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Towards Better Road Contractor Performance

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Abstract. Public Works Department (PWD) is heavily involved in road project management whether the project is conventional in-house, consultant or design and built. The performance of this project will depend on the performance of the contractor who executes the project. Thus, it is important that the appointed contractor performs well to ensure that the project can be completed within the specified time, cost and quality stipulated. To ensure that only the best contractor is chosen, it is important to have a database on the evaluation of contractor's performance. This paper proposes the best method to evaluate contractor performance comprehensively. The evaluation encompasses all aspects during construction including site organisation, administration, planning work progress, work quality, and the control of nominated subcontractors or suppliers. The assessments were done every six months and the mark given can be converted into grades to categorise each contractor's performance. These assessments not only provide the data of contractor performance but will motivate contractors to perform at their peak throughout the project period.

Keyword: *Contractor performance, road contractor performance, evaluation of contractor*

1. Introduction

Construction industry is one of the significant factor that contribute to the growth of the country's economy in Malaysia. The performance in construction industry depend on the contractor performance. The problem of poor performance in the construction industry has been widely recognized and has been documented by Oglesby et al. (1989), Alarcon and Ashley (1992) and Forbes (1993). Explicit solicitude has been reported about the decline in construction quality in the past decade, as well as concerns regarding the decrease in customer satisfaction in the construction industry (USACE Blue Ribbon, 1983) despite the programmes developed to improve the process and the products of construction (Oglesby et al., 1989; Kubal, 1994).

Other than contractor performance, the implementation of new contracting techniques, inadequate pricing methods, lower productivity, insignificant technological growth, reduction in the industry's net worth, dependence on legal assistance, lack of co-operation among professional groups, disappearance of true general contractors, increasing dependence on project consultants, outmoded QA/QC programmes, outmoded safety programmes, and transference of professional liability are considered by some to be causing the decline in the quality of construction (Hindle and Rwelamila, 1993; Kubal, 1994).

This paper proposes the best method to evaluate contractor performance comprehensively. The evaluation encompasses all aspects during construction including site organisation, administration, planning work progress, work quality, and the control of nominated subcontractors or suppliers. The assessments were done every six months and the mark given can be converted into grades to categorise each contractor's performance. The assessment will take into account the aspects of sustainable road development to improve economic and social development simultaneously with environmental protection. These assessments not only provide the data of contractor performance but will motivate contractors to perform at their peak throughout the project period.

2. Background

Contractor performance has long been defined in terms of cost, time and quality, and each of these aspects has been the subject of much research. However, nowaday sustainable development has been included into consideration to evaluate the performance of contractor. Sustainable road development can generate extra life of the road, and at the same time it will help to decrease the cost of maintenance. The philosophy underpinning the development of the overall contractor performance model is that achievement of one aspect of performance should not affect another.

Contractor performance is critical to the success of any construction project as it is contractors who convert designs into practical reality. Improved contractor performance leads to increased client satisfaction, an improvement in the reputation of contractors and hence their competitiveness in the market.

Road development has several major life cycle stages which is planning, construction stage, maintenance and disposal. To build a sustainable road network, three dimensions of sustainability which is economic efficiency, environmental impact, and social equity, need to be prioritized. These dimensions should be taken significantly and concurrently from all stages of road development.

Sustainable road construction can contribute many benefits such as reduce raw material consumption, minimize the use of fossil fuels, generate energy, reduce water consumption, reduce greenhouse gas emission, reduce water pollution, reduce solid waste, conservation of habitats, creating habitat and reduce carbon footprint.

Malaysia's Sustainability Initiative began after the Green building was introduced by the Green Building Index (GBI) in 2008. GBI Malaysia is developed by Pertubuhan Akitek Malaysia (PAM) and the Association of Consulting Engineers Malaysia (ACEM). Now, Malaysia has further developed their rating tool where it's used as a standard measurement and proper guidance to assess the extent of sustainability measures adopted by road projects in Malaysia.

