



The Implementation of Environmental Practices by Malaysian Contractors

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Abstract: Contractors, have huge role in ensuring little harm is inflicted on the environment and people as they are the one who directly involve in construction site activities. This paper focuses on the important contribution of contractor and their effort to minimize environmental impact through the implementation of Site Environmental Practices (SEPs). Site environmental practices are construction site activities that impose little harm to and have benefits on the environment. Through survey, it was revealed that SEPs implementation in Malaysia is still moderate. The contractors largely take a mere 'occasional' effort in addressing environmental matters. The apparent effort only can be seen on the issues related to air and water pollution controls. Moreover, efforts pertaining to prudent utilization of resource consumption in construction activities are seldom emphasized, let alone practiced. A slight disagreement on the level of SEPs between the two most influential managers, i.e. Top and Site Managers were also observed. These findings conclude that commitment of Malaysian contractors for SEPs still need to be improved.

Keywords: environmental practices, contractor, construction site, Malaysia

1. Introduction

Numerous studies reported that construction sector is the major source of adverse consequences on the ecosystem, natural resources, and public health [1]-[3]. Due to multitude construction site activities, the environmental impact is apparently direct and immediate. This calls for the Malaysian contractors to adopt a more environmental friendly site operation, i.e. Site Environmental Practices. SEPs are construction site practices that are conducted in more environmental friendly manner. They impose little harm and have benefits on the environment. In long term these practices are believed to also have benefits on people and economic development [34]. As the builders, both top and site managerial level hold joint accountability to ensure construction site operations fully integrate environmental consideration. Currently, least is known about the SEPs implementation at site. However, the prevailing environmental issues reported each year in many Malaysian local newspapers (see examples in Table 1), elucidate the need to improve the way construction activities are being practiced at site. Currently, there are also studies conducted in investigating environmental issues however, these studies confine on single issues, i.e construction waste, energy and emission (see [27], [17], [32]) with less emphasis on commitment of contractors on environmental aspects in overall. Although Yusof et al. [28] investigated the level of pro-environmental practices in Malaysia, they focus on environmental practices within construction firms. Considering the various environmental effect caused during construction site operation and the huge influence of the project builders on the recurring of these problem at various site locations in Malaysia, this motivate the researcher to delve into improvement that can be done. For improvement to be done, Yusof et al. [28]

suggested that current practices must be first evaluated. Thus, this led to the development of the research question, i.e. What is the current level of SEPs practiced by contractors at various construction site locations in Malaysia.

Table 1 - Examples of issues of construction activities

Environmental Issues at construction site	Environmental Problems	Sources
Construction dust has them fuming	Air and water pollution	The Star, 2016
Construction works irk Taman Putri folk	Water pollution	The Star, 2014
<i>Pemandu lori masih degil</i> (Lorry drivers still stubborn)	Air and noise Pollution	Utusan Online, 2012
Tropical mangrove swamp has become a construction dumpsite	Construction waste	The Star, 2011

