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Validation of Building Maintenance Performance Model for Malaysian Universities

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Abstract—This paper is part of an ongoing research on the development of systemic maintenance management model Malaysian university buildings. In order to achieve this aim, there is a need to develop a performance model against which services are measure. Measuring performance is a significant part of maintenance management service delivery. Maintenance organization needs to know where they are in order to provide user-driven services and to enhance productivity. The aim of this paper is to formulate a template or model for university maintenance organization in Malaysia. The model is based on literature review and survey questionnaire and has been validated. Through grounded theory, this paper developed a 8 points matrix for the university maintenance organizations for measuring and improving their service delivery. The potential of the model is guide and assists towards providing value added service delivery through initiating maintenance according to user value system rather than on the condition of the building.

Keywords—Performance matrix, university buildings, users, maintenance organization

I. Introduction

THERE are many complaints in the media and research literature that many of the university buildings in Malaysia are not performing optimally due to poor maintenance management process. In other words, the maintenance organizations are not providing quality services to the building users.

While there are many causes for this poor performance, it is debatable that there are lacks of performance indicators against which these organizations measure their outputs. Granted there could be problem of in-sufficient funds. But the main issue is due to poor management science and principle. Therefore, this paper is based on the hypothesis that the presence and applications of maintenance metric is positively correlated with the maintenance services provided by the organization. The lack of these metrics would means that the maintenance organization would not be able to locate *where they are*. In other words, there will be problems of whether they are productive or not, how productive they are and if their users are satisfy with the services or not.

Poor maintenance management systems will lead to unnecessary increase in maintenance costs and low user satisfactions and low productivity, however. The objective of this paper is to present the results of the validation of a maintenance performance matrix that was developed. The remainder of the paper is arranged as follows. The next section outlines the method of data collection and analysis. In section III, the maintenance of university buildings is discussed. Section contains literature on maintenance performance current matrix. Data analysis and results are contained in section V. The paper discussion of the results is presented in section VI. Finally, the paper conclusion is drawn and presented in section VII.

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II. Research Design

The main research of which this paper forms part found that there are problems with the university maintenance organizations in Malaysia. A hypothesis of the main research is concerns with lack of matrix against which maintenance services are benchmarked. However, in order to establish whether the services are to the satisfactions of the users or not, there is a need to develop such benchmark-maintenance performance matrix or MPM. This paper reports the validation of the MPM developed by Olanrewaju, Khamidi and Arazi [2010]. In order to achieve this aim, the model was addressed to the most senior officers in development division, facilities department or maintenance division or as the case may be.

The pilot survey and validation commenced in September, 15th 2010 and lasted through to December 2010. The questionnaire was prepared in English. The participants were asked to comments and offer suggestions on each of the matrix. Although, the list may not be exhaustive, they are indicatives of the criteria of the user value systems.

Although, the validation collects both quantitative and qualitative data, it relied much on open ended information. Therefore it strength lies in the insights it provides toward validating the model. This is a basic element of grounded theory research. However, the data collation and gathering does not follows the typical process often used for qualitative research. The approaches used for the validation ranged from structured, semi structured to the structured interview.

It is instructive to stress that the data collection and data analysis stages were not kept separate from each other. The two are intermittingly, an on going and complementary process {2]. There are number of points to note about the approaches adopted for the validations. Firstly, the appointments for the interview were made through phone calls ad emails. Where required, the questionnaire was sent though emails or fax in advance of the interview to the participant.

III. UNIVERSITY BUILDING MAINTENANCE

Government aimed to transform Malaysia into a high-income nation. In other words, the government wants Malaysians to have a better quality of life through better payment. For that purpose that is the concerted need to transform the economy from it present, production leads economy to knowledge economy (K-economy). This will entail increasing the proportion of skilled workers above far above what it is currently. This is to say, there the requirement for knowledge workers are very high.

However, in order to achieve this aim, there is the urgent need to produce quality human resource- well grounded graduates that can compete nationally and internationally. Well trained, analytical, adaptive, creative and innovative workforce with high morals that will spur Malaysia into the high income nation in 2020 and beyond require high performance universities. Higher performance universities require functional assets.

