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Foreword

Alhamdulillah. First of all a big thank you and congratulations to the Editorial Board of *Esteem Academic Journal* of Universiti Teknologi MARA (UiTM), Pulau Pinang for their diligent work in producing this issue. I also would like to thank the academicians for their contributions and the reviewers for their meticulous vetting of the manuscripts. A special thanks to University Publication Centre (UPENA) of UiTM for giving us this precious opportunity to publish this first issue of volume 5. In this engineering issue we have upgraded the standard of the manuscript reviewing process by inviting more reviewers from our university as well as other universities in Malaysia. We have embarked from previous volume to establish a firm benchmark and create a journal of quality and this current issue remarks a new height of the journal quality. Instead of publishing once in every two years, now *Esteem* publishes two issues annually.

In this issue, we have compiled an array of 13 interesting engineering research and technical based articles for your reading. The first article is entitled "The Response of Tube Splitting on Circular Tubes by Using Various Types of Semi-angles Dies and Slits". The authors, Mohd Rozaiman Aziz and Roslan Ahmad investigated the axial splitting and curling behavior of aluminum circular metal tubes which was compressed axially under static loading using three types of dies with different semi-angles. The authors concluded that the introduction of slit to the specimen is necessary to initiate slitting rather than inversion.

Salina Budin, Aznifa Mahyam Zaharudin, and Sugeng Priyanto presents a model of energy conversion and impact energy generation during collision based on free falling experiment, which is closely resembles direct collision between ball and inner wall of the vial. Simulation results from the proposed impact energy model demonstrated that the impact energy generated during the collision is strongly influenced by the thickness of the work materials and reaches zero at certain value of the work materials thickness, which increases with an increase of falling height.

Salina Alias, Caroline Marajan and Mohamad Azrul Jemain wrote an article that looks at adsorption of zinc from waste water using bladderwort (*Utricularia vulgaris*). In batch adsorption studies, data show that dried bladderwort has considerable potential in the removal of metal ions from aqueous solution. The fourth article written by

Muhammad Khusairi Osman et al. looked at 3D object recognition using affine moment invariants and Multiple Adaptive Network Based Fuzzy Inference System (MANFIS). The experimental results show that Affine Moment Invariants combined with MANFIS network attain the best performance in both recognitions, polyhedral and free-form objects.

The article entitled "Construction Waste Management Methods Used by Contractors in the Northern Region" authored by Siti Hafizan Hassan, Nadira Ahzahar and Mohd Nasrul Nizam Nasri reports an ongoing study on the use of construction waste management methods by contractors and its impact on waste reduction in the Northern Region. In conclusion, the sizing and amount of materials to be ordered to reduce wastage is significant in reducing construction waste generation waste, alleviating the burden associated with its management and disposal. The sixth article by Muhammad Sofian Abdullah et al. examined on the performance of Performance of Palm Oil Fuel Ash (POFA) with lime as stabilizing agent for soil improvement. The authors concluded that POFA can be used to treat the silty soil as well as to reduce the environmental problem.

The seventh article penned by Soffian Noor Mat Saliah, Noorsuhada Md. Nor and Megat Azmi Megat Johari presents the results of an experimental study on the interfacial bond strength (IBS) of polypropylene fiber concrete (PFC). It was found that the interfacial bond strength between concrete and reinforcement bar was not affected by the inclusion of polypropylene fibers. However, concrete containing fibers exhibited no breaking of concrete and no debonding of reinforcement. The article by Juliana Zaabar and Rusnani measures, evaluates and analyzes the network link performance of fiber optic cable using OTDR. The authors suggested that the major loss for these measurements is connector loss. Preventive maintenance will increase the life time of fiber optic. From some of the findings, the PVC dust cap has been identified as a main source of contamination for the SC connector.

The article entitled "Symbolic Programming of Finite Element Equation Solving for Plane Truss Problem" by Syahrul Fithry Senin proposed a plane truss problem to be solved by finite element method using MAPLE 12 software. The numerical solution computed by the author was almost matched with the commercial finite element software solution, LUSAS. The tenth article by Nor Azlan Othman, Nor Salwa Damanhuri and Visakan Kadirkamanathan presents a detail review of fault diagnosis in rotating machinery using pattern recognition technique. The authors proposed a solution based on artificial neural network (ANNs) which is Multi-Layer Perceptron (MLP). The authors concluded that

the proposed methods are suitable for rotating machinery on fault detection and diagnosis.