2. Literature Review

2.1 Environmental Issues at Construction Site

Construction site activities involve execution of various physical activities. These processes commonly complete within a short period of time i.e. less than five years. Although the duration is short, the harmful impact they are causing on the environment are direct and irreversible [5]. Impact of construction site activities have been much discussed by many previous works (see [6], [4], [7], [8] etc.) During site operations, dust, emission and odors pollutant (e.g. CO₂, SO₂, NO₂ and PM₁₀) are generated from various operation of construction equipment and transportation [1], [11]. These small particles can penetrate in the lung and cause respiratory illness [8]. In other cases, on-site operation has also brought degradation of many river system in Malaysia. Activities like earthworks, land clearing, disposal of construction waste have been the major contributor to water contamination [8]. These have resulted in the degradation of its quality and the losses of aquatic habitats [13]. Construction site operation is also a major contributor of noise pollution. Earthwork, wall construction, mechanical and electrical works and roof construction are some of the works that produce high level of noise [14]. According to Fernandez et al. [15], excessive noise exposure can cause damage to the hearing system, i.e. deafness. Picard et al. [16] also found that it also has relation to the cause of accidents at site. Begum et al. [9] reported that, extensive construction project development in Malaysia has also led to the increase of construction waste generation. According to statistic by CIDB [18], waste produced by the construction and demolition works alone had account more than 30% of the total waste generated in Malaysia. The waste generated have produced major kinds of pollutant like silt, oil, chemicals and sewage [9], [17] and have caused ecological disturbance, global warming problem, affecting human health and caused nuisance to their life routine. In relation to traffic issues, traffic coming to and leaving the site is another intriguing problem that have caused nuisance to the community and public people nearby. In Malaysia, there have been much reports and complaints on the negative impacts of traffic movement around site. Dirtiness of the construction site entrance and traffic congestion are something that is not tolerable and could lead to bad public relation with the surrounding communities and create unnecessary delays due to complaints against the builder [7]. The ‘environmental side effect’ of traffic problem could further lead to health impairment of the surrounding people and increase their level of stress. Dust and exhaust emission could be more than just annoying. The residents have to re-clean their washing (curtain and clothes), cars and windows. It has also led to several health issues like eye, nose and throat irritation and asthma.

Given these points, the relationship between the need for rapid construction development and environmental quality in Malaysia appears to be a negative one. The ‘side effects’ of the unsustainable ways of construction practices had prevailed the fundamental objective of construction project development. Due to the large time gap between the cause and effect of the construction process, the consequences of the smaller non-environmental action will only be apparent as the cumulative hazardous environmental effect is felt [19], [1]. Thus, it is important for the problem to be resolved prudently by the construction sector with no delay [20].

2.2 Contractors Responsibility in Environmental Protection

Contractor is the backbone of the physical construction work at site. In general, there are three types of contractors, i.e. 1) general contractor, 2) specialist contractor and 3) the installation contractor [23]. Clough [22] define general contractor as a single business entity who is completely in charge of the construction site operation. Upon their legal appointment, the contractors are obliged to carry out work with the quality and standard as in accordance with the requirement of contract documents including the environmental aspects. Although such effort seldom being explicitly mentioned by the project owner as the main project goal, Ofori [24] highlighted that contractors are expected to govern environmental objectives in parallel with other three key objectives (time, cost and quality). For Vanegas [26], the contractors are regarded as the ‘lifesavers’. This notion is also agreed by Sandy [27]. According to her, while the construction project progress, there is a high risk of the ‘environmental responsibility baton’ being dropped from one

construction phase to another (see Fig. 1). However, Sandy [27] is optimistic that although this could happen, there is still an opportunity to increase the project environmental sustainability during the construction phase, i.e. by contractor instituting better construction site environmental practices.

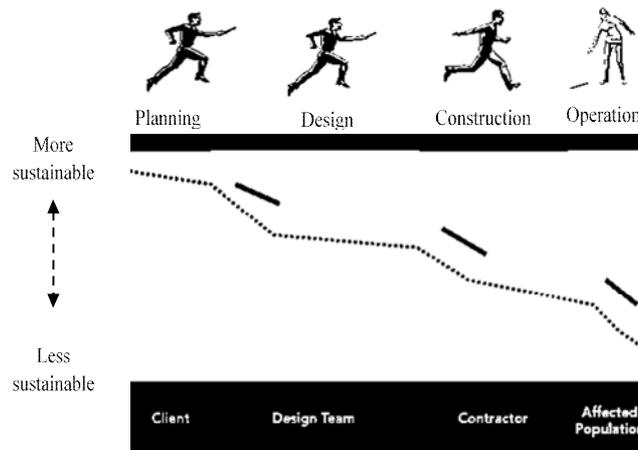


Fig. 1 - Environmental responsibility baton (modify from [27])

For the effective implementation of environmental practices, the work of the contractor is represented by a collective contribution of both Top and Site Managerial level of the firm [37]. According to Oo & Lim [25], the positive attitude of top management level on environmental-related activities will positively influence the implementation of such practices at operational level. As for Site Managers, although their influence in making decision is minimal, as the person who closely involved in the physical operational construction site activities, their involvement in ensuring environmental aspect is protected remain crucial [31]. In a nutshell involvement from each managerial level is important to represent to overall environmental commitment of the firm.

