May-June 2020
ISSN: 0193-4120 Page No. 26563 - 26575

Root Causes of Construction Waste Generation Using Average Index and Factor Analysis Techniques

Suaathi Kaliannan[1], Sasitharan Nagapan[2*], Abd Halid Abdullah[3], Samiullah Sohu[4] Shamrul-Mar Shamsuddin[5]

[1]*Lecturer, Department of Civil Engineering Technology, Lincoln University College, Malaysia*
[2*,3]*Lecturer, Department of Building & Construction Engineering Universiti Tun Hussein Onn Malaysia*
[4]*Lecturer, Department of Civil Eng. Quaid- e- Awam University of Engineering, Science & Technology, Pakistan*
[5]*Director, Pejabat Pembangunan dan Penyenggaraan. Universiti Tun Hussein Onn Malaysia*

Article Info
Volume 83
Page Number: 26563 - 26575
Publication Issue:
May-June 2020

Article History
Article Received: *19 August 2019*
Revised: *27 November 2019*
Accepted: *29 January 2020*
Publication: *6 May 2020*

Abstract:
Construction waste has been perceived as a crucial issue in the construction industry, which has critical implications for both the effectiveness of construction industry and the negative environmental effect. Root causes of construction waste generation plays a vital part in the management of construction system to control waste at site. This paper is aimed to identify the ranking of root causes and to classify the root causes into their respective categories using Factor Analysis approach. The opinions of construction practitioners on the 53 root causes of construction waste generation were collected using questionnaire survey. A total of 217 questionnaires were collected from construction practitioners who are based at site. The data analysis was carried out using Average Index and Exploratory Factor Analysis (EFA) via Statistical Package for the Social Sciences (SPSS). The Average Index analysis determined the highest ranking root causes which is 'lack of efficient site management' with average index of 4.576. Next, EFA classified the 53 root causes into 5 categories namely design and documentation category', 'project management category', 'human resource category', 'material and equipment category' and 'external category'. The outcomes of the paper helps the construction practitioners to understand in depth about root causes which generates construction waste in Malaysia.

***Keywords**: Construction industry, Construction waste, Factor Analysis, Root causes.*

1. Introduction

Construction industry contributes as a strategic part in socio econ-omy of any nation. Construction industry is rapidly developing as a result of upgrading in way of life, demands of infrastructure pro-jects, changes in consumption habits, and increment in population [1].The construction industry is generally environmentally unfriendly [2]. Construction waste account for an extreme share of all types of waste generated worldwide. This sort of waste normally in the range of 15% to 40% of various types of waste [3-6].According to Begum et al.,[7] and Rahim et al.,[8], construction waste generation has been increasing every year in Malaysia. Most of the construction waste are recyclable and reusable, however most of the waste are usually dumped in landfill [9].

TEST Engineering & Management

May-June 2020
ISSN: 0193-4120 Page No. 26563 - 26575

Although government policies mandating reduction of construction wastes, most of the construction companies do not implement comprehensible waste management plans at construction sites in Malaysia. The reason is lack of information on the root causes which generates construction waste and its tools for reduction has not been establishedThis industry contributes significantly to environmental problem in term of natural resources exploration, irreversible transformation of the natural environment and accumulation of pollutants in the atmosphere [10]. Data on construction waste generation at sites is tough to obtain because there is lack of coherent documentation relating to waste management in most construction firms and also due to confidentiality concerns [11]. As the first step to resolve the concern in any country, the root causes of construction waste generation should be identified as pointed out by Kaliannan et al. [12] and Poon et al [13].

The developed countries have dedicated extensive effort to discover such root causes, however developing countries are still lagging behind in determining the main sources of waste generation as indicated by Yuan & Shen [14] and Nikhmehr et al. [15]. Construction waste was generated all through the construction progress, for example, amid site clearance, material damages, material utilize, material non-utilize, overabundance acquirement and human blunder [16]. Hence, the aim of this paper is to identify the ranking for the root causes of construction waste generation in the industry, as well as to classify the categories of root causes acquired.