Initially pH JKR is more focussed on building works which it has four significant criteria used as an assessment scheme of government green building. These are energy efficiency, indoor environmental quality, material resources and water efficiency. In the year 2012, Penarafan Hijau JKR (pH JKR) guideline (version 1.0) of roads category, was produced to serve sustainability rating tool for new road project and in year 2013, pH JKR manual for upgrading of roads category was produced.

In Malaysia, pH JKR by PWD (2012) and INFRASTAR by CIDB (2019) are rating tools used as a standard measurement and proper guidance for property developers and owners to achieve building performance in an environmentally friendly and energy efficient. Each of these tools has its own set of criteria and capacity in delivering the sustainability level of a road.

To achieve sustainable development, all parties must play their roles and strive to work together. In the construction phase, the contractor must play the main role to deliver a sustainable project. To ensure the contractor can deliver a good project, PWD has taken the responsibility to assess contractor performance. The sustainability of the road project will depend on the performance of the contractor who executes the project. For that purpose, PWD must produce a mechanism to monitor the performance of the contractor during the construction stage.

3. Literature Review

Several studies have been conducted to investigate the relationship between sustainability and contractor firm competitiveness. Studies by Tan et al., (2015) and Tan, Shen and Yao, (2011) they found the relationship between sustainability performance and contractor firm competitiveness. This studies show inverse U-shape relationship to both factors. These findings help contractors to understand better the relationship between these two factors and help to evaluate their current position and optimise their resources for sustainable development and integrate sustainability into their strategic planning. Thus, contractors will compete in the market and drive to achieve sustainable development.

Sustainability is an issue that needs to be addressed in the road construction development industry. A study by Zuo et al. (2012) found that successful companies were very focused on good management practices and very keen on sustainable development. These contractor companies emphasise efficiency and energy efficiency, reduction of greenhouse gas emissions and renewable energy integration into the project.

Based on a study conducted by Afzal, Lim and Prasad, (2017) on the Corporate Approach to Sustainability in the Construction Industry, was studied the approaches adopted by contractors to express their commitment to sustainability. This study was conducted on 50 top contractor's construction is listed in the News-Record Engineering (ENR). This study has shown that most contractors focused more on financial performance than other sustainable development factors such as social and environmental. However, there are still a few contractors focused on sustainability in construction. In this study, most European contractors were concerned about and disclosed sustainable development. The performance of the contractor needs to be monitored especially on the contractor's level of awareness on sustainable development issues, and so that it can make sure the number of contractors involved in sustainable development will increase.

Contractors should implement sustainable development practices to meet resource efficiency requirements and adapt to current climate change. Besides, to meet the needs of the environment as well as maintaining the environment, implementing sustainable development practices by the contractor can provide a source of competitive advantage in the future. Now days, more contractors were aware of the development of sustainable construction. Tan, Shen and Yao, (2011) studied the relationship between sustainable practices in the construction industry and the relationship between sustainability performance and business competitiveness. This study found that having a framework for sustainable construction practice will help contractors to design sustainable development and improve the performance of the contractor itself.

Based on a study by Puodziukas, Svarpliene and Braga, (2016) in Lithuania, they found that in 20-year experience before, the road construction in Lithuania does not practice sustainable road development. However, in this study they realised that sustainable in road construction was significant to environmental impact. Other than, this study also found three fundamental principles that must be met to achieve the goals of sustainable development, which is the principles of climate change, human health and biodiversity.

The study conducted by Whang and Kim, (2015) states that to rationalize and achieve the goals of sustainable construction development, the three factors, which is economic, social and environmental need to be emphasized. The performance value of these factors, the correlation and the gaps between these three factors have been studied. Based on their research on some selected contractors found that there was a gap between the importance and value of the contractor's performance on these sustainable development factors. It indicates that there are still contractors who do not practice sustainable development. The results of their study also found that there was a close relationship between economic factors and the environment but not social factors; nevertheless, social factors are only closely related to environmental factors.

For achieving the goals of sustainable development of roads, Molenaar, (2013), in his study, has discussed aspects of sustainable pavement structure in developing countries. In his research, he also discussed the proper construction requirements to achieve the goals of durable road development with a sustainable pavement structure. It shows that the contractor plays a significant role to achieve sustainable development. The contractor is a party responsible for realising the drawings provided by the designer to the exact shape and size specified by the contract. They are also responsible for applying the ideas translated in the form of drawings to the actual shape and specifications of the building.