2.3 Site Environmental Practices (SEPs)

Construction practices that inflict little harm to or have benefits on the environment are termed as environmental practices [28]. Pearce et al. [30] describe these practices as green construction practices. Both terms were used interchangeably and imply activities that are different from the traditional and unsustainable practices. Environmental practices include practices in the construction firm and at the construction site. In the office building, environmental practices involve the energy saving behavior, use of energy-efficient equipment, waste recycling activities (see [28], [30]). While, environmental practices during project implementation relate to environmental effort taken during construction site operation which this study term as Site Environmental Practices (SEPs). SEPs could be evident in the effort to reduce consumption of natural resources consumption, control of environmental pollution (air, water and noise), waste management and traffic control. There is no one-size-fits-all approach to contractors' implementation of SEPs. Considering the various environmental effect caused during construction site operation, implementation of environmental practices should not only limit to specific issues (see [9], [17], [32]). It is imperative for the contractors to adopt a more environmental-friendly construction site practices at every construction site activity. The 'green essence' incorporated in the practices will have a profound positive impact [35].

2.3.1 Reduce Resource Consumption

Construction activities consume massive material and energy resources [1-2]. Previous research highlighted various efforts that can be done in reducing these effects. Jo et al. [35] reported that energy usage can be improved with the use of energy efficient technologies (or machines). According to them, technically, equipment with hybrid power system is a good solution for solving wider range of environmental problems. Efforts to reduce energy consumption at the construction site also require necessary support from the top management level in creating corporate energy saving policy and providing sufficient allocation for green technology investment. Resource consumption could also be reduced through reusing the material within the construction stage or for other project or recycle it as an alternative of other construction material [1]. By reusing and recycling these material, energy and carbon produce during their manufacture can also be reduced.

2.3.2 Air Pollution Control

Air pollution is one of the fundamental concerns in Malaysia. There are great amount of dust, emission and odors pollutant (e.g. CO₂, SO₂, NO₂ and PM₁₀) generated from various operation of construction equipment and

transportation [1], [11]. In Malaysia, there are strict regulation overseeing the state of the well-being of the environment, i.e. the Environmental Quality Act (Amendment) Act 2007. The enforcement of regulations on the prevention of air pollution require the contractors to clearly understand and embed the regulation in their construction plans. It should also be appreciated and complied by all employees at the construction site [37]. For example, open burning is a serious offence that is not tolerable in Malaysia. In Section 29A, heavier penalties will be imposed on those who commit open burning (i.e. RM500,000 or 5 years jail or both). Other good measures related to air pollution control were also being suggested by CIRIA [8] and Tam et al. [39], i.e. spraying and wetting the exposed surface and unpaved roads and covering the transported materials

2.3.3 Water Pollution Control

Malaysia is blessed with rich network of tropical rivers as well as natural and artificial lakes and reservoir that have multiple functions. These water resources are important for water supply, as the habitat of the flora and fauna and for balancing the natural ecosystem. A legislative approach through 'polluter pays' principle is one of the important method used to combat the water quality issues [13]. As governed in EQA 1974 Section 25, a fine of RM 100,000 or 5 years jail or both will be charged to any parties who discharge waste into the rivers. Heavier penalty, RM500,000 will be prosecuted if it is an environmentally hazardous substance [36]. It is the role of the construction practitioners to ensure these regulations are comprehend and compiled [37]. According to CIRIA [8] a site does not need to be next to a river or other watercourses to cause a problem as the threats are generally the non-point sources (i.e. runoffs from the construction site after downpour). Thus, water pollution can be avoided if the construction waste is well managed so that they do not enter the water course. CIRIA [8] also highlighted that drainage system can act as an important pathway to spread the pollutant. Thus, proper management and maintenance of construction site discharges system is part of essential solution for water pollution.