2. Construction Waste

The idea of waste is specifically related with the trash expelled from the site and discarded in landfills. Direct waste consists of a complete loss of materials, due to the fact that they are damaged or lost. Chen and Lu [17] stated that construction waste, is defined as the surplus and damaged products and materials that arise from construction, renovation, demolition, and other construction activities. Besides, Menegaki and Damigos [18] defines construction waste as material, including inert waste, non-inert non-hazardous waste and hazardous waste, generated from construction, renovation, and demolition activities. To sum it up, construction waste is defined as material which is unwanted, damaged and unused without value generated at a construction site.

2.1. Previous research work: Categories and root causes

Previous researchers has classified the root causes into various categories as shown in Table 1.

Table 1.Categories of construction waste root causes

References	Categories	No. of Categories
[19]	Transportation and storage, Procurement	2
[20]	Material management on-site, Material handling transportation and storage, Site management and practices	3
[21]	Design, Procurement, Material handling, Construction	4
[22]	Design, Procurement, Material, Operation, Others	5
[23]	Design and contract documents, Site management, Procurements, Storage and handling of materials, Workers and supervision, Site conditions and external factors.	6
[24]	Transportation, Processing, Production of defective	6

May-June 2020
ISSN: 0193-4120 Page No. 26563 - 26575

	product, Overproduction, Material handling, Inventory	
[25]	Design, Handling, Worker, Management, Site condition, Procurement, External	7
[26]	Design and contract document, Procurement, Handling, Storage, Workers, Site management and supervision, External	7
[27]	Design & documentation, Materials procurement, Materials management on site, Materials handling, storage & transportation, On-site operations, Environmental conditions, Site management & practices, Site supervision	8
[28]	Procurement, Design, Material handling, Operations, Weather, Vandalism, Misplacement, Residual, Others	9

Table 1 indicates that there are various number of categories ranging from 2-9. Most of the categories has been divided according to design, material, site management, workers and procurement. The categories of root causes will aid in controlling the number of root causes in a systematic way. The categories identified from previous literature will support this research to classify the acquired 53 root causes into an acceptable series of groups. The list of 53 root causes which were identified from previous research work are presented in Appendix A.

3. Research Methodology

The exploration of this research is divided into 2 phases. The first phase includes extensive literature review after which 53 root causes contributing to construction waste generation were verified by the 36 construction expertise during pilot study stage. The 53 root causes passed the validity and reliability test with alpha cronbach's more than 0.7 where the data has high internal consistency. In the second phase, a questionnaire was developed. The questionnaire comprises of three parts, demography of the respondents, root causes of construction waste generation rate and construction waste generation rate in Malaysian construction industry. In this study, the layout of the questionnaire is set based on the Likert rating scale, where the scale ranges from not significant to very significant [29,30]. It is then distributed via online survey, e-mail and site visit to construction practitioners (clients, contractors and consultants) who are working at construction sites. Each respondents were asked to answer according to significant level of the root causes for the environment of Malaysian construction industry. A total of 500 questionnaires has been distributed and 278 were received with response rate of 55.6%. The data received were screened and keyed into SPSS which left with 217 valid respondents. The average index, standard deviation and factor analysis were computed through Statistical Package for the Social Sciences (SPSS) and is depicted in Table 2 and Table 3.

4. Data Analysis

Figure 1 displays the respondents' organization. Majority of the respondents are contractors with 86.6% (188 out of 217). The opinions of contractors are considered important as they are the ones who are specified at construction site and have better insights about the root causes of construction waste generation. Besides, 9.7% (21 out of 217) of the respondents are from clients whereas 3.7% (8 out of 217) are from consultants. Clients' and consultants' inputs are crucial as well because they are also having worthy involvement in construction industry field.

May-June 2020
ISSN: 0193-4120 Page No. 26563 - 26575

Figure 2 exhibits the number of respondents and their correspond-ing working experience. The majority, 20.7% (45 out of 217) of the respondents have 11-15 years of experience in the construction industry. The percentage of respondents with experience from 6 -10 years, 16 – 20 years and 21 - 25 years are similar which is 18.9% (41 out of 217). 6.9% (15 out of 217) of the respondents have more than 26 years of experience.