Several studies indicate that contractor performance is important in achieving sustainable road construction development. Xu, X., Li, C. Z., Wang, J. & Huang, W. (2019) have studied and analysed several dynamic behaviours between designers and contractors in different scenarios using Nash equilibrium models. Based on the parameter discussion, they have proposed five effective solutions for achieving collaboration between designers and contractors. Therefore, it can be said that if there is good cooperation between the planner and the contractor, then the work done will be easy and will help in achieving the goals. It can be concluded that the factor in selecting a contractor in a project is important to ensure that cooperation between the contractor and designer is achieved. Thus, it can help improved the contractor performance to deliver the project.

The contractor is responsible for completing the project from the beginning of construction to the end of development, so the selection of contractors at the pre-project qualification stage is important to ensure the contractor performs well throughout the construction period without causing any problems. Failure to select the contractor is likely to cause problems during construction. Issues such as project delays and project costs, time, quality and sustainable development goals are not met.

Doloi, Iyer, & Sawhney, (2011), in their study, found that contractor performance is an important element in successful project delivery. The client will choose the best contractor with good expertise and performance, but the contractor selection stage is one of the critical and challenging stages. The selected contractor must do the right job and deliver the project well. Mistakes in the selection of the contractor will cause many adverse effects of a project. In their study, a hierarchical structure model was established to understand the contractor's eligibility criteria and to identify the contractor's behaviour in a project. Five factors of validity namely business and labour force (SBW), planning and control (PC), quality performance (QP), past performance (PP) and overall project success (OPS) involved and evaluated. The study also suggests that the results of a model study conducted in Australia confirm that the key to achieving project success is technical planning and contractor expertise.

Regular monitoring of contractor performance should be implemented to ensure that undesirable shortfall or failures do not occur in a project. Ng, Palaneeswaran and Kumaraswamy, (2002) in their study, found that the structured approach to contractor Performance Appraisal and Reporting (PAR) are needed, to monitor contractor performance. With today's technological advancements, they found that electronic systems are better suited to monitor contractor performance. In this regard, e-reporting is suggested because it will contribute benefit in time and cost-effective. They have studied the conceptual framework of an e-reporting system in the form of a web-based PAR.

Research by Luu, Kim and Huynh, (2008) found that contractor performance benchmark approach is one of the methods that can be used to evaluate and identify the performances of the contractor. It is not only as a benchmark, but it helps to assess and improve the management of construction projects. In their research, they developed a project management performance benchmark (PMP). Nine key performance indicators (KPIs) have been emphasized. They also found that PMP has been designed not only to benefit the client to monitor the implementation of the project but they also it could help the construction firm to consistently adopt good project management practices in the implementation of development projects. Therefore, it will help in achieving sustainable development.

4. Research Methodology

In this study, contractor performance will be assessed in two parts. The first part is the perfomance of contractor during consruction and the second part is their contribution to sustainable development. For the first part, contractor will be assessed using Contractor Perforamance Form. The assessment will include site organisation, administration, planning work progress, work quality, and the control of nominated subcontractors or suppliers. The contractor will be assessed every sixth month by SO. Table 1 shows the Contractor Performance Form used in this study.

Table 1: Contractor's Performance Form

PROJECT:
CONTRACT NO.:
CONTRACTOR:

CRITERIA	SCORE (%)
Site Organisation (10%)	
Administration (10%)	
Planning/Progress (30%)	
Work Quality (30%)	
Control of Nominated Sub-Contractors/Suppliers (20%)	
Total Score (6 Months)	
Grade (6 Months)	

Cumulative Score	
Average Score	
Overall Grade	

Comment	

Note:

Grade	Achievement	Score
1	Excellent	≥ 90%
2	Good	75%-89%
3	Average	50%-74%
4	Unsatisfactory	≤ 49%

Signature

……..
Name:
Position:
Date:

While for the second part which is sustainable development, contractors will be assessed using pH JKR. pH JKR is a tool that can be used by government projects to measure the sustainability of a development. It was built based on the operation of the existing government development and also the requirements set by government projects. Therefore, this scheme is friendlier to government developments. Since 2013 PWD have developed green rating tool which is pH JKR or Skim Penilaian Penarafan Hijau JKR. This rating tool focuses on the design stage and the assessment is based on a list of set criteria. Based on pH JKR Guideline (2013), the selected project's will be assesed by the appointed auditor.