2.3.4 Noise Pollution Control

Noise is commonly referred as an unwanted sound. Sound is a wave transmitted as small changes in air pressure between a source and receiver, i.e. the construction site and nearby resident or the workers. To reduce the nuisance, the Department of Environment Malaysia has produced a guideline for environmental noise limits and control that prescribe a comprehensive methodology to measure and report noise emission from outdoor sources. They also have set permissible limits for noise emission that need to be strictly followed by the builders [40]. Previous study suggests that there are three ways of controlling noise; the source, environment and the receiver. Thalmeir [41] echoed similarly that noise control strategies include source, pathway and receiver control. Construction noise can be effectively control by eliminating the noise source. Example of source control is prohibiting work during sensitive nighttime hours or substitute method with quitter methods or equipment [41], [42]. According to Thalmeir [41] path control measures is an important backup strategy when the source controls are not sufficient. Construction method can be effectively interrupted through blocking the noise sources and the affected receptors. This can be done by installing noise barriers or curtains. In the case where the source and path noise control are not feasible or sufficient, receptor control are necessary. Working in partnership with the affected community would greatly increase the community's tolerance to noise. One of the probable measures is to inform the affected residents in advance and to be able to respond to their noise complaints and be able to accommodate the community needs.

2.3.5 Construction Waste Management

The materials use at site are also associated with the problem of massive amount of waste produced which have negatively impaired the environment [43]. There are various approaches for improving waste management activities at construction site as suggested in previous studies. The measures include six principles for waste management procedures i.e. eliminate, reduce, reuse, recycle, recover and dispose [8]. Shen et al. [44] also agreed that waste reduction should be placed as the highest priority of the waste management measurers. Through waste sorting the next steps is to consider whether the waste can be reused or recycled [45]. Following these steps allow the reduction of unnecessary and unwanted waste before they are disposed to the permitted landfill. Towards a holistic strategy for managing the construction waste, Mc Donald et al. [46] and CIRIA [8] suggested the efforts to be comprehensively laid out in the Waste Management Plan. The plan should include a comprehensive and clear guideline regarding the waste action plan which combine information on legislative requirements and good waste management techniques that would lead to the optimal amount of waste deposited on landfill sites and maximize resources efficiency [46], [8], [47]. Waste sorting, recycling or reuse and waste disposal procedures are the important waste management techniques that should be part of the plan. Following correct waste disposal procedures and recycle or reuse the waste could mitigate the serious polluting effect caused by the construction waste. Although the benefits of having the plan is evident, it would only be effective if the workers at site participate and apply them. Thus, it is the responsible of the authorized managers to ensure the plan is followed by the workers [47], [48].

2.3.6 Traffic Management

Traffic or vehicle movement is a crucial environmental issue highlighted by many researchers (see [47], [48], [7]). To minimize the disruption on local people, the amenities and traffic, Gangoellis et al. [7] and CIRIA [8] suggested that deliveries of construction material are scheduled off-peak hours, reduce traffic flow by encouraging car-sharing and make restriction on the use of public road for site access and minimize dirtiness by keep cleaning the vehicles which leaving the site.