The eleventh article is entitled "RAS Index as a Tool to Predict Sinkhole Failures in Limestone Formation Areas in Malaysia". Damanhuri Jamalludin et al. found that, using the RAS classification method, the prediction of sinkhole occurrences can be easily be made by simply knowing the weekly rainfall especially in areas having limestone as the bedrock. The twelfth by Muhammad Hafeez Osman et al. explores cases regarding the histories of rock slope repair and stabilization of unstable boulder along the road from Bukit Cincin to Genting Highland and along the road from Gap to Fraser Hill. The last article is "Soil Nail and Guniting Works in Pahang". The authors, Damanhuri Jamalludin et al. concluded that if the stability of the embankment needs to be improved, soil nails can be installed and embankment surface can be covered with gunite to prevent erosion.

We do hope that you not only have an enjoyable time reading the articles but would also find them useful. Thank you.

Mohd Aminudin Murad
Chief Editor
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(Engineering)

Construction Waste Management Methods Used by Contractors in the Northern Region

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ABSTRACT

The construction industry produces a significant amount of building waste. The government is taking action to tackle the problem, such as by introducing a construction waste landfill charge, and promoting prefabrication to reduce onsite waste generation. This paper reports an ongoing study on the use of construction waste management methods by contractor and its impact on waste reduction in the Northern Region. A questionnaire survey was administered to experienced professionals, such as main contractors, sub-contractors, and consultancy agencies. The results revealed that construction waste reduction is one of the major benefits when emphasizing on the sizing and amount of materials to be ordered in reducing wastage with the mean response of normally practiced toward mostly practiced. Source reduction by accurate estimating and ordering of materials are the methods that are mostly used by industry participants in minimizing construction waste. But when there are wastes, the respondents prefer to reuse, burn or land fill as the methods for disposing construction waste at their sites. This implies that contractors in the Northern Region try to reduce their construction wastes at

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the very earliest stage in construction but they like to use burning as a method of disposing which is not good for the environment.

Keywords: *Construction waste, northern region, waste management, waste minimization, waste reduction*

Introduction

Definition of Construction Waste

Construction waste materials consist of the debris generated during the construction, renovation, and demolition of buildings, roads, bridges and all other work related to civil engineering. Construction waste materials often contain bulky, heavy materials that include concrete, wood, asphalt (from roads and roofing shingles), gypsum (the main component of drywall), metals, bricks, glass, plastics, PVC, trees, stumps, earth, and rock from clearing sites (U.S Environmental Protection Agency, 2008).

Construction waste may contain hazardous material which may affect humans and the environment. Hazardous wastes commonly generated during construction activities include paints, solvents, adhesives, caulks, pesticides, wood preservatives, oil, or stored materials (such as solvents or pesticides) that have exceeded their shelf life. Others common examples of hazardous construction wastes are asbestos, polychlorinated biphenyls (PCBs) and heavy metals that can be released during demolition or renovation of existing structures (U.S Environmental Protection Agency, 2008).

Construction waste is becoming a serious environmental problem in many large cities in the world (Chen, Li & Wong, 2002; Ferguson, Kermode, Nash, Sketch & Huxford, 1995; Shen, Tam & Ho, 2002; Smallwood, 2000). According to statistical data, construction and demolition (C&D) debris frequently makes up 10% to 30% of the waste received at many landfill sites around the world (Fishbein, 1998).

In the Malaysian construction industry, data is not readily available on the current structure of construction waste flows by the source of generation, type of waste, intermediate and final disposal and the amount of waste reduced at source, reused or recycled on-site or off-site. A study by Hassan, Yusoff, Sulaiman and Rahman (1998) shows that on average, the breakdown of waste generation according to source are 36.73% from household waste, 28.34% from industrial and construction waste while other sources (market and commercial waste, institutional

waste, landscaping waste and street sweeping waste) account for the remaining 34.93% in the Central and Southern regions of Malaysia. This shows that in Malaysia construction waste forms a significant portion of wastes, which is finally disposed of in landfills.