University assets are funds, technology, human, equipments and plant as well as the constructed facilities (i.e. buildings). University education being labour intensive, human resource is it most significant resources. However, apart, from the human resources building is the most significant resource of a university institution. In fact, buildings could sometime constitute up 90% of a university's assets. University buildings are procured to create suitable, conducive, and adequate environment to support, stimulate and encourage learning, teaching, innovation and research

Therefore, any inadequacy with the building facilities is loss of values to the university institution, users and other stakeholders. Thus the prime objective of the university will be difficult if not impossible to be achieved. From the one hand, it is not possible to replace or rebuilt all university's buildings at a time. This is an illustration. The replacement costs of sixties buildings in English universities alone is estimated to cost £11 bn [3].

From the one hand, buildings cannot remain new throughout their entire life. In fact, before a building is completed, a maintenance problem starts to creep in. Therefore, the need for maintenance will only intensive. Building maintenance constantly affects everyone's life because people's comfort and productivity is relative to the performance of the building they live, learn, conduct research and work in (e.g. home, offices, schools, university and markets). There are sufficient literature to conclude that the current maintenance practices failed to link building performance with organisation mission and vision [4, 5 and 6]. The current systems are fragmented, bias and condition based.

Consequently, there is the need for a value based maintenance management. Organization that put *value* at the *heart* of its mission statement means that the organization is viewing their processes from concept to application and disposal from both the consumers and providers perspectives. From the other hand, maintenance is treated as an engineering issue and likewise it management. However, maintenance management should be entrepreneur-led. The mission statement or MS (the underlying purposes and values) of maintenance department should be to enhance users satisfactions firstly and then to improve productivity. Building users are not different from customers in terms of their requirements. The MS must be translated into SMART (specific, measurable, achievable, realistic and time bound) objectives. The maintenance organization will need to provide high quality services to their customers. In order to provide service with high standards, maintenance organization must continually benchmark their services with users' expectations and perceptions internally and externally.

Through the performance indicators it is possible not only, to evaluate the quality of the process, but also to indicate the improvements that can be made in the processes [7]. One of the main function of the maintenance management is the assessment of services of maintenance service provider be it for the in-source or outsource organization. See also Hoffmann and Schumann [8]. However, this can only be done if there is compressive metric to measure the performance of their services delivery. If there is no established performance metric, maintenance service cannot be systemically optimized. In this situation, it will be difficult to make improvement since improvements with user satisfactions and productivity cannot be measured or monitored.

Customer intimacy demands that companies must have sufficient and adequate knowledge of their customers' needs and wants [9]. The service provider must look far beyond the immediate objectives of the products or services to the users. The providers must provide service that has a wider ends than the customers experience, perceptions and expectations [9]. Strictly, maintenance is business. The maintenance department should be seen as business unit. It should be strengthen by including it in the university strategic business units (USBUs).

IV. MAINTENANCE PERFORMANC MATRIX

There are sufficient literature on the development of performance measurement for new built [4, 7 and 10] and maintenance services [11]. The theory behind performance measurement is that completed building or maintenance service should be measured based on outcomes. In other words, the fundamental issue is not about the input *per se*, rather with meeting the users' functional requirements. This theory emerges based on the philosophy and understanding that buildings are capital good. That is the good that are produced not necessarily for their own sake but for what they help to create, produces and provide. Therefore, maintenance services should be initiated based on the same theory and philosophy [6]. However, there are evidences that the current performance measurements are not also conclusive.

They do not in any way link maintenance expenditure with business performance and most importantly with users' satisfactions. However, there is shortage of literature on performance measurement for the maintenance organizations.

Furthermore, a review of literature would suggest the existing performance measurements are not specific for the maintenance organizations and what more not for the university organizations.

Also, the existing models placed much emphasized on maintenance technology whereas; in this current study it is concerns with the qualitative issues in the maintenance service delivery. The MPM relies on the users' satisfactions for initiating maintenance and improvement in services deliveries. This is crucial because customers' satisfaction is a significant performance measurement metric [12].

V. Data Analysis and Results

This section presents the results of data obtained from the respondents. But initially it reports the information background on the development of the model. The model was developed based on the information and knowledge garnered from survey questionnaire. The questionnaire was divided into two parts. Specifically, a part of the questionnaire was addressed to the maintenance managers (as the service providers) and the university building users. The questionnaires for the service providers were administered on 50 "maintenance managers" of recognized universities in Malaysia and five hundred and fifty university building users.