All projects fulfilling any of the criteria stated in pH JKR Guideline 3rd Edition (2015) are subjected to pH JKR rating scheme. The requirements of the projects depend on project cost more than RM 50 million, federal road and site located within the Environmentally Sensitive Areas (ESA) and/or project is subjected to Environmental Impact Assessment (EIA). Based on pH JKR Guideline 3rd Edition (2015) it has four classifications rating starting with two (2) stars until five (5) stars.

pH JKR rating is valid for 3 years only. Ratings will be given to full occupancy or at least 6 months upon completion of 50% has been occupied. This period is sufficient to evaluate the project that is normally completed and lived for 3 years. Table 2 shows classification rating used in sustainable development evaluation.

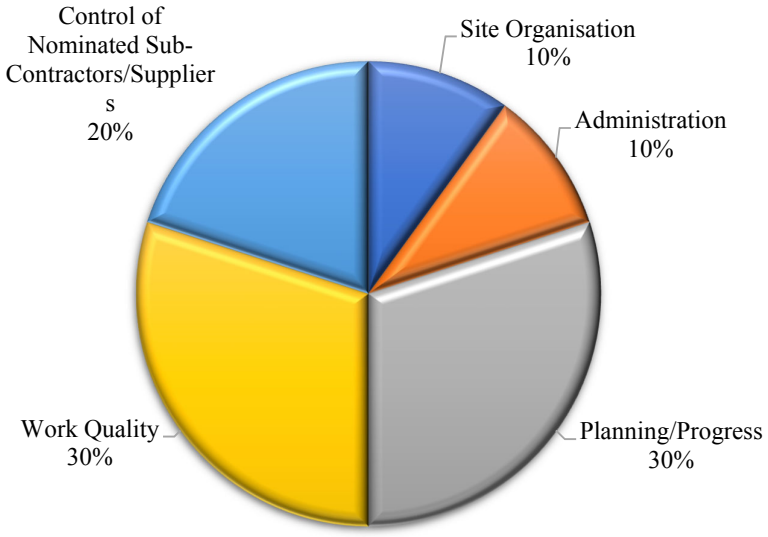
Table 2: Classification Rating, Source: pH JKR Guideline 3rd Edition (2015)

PERCENTAGE (%)	STAR	pH JKR RATINGS
40 - 49	★★	Potential Recognition
50 - 69	★★★	Best Management Practices
70 - 84	★★★★	National Excellence
85 - 100	★★★★★	Global Excellence

5. Finding and Discussion

To ensure a project achieves sustainable road development, the contractor's performance is extremely important to evaluate. In this study, a contractor performance monitoring template proposal was provided. This template is the result of the refinement of “Contractor Performance Form -JKR 8”. Initially, the contractor's assessments were done after the project is fully completed. For the new proposal, the assessments were done every six months, and the marks given can be converted into grades to categorise each contractor’s performance.

The assessment can reflect the overall performance of the contractor throughout the project. This is to ensure the contractor's performance throughout the construction phase is monitored and to help improve the quality of the contractor, thus delivering the project. It not only provides the data of contractor performance but will motivate contractor to perform at their peak throughout the project period. Contractor performance will be evaluated in stages every six months based on the percentages as shown in Graph 1.



Graph 1: Percentage of Criteria for Evaluate Contractor Performance.