Construction Methods

The quality of the builder or subcontractor and the methods they employ can contribute to waste. Mistakes, inefficient product use, time pressures and poor project planning can lead to more waste produced.

Many products are installed to manufacturer specifications, which may not take into account the efficient use of the product (Merz, 2004).

Material Ordering and Storage

Waste is created by product damage during on-site storage. This can happen through incidents such as machinery accidents, weather or dust contamination. It was also discussed at the workshops that waste occurs where there is oversupply of material. In many cases the client has already paid for materials, subcontractors and builders do not have an incentive to be efficient with resource use and oversupply is often disposed of rather than being taken back to the supplier or on to another project. Where 'just enough' product has been ordered, and builders and subcontractors are more likely to be resource efficient (Merz, 2004).

There are many contributory factors in the generation of waste on site, both human and mechanical and these are outlined in Table 1.

Reduction of Material Wastage

Support from the management is vital in order to be successful in the reduction of material wastage. The following guidelines can be used for the reduction of material wastage as shown in Table 2.

Conceptual Framework of Waste Minimization

Waste minimization includes source reduction and recycling. Source reduction is defined as any activity that reduces or eliminates the generation of waste at the source, usually within a process. Recycling is defined as the recovery and or reuse of what would otherwise be waste material. Existing publications have discussed many different waste

Table 1: Causes and Examples of Building Waste on Site

	Causes of building waste on site	Examples
Site management and practices	Lack of a quality management system aimed at waste minimization	Lack of waste management plan
	Untidy construction sites	Waste materials are not segregated from useful materials
	Poor handling	Breakage, damage, losses
Delivery of products	Over-sized foundations and other elements	Over design leads to excess excavation and cut-offs
	Inadequate protection to finished work	Finished concrete staircase are not protected by boarding
	Limited visibility on site resulting in damage	Inadequate lighting in covered storage area
	Poor storage	Pallet is not used to protect cement bags from contamination by ground water
	Poor workmanship	Poor workmanship of formwork
	Waste generation inherited with traditional construction method	Timber formwork, wet trade
	Over-ordering	Over ordering of concrete becomes waste
	Method of packaging	Inadequate protection to the materials
	Method of transport	Materials drop from forklift
	Inadequate data regarding time and method of delivery	Lack of records concerning materials delivery

(*Source*: Hong Kong Polytechnic University, 1993)

minimization options or measures or practices (Lorton, Fromn & Freeman, 1988; Sherman, 1996; Maclaren, 2002).

Problem Statement

Nowadays, around the world, construction waste has become a serious environmental and health problem. Malaysia is one of the developing countries facing this problem. In Malaysia, solid waste is one of the three environmental problems faced by most municipals. Since Malaysia is a rapid developing country, the construction industries in this country are growing. The construction industry is responsible for producing a

Table 2: Measures for Reduction of Material Wastage

Material ordering and handling	Purchasing inventory should be carefully controlled to prevent wastage of materials
	Adopt just-in-time ordering and to ensure materials arrive on site when they are needed, thereby avoiding damage while stored on site and additional moving of materials.
	Order appropriate material sizes to minimize cutting, and order appropriate quantities to avoid excess.
	Designate central areas for cutting and storage so reusable pieces can be easily located
	Do not use tropical hardwood for temporary works. Use metal false work instead
	Avoid buying poor quality materials. If the wear-out rate is high, another source of supply should be considered
	Whenever possible, packaging materials should be returned to the supplier for reuse. In some cases the supplier holds a deposit until the pallets are returned
	Avoid overloading limited storage space on site
	Avoid unnecessary handling
	Whenever using timber for a specific purpose, try to avoid treating it with chemicals and using nails, as this will make it difficult to reuse/recycle the timber afterwards
Site management and practices	Coordinate with designer and specification writer to ensure dimensional coordination of building design with materials and components to minimize cutting waste
	Coordinate with designer and specification writer to use alternative materials instead of timber
	Provide training to workers to improve their skill in handling materials and performing construction work
	Review waste management periodically to identify additional waste reduction alternatives
	Consider reduction of construction waste and awareness of environmental protection as basic requirements in building management
	Improve building construction technology by research or adoption.
	Employ competent subcontractors and skilled labourers.