The data for the building users is limited to 3 public universities and two private universities. The response rate for the maintenance organization is 66% (n=33). This is a response rate of 66%. This is considered satisfactory for postal survey. The normal response for postal survey is about 30% in fact researchers have reported findings from response rate with less than 20%. However, this high response rate was possible mainly because of the long survey duration and the numerous remainders sent to the respondents. Survey actually span about four months.

The analyses of data, indicates that 17 of the universities surveyed were private university while the remainder of 16 was publicly owned universities. The survey also revealed that about 50% of them possessed Bachelor degree and 21.9% had obtained MSc degrees. Nearly, 32% of the respondents were actually maintenance managers while about 19% were facilities managers. Substantial pats of the "other" are director of development or and maintenance "executive" (this is another title / term for maintenance manager).

From the analysis of the survey, 52% of the universities spent less than RM10 million each on maintenance annually while about 10% spent about RM30 million each on maintenance per annum. Majority (42%) of the buildings were about 15 years old while only about 10% were between 30 to 50 years old.

Response rate for the building users is 81%. It should be mentioned that the respondents of users is limited to only the students. Student is preferred because they are major users of the university buildings. Fifty four percent of the respondents were female, while the remaining (46%) were male. The analyses revealed that about 74% of the respondents were from publicly owned universities. 26% of the students were from private universities. The results of the survey indicate that majority (40%) of the students were in their third years or year three which follows closely with those in their second years.

Many (19.1%) of the responding students were in their first year. Only 6.3% were in year four while less than 1% were in the fifty years. The results further revealed that 1.5% (n=7) of the students were doing either master or PhD degrees. On the average the respondents have spent more than a year on the campus. More than 70% of the students live on carouses while the remainders stay of the campus. With these backgrounds, both the maintenance managers and the building users are capable to provide unbiased feedbacks suitable to achieve the aim of the research.

On the basis of the survey, a maintenance performance matrix was developed. The developed model was sent through email to 40 maintenance managers of director of developments. By end of the cut-off of date, only three of the returned their completed questionnaire. However after several telephone calls, five of them returned theirs within a week.

However, it is quite unusual to conduct a validation exercise using questionnaire survey, however. This is because it is more common to use interviews where face-to-face clarification may be provided to the respondents. However, because of time and financial constraints, this paper based the validation on the survey questionnaire.

Altogether, replies of nine participants on the validation were reported here. Three of the respondents were from the public universities while the other five were from the privately owned universities. From the outcomes, the total number of buildings in the portfolio of the nine respondents is 675 while the size of the floor area totaled 1, 850, 000 square meters. In Table 1 are the results of survey on the matrix validation. Participants were required to either agree (YES) or disagreed (NO) with the target value that was set. However, they are required to provide alternative value in case they do not agreed with the target value. The period achievement in columns 4 of table 1 implies the time difference could be monthly, quarterly or annually or as the case may be determined by the concern maintenance organization.

TABLE I
MAINTENANCE PERFORMANCE MATRIX

No	Metric	Location	Target value	Periodic Achievement	Remark
1	User Satisfaction Survey	Administrative, Academic and Residential	Rating of 4.00 Minimum of4 (on scale of 5)		
2	Customers Complaints	Academic and Administrative	Maximum of 5 complaints / building		
		Residential	Maximum of 10 complaints / building		
3	Response Time To Complaints	Academic and Administrative	85% of customer complaints responded within 30 minutes of complaint received		
		Residential	80% of customer complaints responded within 30 minutes of complaint received		
4	Response Time To Complaints	Academic and Administrative	100% of customer complaints responded within 48 hours of complaint received		
5	Turnaround Time to resolve complaint	Academic and Administrative	80% of customer complaints resolved within same day		
		Residential	40% of customer complaints resolved within same day		
6	Recurring Complaint	Administrative, Academic and Residential	Maximum of 5% of total work order		
7	Engineering System Stability	Administrative, Academic and Residential	Minimum 90% of works based on Planned Preventive Maintenance		
8	Efficiency of work order execution	Academic and Administrative	Minimum 90% closed		

VI. Discussions

All the participants agreed in affirmative that a minimum of 4 on a continuum scale of five is acceptable or reasonable enough the buildings (building fabrics, structure or / services). In another words, a good service should be provided to the extent that users will not be satisfied only to the level of less than 4 point.