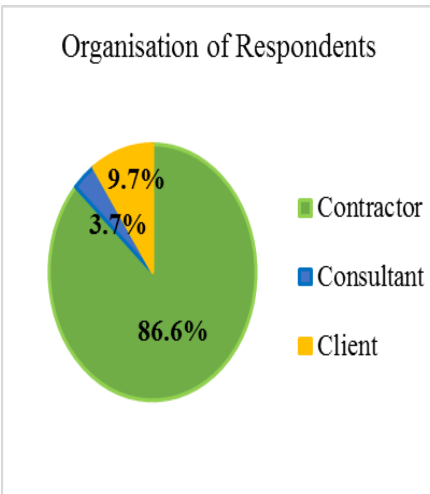

Fig 1: Organization of respondents

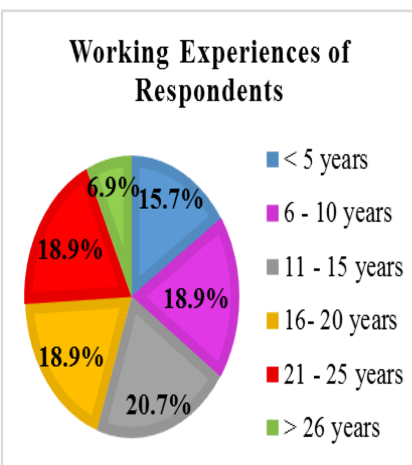

Fig 2: Working experience of respondents

Hence, the total number of respondents with experience more than 10 years in the industry is about 65.4%. This shows that majority of respondents are highly experienced and vastly knowledgeable in Malaysian construction industry.

4.1. Average Index Analysis: Ranking of Root Causes

The average index of each root cause of material waste generation is presented in Table 2. Result analysis showed that the root causes with the highest average index for generation of waste in Malaysian construction industry is 'Lack of efficient site management' with average index of 4.576. Site management and administration is a task drift according to the project's timeline [31-33]. Teamwork should be incorporated for an efficient site management plan [34, 35]. This includes managing scope, issues, risks, communication and the work plan. The weakness in site management can cause various material wastages at site such as concrete, metal, sand, timber will be generated. This root cause is one of the main contributors to construction waste generation.

May-June 2020
ISSN: 0193-4120 Page No. 26563 - 26575

Table 2. Ranking and Average Index of Root causes

Rank	Code	Root Causes	Average Index	Std. Deviation	Rank	Code	Root Causes	Average Index	Std. Deviation
1	RC2	Lack of efficient site management	4.576	0.605	28	RC49	Political involvement	3.853	0.762
2	RC1	Supervision during construction stage is poor	4.355	0.787	29	RC45	Damages caused by third parties at construction site	3.848	0.776
3	RC3	Last minute changes due to client requirements	4.350	0.780	30	RC34	Effect of weather condition	3.839	0.803
4	RC5	Constant design changes during construction period	4.272	0.790	31	RC15	Inefficient methods of unloading materials at construction site	3.834	0.839
5	RC18	Planning of technical team at site is weak	4.263	0.776	32	RC53	Lack of Building Information Modelling (BIM) usage for design work	3.834	0.833
6	RC8	Late information flow among all parties involved in the project causes redundant of work	4.258	0.750	33	RC46	Inadequate lights provided at night	3.829	0.747
7	RC30	Lack of environmental awareness by the site team	4.244	0.794	34	RC41	Inadequate security at construction site	3.816	0.728
8	RC29	Inadequate storage place at project site	4.217	0.836	35	RC6	Unsuitable tools used during construction stage	3.806	0.897
9	RC12	Lack of coordination among parties involved in the project	4.212	0.794	36	RC37	Occurrence of accidents at site	3.802	0.823
10	RC35	Insufficient training for workers by the employer	4.207	0.787	37	RC17	Material stored wrongly even though storage is allocated	3.797	0.945
11	RC39	Management and technical team at site at less experienced	4.203	0.831	38	RC9	Lack of possibility ordering small quantity of materials	3.793	0.876
12	RC28	Ordering errors by the procurement staff	4.129	0.823	39	RC52	Breakdown of equipment during concreting work	3.788	0.888
13	RC10	Improper way of material handling by the workers	4.065	0.802	40	RC21	Inaccurate material delivery procedures	3.765	0.885
14	RC50	Error during installation	4.028	0.810	41	RC22	Unforeseen geological conditions	3.751	0.812
15	RC31	Language problems among foreign workers and Malaysians	3.982	0.828	42	RC43	Design errors due to careless of inexperienced designer	3.751	0.851
16	RC48	Human mind set of ignorance of construction practitioners	3.972	0.793	43	RC19	Design produced by consultant is complex	3.747	0.797
17	RC11	Rework due to miscommunication among engineers and workers	3.972	0.775	44	RC25	Damage of materials during transportation by the supplier	3.742	0.961
18	RC24	Poor workmanship by the workers	3.963	0.804	45	RC13	Usage of wrong material	3.728	0.884
19	RC40	Frequent variation orders due to carelessness	3.949	0.812	46	RC32	Error in shipping of materials to different site location	3.724	0.906
20	RC7	Unsatisfactory attitudes of workers	3.940	0.845	47	RC27	Miscalculation in quantity surveys	3.719	0.822
21	RC20	Fault of workers during construction process	3.931	0.844	48	RC26	Abandonment of material on site without proper waste control	3.719	0.876
22	RC4	Cutting uneconomical sizes of materials	3.894	0.878	49	RC23	Items ordered are not in compliance with specification	3.714	0.919
23	RC33	Incomplete information provided in the drawing	3.880	0.766	50	RC38	Improper design quality produced by consultant	3.714	0.794
24	RC36	Inventory of material not according to site condition	3.866	0.869	51	RC42	Materials supplied in untied form	3.696	0.902
25	RC44	Vandalism	3.857	0.772	52	RC14	Poor quality of materials supplied	3.668	0.908
26	RC47	Designing without considering wastage	3.857	0.807	53	RC51	Less usage of pre-fabricated materials	3.622	0.895
27	RC16	Improper construction methods applied by the workers	3.853	0.896					