(*Source*: Hong Kong Polytechnic University, 1993)

whole variety of different wastes, the amount and type of which depends on factors such as the stage of construction, type of construction work and practices on site. As the construction industry in Malaysia develops, it generates a lot of construction waste which contributes a substantial

impact on the human health and the surrounding environment. The construction wastes which can cause land and water pollution are one of the major threats to local environment ecosystem. Besides that, the illegal dumping or improper disposal of hazardous construction waste is a serious issue as asbestos and heavy metal can affect human health. In Malaysia, the data and study on construction waste is still lacking. This study aims at reducing or minimizing the wastes produced by contractors to improve the management of the construction waste in the Northern Region.

Research Methodology

Questionnaires

Data was collected through questionnaires given to the project participants at the selected project site. The questionnaire was constructed based on the review of literature. Questions were chosen to get information of construction waste from the selected contractors. The entire questionnaire was distributed to the selected respondent in Kedah and Pulau Pinang.

All the respondents were approached at the construction site within Kedah and Pulau Pinang. A total of 42 respondents gave their response. The respondents came from various company backgrounds such as main contractors, sub-contractors, consultancy agencies, mechanical and electrical consultants and architects.

Ordinal Scale

Measurements with ordinal scales are ordered in the sense that higher numbers represent higher values. When items are classified according to whether they have more or less of a characteristic, the scale used is referred to as an ordinal scale. The main characteristic of the ordinal scale is that the categories have a logical or ordered relationship to each other. These types of scale permit the measurement of degrees of difference, but not the specific amount of difference. This means that data can be interpreted in term of differences in the distance along the scale. Example of the ordinal scales that is used in the questionnaire for this research is:

(1 = not practiced at all, 2 = least practiced, 3 = moderately practiced, 4 = normally practiced, 5 = mostly practiced)

Data Analysis and Presentation

Because the data that is obtained from the field survey is in the form of an ordinal scale, it will be analyzed based on the mean response of respondents so that the data can be categorized among the ordinal scale of the mean response. The result and findings will be presented in the bar chart with a scale of 1 to 5 and a summary table which will indicate the categories and ranking of the mean response. The ranking will compare the factor from the most preferable factor to the least preferable factor.

Results and Discussion

There were a total of 42 respondents in this study. The survey shows that 60% of the respondents answered the questionnaires out of the 70 distributed. A majority of the respondents (59%) have more than 10 years of work experience, with 20% in the range of 5 to 10 years and 21% with less than 5 years of work experience. Almost all the respondents have bachelor degree (95%). The respondents are project managers (70%), and site engineers (30%).

Methods of Managing Construction Waste

The result from responses on method practices in managing the construction waste among the respondents is summarised in Figure 1 and Table 3.

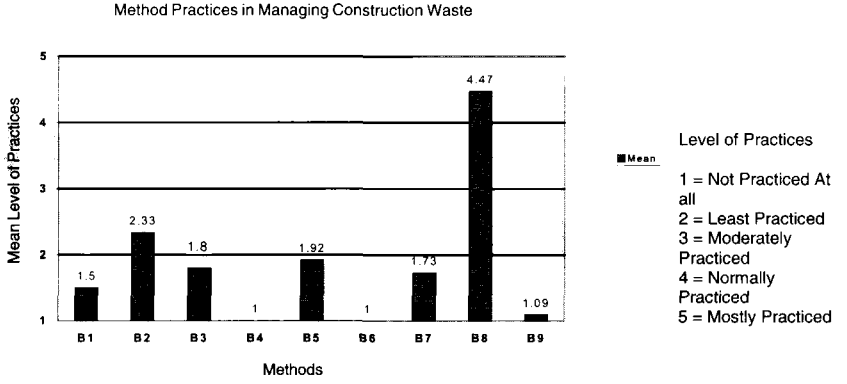

Figure 1: Level of Practices by the Local Construction Industry Participants in Managing the Construction Waste