3. Research Methodology

To investigate the environmental practices by the Malaysian contractors, a questionnaire survey has been distributed to 450 construction companies from Grade 1 (G1) to Grade 7 (G7). In total, about 194 usable questionnaires were received which equivalent to response rate of 43%. The 194 respondents participated in this study also represent a mixed of G1 to G7 construction companies in Malaysia. Majority of the respondents have extensive working experience in construction industry with more than 50% of the respondents have worked in the industry for 5 to 25 years. The respondents also hold various job position that are relevant to construction project and site management works. In this study, there is also an equal percentage of respondents (50%) between top and site management. The top management includes the company owners, directors and managers, while the site management level is those involve at the site such as site engineers, site managers and site supervisors. With reference to the number of years they have been in the industry and the position they hold in the company, their insight on the implementation of SEPs is essential to provide overview of current implementation of SEPs at construction site. For this study, reliability of the 25 items in the questionnaires are measured using the Cronbach's Alpha. The coefficient alpha for all instruments used are all close to 1, i.e 0.943. This shows an excellent internal consistency for the instruments used for this study [49]. The validity of each questionnaire items is also established through content validity. Prior to the data collection stage, the validity content of all items was evaluated by four (4) experts from Malaysia construction industry and academician. Experts were asked specifically to review each item according to 1) how it relevantly represents the current issues of site environmental practices, 2) whether the Likert scale assigned to each item has meaning and 3) the overall presentation and layout of the questionnaire booklet. The comments and concerns raised by these experts during the review process have been acknowledged to improve the questionnaire instruments for the use in data collection stage. Considering the instrument used in this research has scored a satisfactory reliability measure of Cronbach alpha close to 1 and have gone through the process of experts' review, the questionnaires used in this research are presumed as a valid instrument.

4. Results and Discussions

The findings of the survey on the current implementation of SEPs are analyzed based on the overall execution of all twenty-five SEPs, the emphasis given on SEPs by environmental categories and SEPs implementation as evaluated by Top and Site Managers. Table 2 summarizes distribution of the mean of responses for each SEPs. Based on the 5-point Likert scales, the respondents were asked to indicate their agreement on the level of practices for the twenty-five SEPs at the construction site;

- 1- whether they have not practice it at all,
- 2- practice very rarely,
- 3- occasionally practice,
- 4- often practice or
- 5- practice very frequently.

As shown in Table 2, the respondents were asked on four (4) items related to Air Pollution Control. The mean distribution of the responses shows that most practiced air pollution control is A4, A3 and A2. The mean for compliance (A1) is ranked the least of all other practices. All contractors in Malaysia should ensure the employees comply with the basic contractual requirement, i.e. observing to all relevant laws of Malaysia imposed by the relevant authority. On top of that, the small presence of respondents who admit had carried out open burning (A2) is also a big concern. For *Water Pollution Control*, findings in Table 2 reveals that considerable effort have been practiced in safeguarding the national water quality in terms of ensuring no effluent are discharged into the watercourses (W2) and maintaining the construction site water discharge system (W3). However, much need to be improved to ensure the national water regulation are strictly complied at all times. Similar to Air Pollution Control, the score for compliance for Water Pollution Control is ranked the least of all other practices. Thus, it is the responsibility of the contractor to identify these legal obligations and ensure it is clearly understood and complied by the construction site workers. For Noise Pollution Control, of all the moderately practiced noise pollution control, the respondent rank item N3 (substitution of quieter equipment) as the least implemented at site. The finding shows that practices which have financial implication is less popular. For Traffic Management practices, the respondents rank high on item T3 (restriction on the use of public road). Following this are item T4 (regular truck tire wash) and T1 (delivery scheduling). T2 (car-sharing concept) is ranked as the lowest. In Malaysia the culture of car-pooling in Malaysia is not

widely embraced compared to other developed countries. For Waste Management, the respondents have given considerable attention on the practicality of providing guideline on waste management (S2) and ‘ensuring the workers follow the right waste management procedure’ (S4). Interestingly the finding shows that, recycling and reusing of construction waste is still not being extensively being practiced at the construction site. For practices related to Reduce Resource Consumption, the findings reveal that effort to reduce the energy consumption centered towards management of the resources through activities like R1 (planning and monitoring), R3 (use efficiently) and R5 (recycling and reusing). However, the effort to increase the awareness and promote the implementation of SEPS through the use of signage and posters (R2) and opting for more environmental friendly material (R4) are still lacking. The findings indicate that many respondents remain in their conventional ways of managing energy which do not demand extra investment in time, cost and effort.