4.2. Factor Analysis: Categorisation of Root Causes

Factor analysis can be used to test the construct validity of a questionnaire [36]. If a questionnaire is construct valid, all root causes will signify the underlying construct well. Hence, factor analysis condenses the root causes into its appropriate categories. The impact of various root causes are calculated (Factor loadings) and the root causes grouped into their corresponding categories. The number of groups extracted should be able to explain the maximum amount of variance in all the root causes. An exploratory factor analysis was performed and the root causes are grouped into 5 categories. Root causes and their factor loadings are presented in Table 3. Factor analysis is performed to find out factor loadings or weightage of each root cause. In order to achieve this, factor analysis was carried out for the purpose of substituting the 53 root causes with a small number of practices that are capable of providing root causes of construction waste as the whole list of measures. Usually, factor analysis is carried out through four steps, which are a test for reliability of data, Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) & Bartlett's test of sphericity, factor extraction and factor rotation [37]. A group is a linear combination of root causes. It is a construct which is not directly observed but needs to be inferred from other input root causes.

4.3. Reliability analysis

The internal consistency of items in the questionnaire is measured using Cronbach’s alpha, whose value is calculated in this study, using SPSS. The Cronbach’s alpha value is charted in Table 4. According to Kaliannan et al. [12], if Cronbach’s alpha value is higher than 0.7, the inner consistency of data is highly acceptable.

Table 4. Cronbach’s Alpha value for each category

Category	Cronbach's Alpha	N of Items
Design and Documentation	0.894	7
Project Management	0.889	12
Material and Equipment	0.895	16
Human Resource	0.891	9
External Root Causes	0.878	9

Hence, based on Table 4, the cronbach’s alpha value for all the categories are more than 0.7 which shows that the data for this study is reliable and valid.

4.4. Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) and Bartlett's test of sphericity

The primary step in factor analysis is to check Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) and Bartlett's Test of Sphericity of the data. KMO checks the adequacy of data for running factor analysis. The value of KMO ranges from 0 to 1. Greater the value of KMO, more appropriate is the sample for performing factor analysis. Hof [38] stated that values greater than

May-June 2020
ISSN: 0193-4120 Page No. 26563 - 26575

0.7 as acceptable and good. Whereas, Bartlett's Test of Sphericity tests the null hypothesis of the correlation matrix. It tests whether the correlation matrix is an identity matrix or not. If it is an identity matrix, then factor analysis becomes irrelevant. Acceptable significance values should be less than 0.05.

Table 5. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.815
Bartlett's Test of Sphericity	Approx. Chi-Square	6018.457

The results calculated provides valid values of KMO and Bartlett's Test of Sphericity and are shown in Table 5. The KMO value is 0.815 where it shows that the sampling is adequate whereas the significance value is 0 which is acceptable for this study.