Table 3: List of Methods

Methods	Descriptions
B1	Applying company corporate policy for construction waste management
B2	Hiring staff person who has the responsibility to construction waste management.
B3	Applying company corporate policy for waste minimization and recycling.
B4	Hiring staff person who has the responsibility to ensure waste minimization and recycling principles are applied.
B5	Practicing waste management plan for each individual project.
B6	Staff training in waste management and minimization issues
B7	Preparing a waste management / minimization plan before the construction stage.
B8	Emphasis on the sizing and amount of ordering materials in order to reduce wastage.
B9	Requiring subcontractors to participate in waste minimization as part of their contractual obligations.

From the analysis, it clearly shows that the method of emphasizing on the sizing and amount of materials to be ordered to reduce wastage is the method that has the highest ranking compared to other methods with the mean response of normally practiced towards mostly practiced (mean value 4.47). The analysis also shows that hiring staff that are responsible for construction waste management is the method in the second ranking with the mean response of least practices towards moderately practiced (mean value 2.33). It satisfied what Merz (2004) states that when 'just enough' product has been ordered, builders and subcontractors are more likely to be resource efficient.

The method of applying company corporate policy for construction waste management, applying company corporate policy for waste minimization and recycling, practicing waste management plan for each individual project, preparing a waste management or minimization plan before the construction stage, requiring subcontractors to participate in waste minimization as part of their contractual obligations are the methods with the mean response of not practiced at all toward least practiced.

There are two methods with the mean response of not practiced at all. The methods are hiring staff that has the responsibility to ensure waste minimization and recycling principles are applied and staff training in waste management and minimization issues.

Previous studies showed that 'last minute changes due to client requirements' and 'design changes' were the major causes of waste during design stages (Poon, Yu & Jaillon, 2004; Osmani, Glass & Price, 2006). In view of this, proper planning appears to be an advantageous solution to tackle the major causes of waste during both the design and the construction stages.

Method of Minimizing Construction Waste

Figure 3 shows the result of level practices by the local construction industry participants in minimizing the construction waste. From Figure 3, the result shows that source reduction by accurate estimating and ordering of materials is the method that is mostly used by the industry participants in minimizing the construction waste with the mean response of normally practiced towards mostly practiced (mean value 4.42). The ranking is followed by implementing efficient material handling and storing and implement efficient framing and other material saving techniques with the mean response of moderately practiced towards normally practiced (mean value 3.64 and 3.33).

The last ranking is filled by the method of resource optimization by redesign and applying new technology or method of construction that minimize the generation of waste with the mean response of not practiced

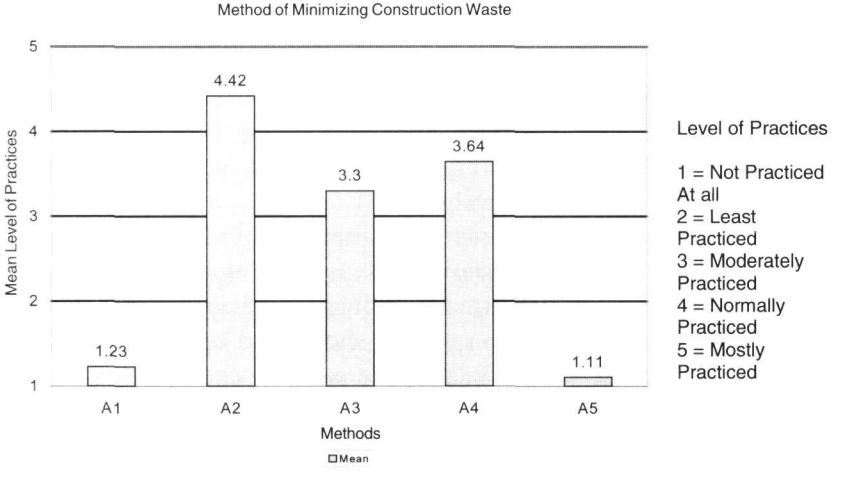

Figure 3: Level of Practices by the Local Construction Industry Participants in Minimizing the Construction Waste

Methods	Descriptions
A1	Resource optimization by redesign
A2	Source reduction by accurate estimating and ordering of material
A3	Implement efficient framing and other material saving techniques
A4	Implementing efficient material handling and storing
A5	Applying new technology or method of construction that minimize the generation of waste.

at all towards least practiced (mean value 1.23 and 1.11).This result implies with the research done by Lorton (1988) that source reduction one of the method in waste minimization practices.