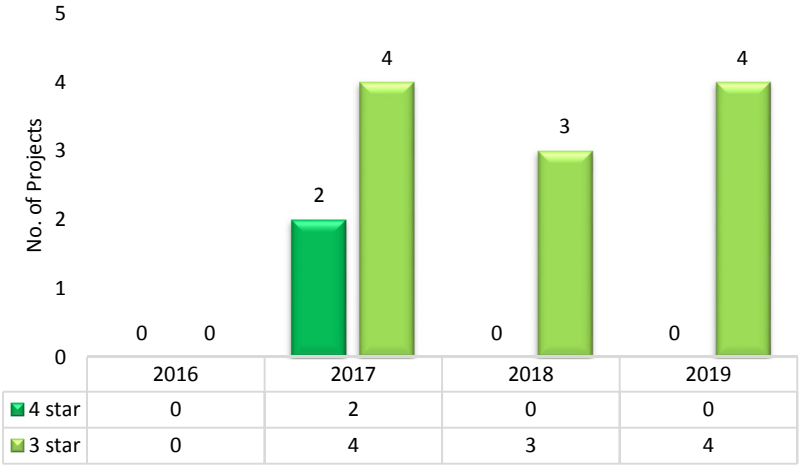
Average scores should be calculated for each evaluation session and throughout the project. Grades are awarded to contractors/suppliers based on a scoring scale to reflect the current performance of the contractor. The grade will be divided into four achievements, which is Excellent (90% and above), Good (75%-89%), Average (50%-74%) and Unsatisfactory (49% and below) as shown in Table 3.

Table 3: Contractor Grade Performance

Grade	Achievement	Mark
1	Excellent	≥ 90%
2	Good	75%-89%
3	Average	50%-74%
4	Unsatisfactory	≤ 49%

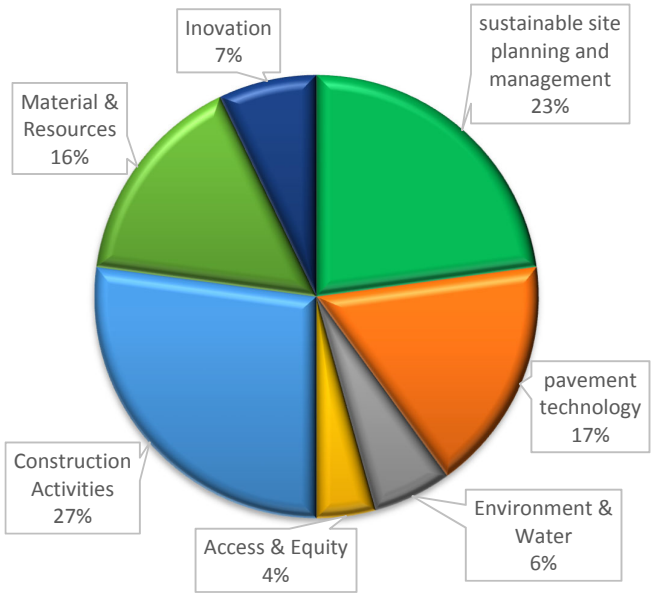
Contractors should be required to achieve the level of excellent or good. If the contractors are categorised in average achievement, they are responsible to improve their performance and if no action is executed for that purpose, it would be fair for PWD to issues a warning to the contractor. If the contractors have marks of 49% and below, appropriate action will be taken, such as a warning.

For sustainable development, data pH JKR from the year 2016 until the year 2019 show that 13 roads in the design stage have been certified pH JKR. Based on that data, 2 of the projects in the 4-star category, which is national excellent, and these projects have to implement the sustainability road development in the design stage.



Graph 2: Number of Road Project have been certificated pH JKR from year 2016 until 2019

In 2019, only 4 projects have been examined and the rest of the 11 projects will be examined. From the data, it shows that the number of projects has been certified in pH JKR increase from year to year. To increase the number of projects, it needs to introduce some strategies according to pH JKR Criteria. All parties involved in projects, need to take action to deliver the sustainable project and get pH JKR certification.