Similarly, most of the participants concurred that a maximum of 10 complaints (of defects) is good enough. Although one of them believed it should in fact be reduced to less 5 complaints per month in buildings. However, it is interesting to also found that a participant does not agree to this assessment. In the opinion of the disagreed respondent, 10 should be the minimum because it affects their KPI. One respondent also made us to understand that the "number of complaint does not reflect actual performance but rather time for solving". This observation could sometime be the case. An example of this can now be cited. Female students are more particular or demanding as compared with their male counterpart regarding the condition and performance of their buildings.

However, with regards to the "ceiling level" we set for the maximum complaints in a month per building. The pattern of response is not very much different from the one on the minimum complaints. As an illustration, while some agreed that the 100 complaints we set is realistic, some believed it is too much but at the same time, one of the respondent argued vehemently that it is not realistic to achieved that target. The respondent argued that there should not be a maximum limit because; it might put them under high pressure.

All of the participants agreed that the RTC (response time to complaint) is very critical in service delivery. This indicated in the response to this aspect of the model. Some believe, 85% is bit on the higher scale but some argued it is appropriate enough because of the criticality of maintenance. In fact all of those that made their interests known indicate that at least 70% of the complaints must be responded to within 30 minutes. However, in our model, we set that 85% of complaints for the academic and administrative buildings must be responded within 30 minutes and for the residence (i.e. student hostels), 80% of the complaints must be responded to within the same time scale. In another regards, the participants also agreed that all complaints must be responded with 48 hours. However, a participant disagreed that the 48 hours to respond to all complaints is not realistic. However, the participant failed to provide a convince case to the total objection.

The turn around time to resolve complaints we set, was found to be reasonable. In fact, some of the respondents believed that the 80% we set for the turn around time to resolve complaints in academic and administrative buildings is low. In other words, the participants held that all complaints must be resolved on same day. The participants also believed that the 40% we set for residence is too low. That it should be closed to or on the same scale with that for academic and administrative buildings. However, a participant suggest, that in general the turnaround to resolve complaints "shall be priorities based on urgency and plan works to avoid unnecessary maintenance cost"

In another aspect, the entire participants concurred with high confidence that the maximum recurrent complaints should not be more than 5% of the total work executed in the entire buildings category. Similarly, all the participants concurred that more than 90% of engineering service should be based on planned preventive maintenance. These results are not however unexpected. In fact, our undisclosed hypothesis was that all mechanical and electrical will be based on planned maintenance.

With regards to the efficiency of work, our target values of 90% for academic and administrative and 85% for residence are realistic enough. Yet a participant opined that it depends

on various factors including availability of skill workforce, materials and fund. That notwithstanding, some of the participants further alleged that the figure should be 100% in actual reality.

While it might not be possible to achieve 100% efficiency with all works executed, these figures should be kept at the barest minimum. To this, all the participants concurred that it should not exceed 5% of the total work executed. In another words, at least 95% of the works must be efficient. Though as expected, all the participants held that all repairs must be efficiently maintained within 60 days. In other words, the 5% (less) of the repairs must be rectified within 60 day.

VII. Conclusion and Further Research

The main research, to which this paper forms part, is concern with the development of a conceptual model for the university maintenance organization. Specifically, the main research aimed to develop Value-based Maintenance Management Model or VMMM. VMMM is an emerging management science that is touted by its proponents to help maintenance organization to deliver satisfactory service to buildings users, reduce maintenance backlogs, reduce maintenance costs and increase maintenance organization's productivity.

The maintenance performance matrix has bee n developed and validated. The outcomes of the validation are positive. While the model is specifically for university organization, the model can be used for all organizations that have substantial buildings in there portfolio. While the paper presented the outcome of the initial validation process, efforts are vigorously ongoing towards improving its robustness. Furthermore, explanations of each of the matrix are on going which will be reported as soon as it is completed.

The matrix was designed to be dynamic and flexible, since no tool, regardless of its sophistication may predict future absolutely. However, the matrix is not an end in itself rather it is a means towards better maintenance management. Universities must align maintenance objective and maintenance policy with their corporate mission and vision. These will align maintenance standard with organization corporate objectives.

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