Method Used in Disposing Construction Waste

There are five methods that can be used in disposing construction waste. The five methods are reuse, recycle, composting, burning and land filling. The level of application of these methods among the local construction industry participants is shown in Figure 2.

From the analysis, it shows most of the respondents prefer to reuse, burn or land fill as the method for disposing the construction waste at their site. This is proven by the mean response of moderately practiced toward normally practiced for all three of this method (mean value from 3-5).

The result also shows that the recycling method is also one of the methods that are used by the local construction industry participants in disposing construction waste but it is less practiced compared to the other three methods that had been mentioned before. The mean response for recycle as waste disposing method is least practiced towards moderately practiced. (Mean value 2.54)

The last method with the mean response of not practiced at all (mean value 1) is composting. This shows that composting is not the method that is used by the local construction industry participants in disposing construction waste. From this result, it shows that reuse is one of the methods of disposing that has been implemented by contractors. This is in accordance to the research done by Charles & Jennifer (2000) that reduce, also referred to as Source Reduction or Resource Optimization, is the first and most important step in material efficiency and waste prevention practices. Reducing involves action to eliminate or reduce the amount of materials used on site, before they enter the solid waste

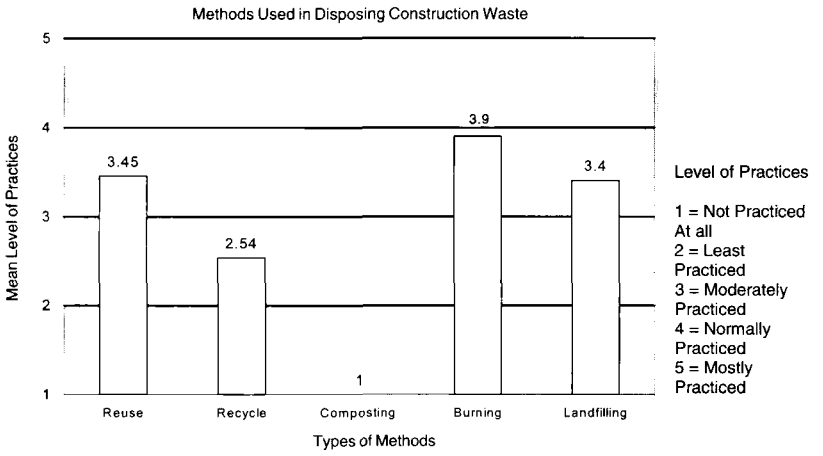

Figure 4: Level of Practices of Method Used in Disposing Construction Waste

stream. But the contractors in the Northern Region prefer to use the burning method which should be the last alternative as stated Charles & Jennifer (2000) that burning where permitted should be one of the last alternatives for construction waste. Caution must be used when burning to avoid adverse health effects. Many communities have waste-to-energy incineration plants for combustible materials; however most of the materials used during construction are inappropriate for incineration.

Conclusion

In conclusion, emphasizing on the sizing and amount of materials to be ordered to reduce wastage is significant in reducing construction waste generation and alleviating the burden associated with its management and disposal. Source reduction by accurate estimating and ordering of material is the method that is mostly used by industry participants in minimizing the construction waste. From the analysis, it shows that most of the respondents prefer to choose reuse, burn or land fill as the method for disposing the construction waste at their site. From this study, the respondents state that they are trying to reuse all these materials first before burning or land filling. It shows that the contractors in the Northern Region tries to reduce or minimize the waste using the methods above but if the waste disposed by burning, it is not good for our environment.

However, this study only focused on the Northern Region of Malaysia. Further studies should be conducted to assess wider areas and any related factors that contribute to management methods used by construction players in Malaysia. In conclusion, construction waste management methods used by contractors in the Northern Region has been identified.

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