4.5. Factor extraction

Factor extraction is performed in two ways; one method is by choosing Eigen values and other is by using scree plot or combination of both. According to John & Brendan [39], the scree test is performed by searching for an "elbow" in the plot, or an abrupt transition from large to small eigenvalues. Maskey, Fei & Nguyen [40] suggested choosing root causes with Eigen values greater than 1.

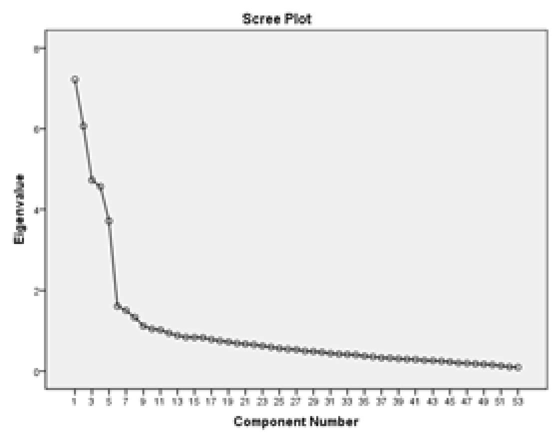

Fig 3: Scree plot

The scree plot is a graph between Eigen values and component number Figure 3 shows the graphical representation of extracted root causes.

4.6. Factor rotation

The interpretability of the root causes were enhanced by using the rotation technique. Rotation maximizes the loading of each variable on one of the extracted root causes and minimizes the loading on outstanding root causes. This ensures that the transformation matrix for the retained five (5) categories have some measurement root causes load high on the category while some of the

May-June 2020
ISSN: 0193-4120 Page No. 26563 - 26575

measurement root causes load low on the category. In order to determine the number of key categories that will suitably represent the whole root causes, the orthogonal factor rotation was carried out using Varimax method.

Table 3. Rotated Component Matrix

Code	Root Causes	Component				
		Equipment Category	Management Category	Resource Category	Category	Design & ımentation Category
RC42	Materials supplied in untied form	0.818				
RC26	Abandonment of material on site without proper waste control	0.774				
RC23	Items ordered are not in compliance with specification	0.773				
RC14	Poor quality of materials supplied	0.757				
RC25	Damage of materials during transportation by the supplier	0.649				
RC9	Lack of possibility ordering small quantity of materials	0.638				
RC36	Inventory of material not according to site condition	0.634				
RC15	Inefficient methods of unloading materials at construction site	0.585				
RC13	Usage of wrong material	0.583				
RC21	Inaccurate material delivery procedures	0.569				
RC32	Error in shipping of materials to different site location	0.566				
RC17	Material stored wrongly even though storage is allocated	0.555				
RC52	Breakdown of equipment during concreting work	0.529				
RC4	Cutting uneconomical sizes of materials	0.525				
RC6	Unsuitable tools used during construction stage	0.485				
RC51	Less usage of pre-fabricated materials	0.459				

May-June 2020
ISSN: 0193-4120 Page No. 26563 - 26575

RC1	Supervision during construction stage is poor		0.784			
RC5	Constant design changes during construction period		0.781			
RC29	Inadequate storage place at project site		0.697			
RC3	Last minute changes due to client requirements		0.680			
RC12	Lack of coordination among parties involved in the project		0.677			
RC18	Planning of technical team at site is weak		0.661			
RC39	Management and technical team at site at less experienced		0.647			
RC35	Insufficient training for workers by the employer		0.640			
RC30	Lack of environmental awareness by the site team		0.640			
RC8	Late information flow among all parties involved in the project causes redundant of work		0.621			
RC2	Lack of efficient site management		0.597			
RC28	Ordering errors by the procurement staff		0.580			
RC16	Improper construction methods applied by the workers			0.782		
RC40	Frequent variation orders due to carelessness			0.780		
RC7	Unsatisfactory attitudes of workers			0.760		
RC50	Error during installation			0.756		
RC11	Rework due to miscommunication among engineers and workers			0.744		
RC24	Poor workmanship by the workers			0.743		
RC20	Fault of workers during construction process			0.735		
RC10	Improper way of material handling by the workers			0.682		