Graph 3: Percentage of Criteria for pH JKR

The criteria to be considered in the pH JKR rating are as shown as in the Graph 3: Percentage of Criteria for pH JKR. The chart shows that all the criteria in pH JKR taken are factors in achieving sustainable development goals. Almost all of these criteria are involved from the beginning of the project, planning to the design stage except for the construction activity criteria. Note that Percentage criteria for construction activity 27% are the highest criteria to determining pH JKR rating. Therefore, the contractor needs to construct the road project by adopting the best practices to achieve sustainable development goals and to get pH JKR certificate.

Based on Graph 3, sustainable site management is 23%, pavement technologies are 17%, material resources are 17%, innovation 7%, environment & water is 6%, and access & equity is 4%. All of these criteria should be fulfilled to get pH JKR certified.

In this paper, it is proposed some actions to be taken in the road project. In the beginning of the project, sustainable site planning and management should be implemented. Sites that have been identified are to be managed and developed in a sustainable manner in order to minimize environmental impact. Road design should be considered to choose the best option of alignment such as follow closely the contours to minimize high cutting and embankment. To avoid construction of road in sensitive areas such as swampy areas, forest reserved and catchment areas. Thus, it can improve the quality and comforts of traveling and improve local economies.

The road designer should consider the requirement of site vegetation, such as close turfing or hydro-seeding system on slope area unpaved shoulder. This consideration will reduce greenhouse gases, increase aesthetics and reduce soil erosion. Besides that, preservation of existing tree or vegetation also must be considered.

Figure 1: Slope protection

Noise mitigation plan need to be prepared to reduce or eliminate annoyance or disturbance to surrounding neighbourhoods and environment from road construction noise. During construction stage noise barrier must be installed and the contractor must ensure site equipment is using low decibel to control noise pollution. Department of Environment Malaysia (DOE) have provided the noise limit guideline for control noise pollution as shown as in Recommended Permissible Sound Level (Laeq) By Receiving Land Use for New Development. The contractor should follow this guideline during construction. The benefit of noise mitigation, it can improve human health and safety.

Table 4: Recommended Permissible Sound Level (Laeq) By Receiving Land Use for New Development

Receiving Land Use Category	L_{Aeq} Day 7.00 am - 10.00 pm	L_{Aeq} Night 10.00 pm - 7.00 am
Low Density Residential, Noise Sensitive Receptors, Institutional (School, Hospital, Worship).	55 dBA	50 dBA
Suburban Residential (Medium Density), Recreational	60 dBA	55 dBA
Urban Residential (High Density), Mixed Development	65 dBA	60 dBA
Commercial Business Zones.	65 dBA	60 dBA
Industrial Zones	70 dBA	65 dBA

Source: Schedule 1 from Guidelines for Environmental Noise Limits and Control, Third Edition (Department of Environment Malaysia, DOE Malaysia)

Technologies in design and construction of roads can increase the sustainability of a road should be adopted. Application of technology in pavement can reduce the environmental problem and abundance of solid waste. Pavement technology for new road construction, such as permeable pavement or also known as porous pavement can be used to meet the sustainable road development. It can eliminate runoff, recharge groundwater, reduces surface temperatures. It also has lower installation cost, can eliminate cost for curbs and gutters. Besides that, Cold in Place Recycle (CIPR) and Hot in Place Recycle (HIPR) can be used as a technique to rehabilitate the existing pavement. This technique applied recycles and reuse method, uses 100 % Reclaimed Asphalt Pavement (RAP) mixed with a new binder either emulsion, foamed bitumen or cement. It can mini mise the usage of quarries products, minimises disposal, reduced construction cost, reduces energy use or green technology and less trucks or machinery at work site which means less fuel and pollution.

6. Conclusion

The appointed contractor must perform competently to ensure that the project can be completed within the specified time, cost and quality stipulated and achieved the goals of sustainable road development. The evaluation encompasses all aspects during construction, including site organisation, administration, planning work progress, work quality, the control of nominated subcontractors or suppliers, and implementing sustainable road development. The assessments were done every six months, and the marks given can be converted into grades to categorise each contractor's performance. These assessments not only provide the data of contractor performance but will motivate contractors to perform at their peak throughout the project period. Regular evaluation methods will ensure that the evaluations conducted are more accurate and comprehensive than the assessments that are implemented when the project is completed.

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