Table 2 - Implementation of SEPs based on environmental elements

Site Environmental Practices (SEPs)		Mean	Rank
Air Pollution Control			
A1	Comply with regulation related to air pollution control	3.35	4
A2	Do not conduct open burning at the construction site	3.54	3
A3	Spray water on exposed surface and unpaved road	3.58	2
A4	Cover truck compartment carrying dusty loads	3.65	1
Water Pollution Control			
W1	Compliance with regulation related to water pollution control	3.35	3
W2	Ensure no contaminants are discharged into watercourses	3.59	1
W3	Management and maintenance of construction site water discharge system	3.49	2
Noise Pollution Control			
N1	Follow work specification related to noise control	3.36	1
N2	Ensure construction works are operated only during permitted working hours	3.33	3
N3	Substitution of quitter equipment	3.28	5
N4	Installation of noise barrier or curtain	3.34	2
N5	Accommodate complaints and community needs	3.31	4
Traffic Management			
T1	Schedule delivery of construction material at off-peak hours	3.25	3
T2	Encourage car sharing among site staff	3.14	4
T3	Restrict the use of public road	3.84	1
T4	Regular truck tire wash when leaving the site	3.48	2
Waste Management			
S1	Develop a waste management plan,	3.39	3
S2	Clear guideline of waste disposal procedures	3.42	1
S3	Recycle and reuse waste	3.28	4
S4	Ensure site staff following the right waste management procedures	3.40	2
Reduce Resource Consumption			
R1	Planning and monitoring of energy consumption	3.30	1
R2	Display of signage and posters on energy savings practices	2.97	4
R3	The use of energy efficient machine and equipment	3.25	2
R4	The use of material with recycled content	2.95	5
R5	Reusing and recycling of construction materials.	3.09	3

Overall, the finding on the implementation of SEPs, largely skewed towards ‘occasionally practice’ with mean practices score below 4.00. This is agreed by both Top and Site Managers (as shown in Fig. 4). In congruent to the finding of Begum et, al [9] ten years ago, who also reported the moderate practice of waste management at site, the stagnant level of commitment of contractors towards safeguarding the environment is very alarming.

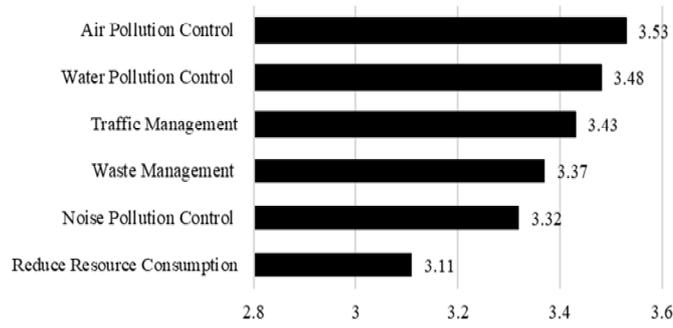


Fig. 3 - Implementation of SEPs by environmental categories

Similar with Pearce et al. [30], the finding of this study further shows that effort on environmental protection tend to incline on certain environmental category. Fig. 3 indicate that Air Pollution Control and Water Pollution Control are the two most addressed issues at the construction site. The recent haze crisis that spread across the states and the deterioration of national air and water quality standard due to industrial activities (including construction industry) has a pressing national concern [10]. The sentiments induced by the surrounding environmental crisis and national bodies concern has triggered the contractors’ awareness to be extra cautious on practices which may cause pollution on air and water. Following this are practices related to Traffic Management, Waste Management and Noise Pollution Control with a comparable mean score. By comparison to the two former issues, these practices are more associated with issues which exert impact on a short-term time span and most often concentrate on a bounded geographical area [8]. Due to the nature of temporary impact caused by these issues, contractors often disregard its importance. The aspect of Reducing the Energy Consumption is the least being emphasized during construction operation. SEPs associated with minimizing this energy consumption is often regarded trivial due to the lack of awareness on the importance of safeguarding the resources.

