=com_content&view=article&id=145&Itemid=158

Qingfeng, W., L.Wenbin, Z., Y.Jianfeng, & Y.Qingbin. (2011). Development and Application of Equipment Maintenance and Safety Integrity Management System. *Journal of Loss Prevention in the Process Industries*, Vol. 24, 321-332.

Qu, S. Q., & Dumay, J. (2011). The qualitative research interview. *Qualitative Research in Accounting & Management*, Vol. 8 No. 3, 238-264.

Rowley, J. (2012). Conducting research interviews. *Management Research Review*, Vol. 35 Iss 3/4, 260 - 271.

Schokry, A. (2010). Introduction to Maintenance. Islamic University of Gaza, Palestine.

Sharaf, E. A., & Youssef, M. A. (2001). A Two Fold Optimization System for Highway Maintenance Fund Allocation. *5th International Conference on Managing Pavements*.

Sinha, P. (2015). Reliability Paper: Towards higher maintenance effectiveness - Integrating maintenance management with reliability engineering. *International Journal of Quality & Reliability Management* Vol. 32 No. 7, 754-762.

The Chartered Institution of Highways & Transportation. (2012, November 21). *Sixty Years of Highway Maintenance*. Retrieved Januari 1, 2016, from <http://www.cihgt.org.uk/>
<http://www.cihgt.org.uk/download.cfm/docid/7A6FEA4C-784B-4201-A06C230E28358559>.

The Levin Firm. (2014, October 27). *Can I sue after an accident caused by poor road design or maintenance?* Retrieved January 1, 2016, from <http://www.levininjuryfirm.com/>
<http://www.levininjuryfirm.com/can-sue-accident-caused-poor-road-design-maintenance/>

Velmurugan, R., & Dhingra, T. (2015). Maintenance strategy selection and its impact in maintenance function: A conceptual framework. *International Journal of Operations & Production Management, Vol. 35 No. 12*, 1622-1661.

Wang, I., Chu, J., & Wu, J. (2007). Selection of optimum maintenance strategies based on a fuzzy analytical hierarchy process. *International Journal of Production Economics, Vol. 107*, 151-163.

Yin, R. K. (1989). *Case Study Research*. Newbury Park, CA: Sage Publications Inc.

Zaim, S., Turkyilmaz, A., Acar, M. F., Al-Turki, U., & Demirel, O. F. (2013). Maintenance Strategy Selection: A Case Study. *Journal of Quality in Maintenance Engineering, January 2013*.