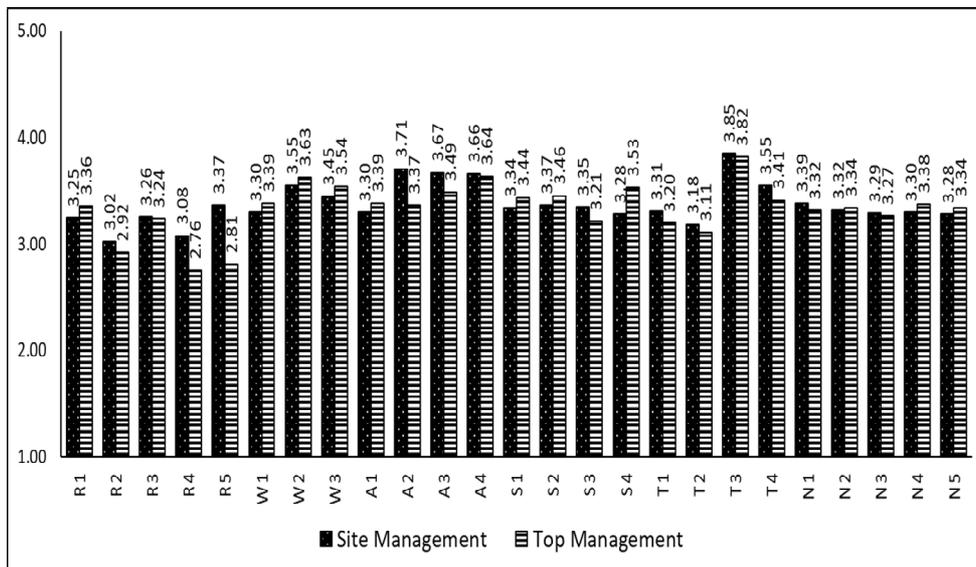


Fig. 4 - Comparison on the implementation of SEPs as evaluated by Top and Site Management

Findings in Fig. 4 further indicate that there are differences in perception on the implementation of SEPs as perceived by Top and Site Managerial level. For example, Top Managers inform that proper plan has been carried out in the management of environmental practices (S1) and in accordance with environmental laws and project requirement (A1, W1, W2, W3, S2, S4, N2, N4 and N5), however, the site managers who monitor construction operation on day-to-day basis had different opinion. They appraised implementation of most SEPs as lower. This shows that, in reality, on-site construction tasks demand a more practical environmental management approaches that could be beyond the Top Management knowledge and concern. Interestingly, the finding also shows that Site Managers are more receptive to ideas relate to ‘reuse and recycle’. Top Managers were found to be quite reluctant on environmental practices that have implication on financial commitment. The different perception of both managerial levels on the actual level of SEPs

being implemented at site provide reflection on the reality of commitment of both parties towards the practices. It further reinforced the finding on the moderate practices of SEPs among Malaysian contractors.

5. Summary

In the effort to understand and find ways for improving the recurring environmental issues as reported each year, this study focusses at investigating the current level of SEPs by contractors in Malaysia. As various construction sites in Malaysia are studied, it is found that currently, SEPs in Malaysia are still being implemented at a 'moderate' pace. Contractors only address some of the environmental practices rather than extensively implement SEPS throughout the construction projects. As the significant roles of contractors in minimizing environmental impacts are of concerns, the presence of disagreement on the level of SEPs between the top and site managers is observed, signifying a lack of mutual commitment between these two parties. Having understand these alarming findings, an-depth study is imperative in the future to investigate the 'occasionally' trend of practices of Malaysian contractors and the commitment of both Top and Site Managers to fully embrace SEPs.

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