RC31	Language problems among foreign workers and Malaysians			0.568		
RC48	Human mind set of ignorance of construction practitioners				0.758	
RC41	Inadequate security at construction site				0.758	
RC22	Unforeseen geological conditions				0.750	
RC46	Inadequate lights provided at night				0.745	
RC45	Damages caused by third parties at construction site				0.735	
RC34	Effect of weather condition				0.733	
RC49	Political involvement				0.701	
RC44	Vandalism				0.669	
RC37	Occurrence of accidents at site				0.654	
RC38	Improper design quality produced by consultant					0.830
RC27	Miscalculation in quantity surveys					0.811
RC43	Design errors due to careless of inexperienced designer					0.789
RC47	Designing without considering wastage					0.783
RC53	Lack of Building Information Modelling (BIM) usage for design work					0.778
RC19	Design produced by consultant is complex					0.758
RC33	Incomplete information provided in the drawing					0.659

5. Conclusion

The highest ranked root causes generated from this study is ‘lack of efficient site management’ with average index of 4.576. Based on factor analysis (rotated component matrix), the 53 root causes are grouped into 5 categories. Finally, the categories were sorted and labelled according to the character of the root causes in that category where ‘design and documentation’ category consist of 7 root causes, ‘project management’ category comprise of 12 root causes, ‘human resource’ category contains 9 root causes’, ‘material and equipment’ category has 16 root causes and ‘external category holds 9 root causes. Once, the root causes are classified into their respective categories, next structural equation modelling analysis can be proceeded in order to explore a new relationship by using the root causes of construction waste generation.

Acknowledgments

The author would like to thank Universiti Tun Hussein Onn Malaysia (UTHM) and Ministry of Education Malaysia. Funds for the study were provided by the Fundamental Research Grant Scheme (FRGS) No.1624, and is duly acknowledged.

References

[1] Nagapan, S., Rahman, I. A., Asmi, A., Memon, A. H., & Latif, I, "Issues on construction waste: the need for sustainable waste management". 2012 - 2012 IEEE Colloquium on Humanities, Science and Engineering Research, (Chuser), (2012) ,325–330

[2] Lockrey, S., Nguyen, H., Crossin, E., Verghese, K., "Recycling the construction and demolition waste in Vietnam: opportunities and challenges in practice". J. Clean. Prod. 133, (2016), 757–766.

[3] Brooks, K., Adams, and Demsetz, "Germany's construction and demolition debris recycling infrastructure: what lessons does it have for the US. In: KIBERT, C.J., Sustainable construction", Proceedings of the 1st Conference of CIB TG16, Tampa, FL, November 6-9. Centre for Construction and Environment, (1994), pp.647- 656

[4] Forsythe, P. and Marsden, P.K.. "Modelling construction waste performance- an arising procurement issue." S.O. Ogunlana ed., profitable partnering in construction procurement, CIB W92 (Procurement systems) and CIB TG23 (Culture in construction) joint symposium, Spon, London, (1999), 679-688

[5] Osmani, M.. "Construction Waste". Waste. Elsevier Inc. (2011)https://doi.org/10.1016/B978-0-12-381475-3.10015-4

[6] Tam, V. W. Y., & Lu, W. "Construction waste management profiles, practices, and performance: A cross-jurisdictional analysis in four countries". Sustainability (Switzerland), (2016). 8(2), 1–16. https://doi.org/10.3390/su8020190

[7] Begum R.A., Satari S.K. and Pereira J J. "Waste generation and recycling. comparison of conventional and industrialized building systems". American Journal of Environmental Sciences 6(4) (2010),.383-388.

[8] Rahim, M. H. I. A., Kasim, N., Mohamed, I., Zainal, R., Sarpin, N., & Saikah, M. "Construction waste generation in malaysia construction industry: illegal dumping activities". IOP Conference Series: Materials Science and Engineering, 271, (2017). 012040. https://doi.org/10.1088/1757-899X/271/1/012040

[9] Shen, L. Y., Vivian, W. Y. T., Tam, C.M., & D. Drew. "Mapping approach for examining waste management on construction sites". Journal of Construction Engineering and Management, 130(6), (2004), 918-923. http://doi.org/10.1061/(ASCE)0733-9364(2004)130.

[10] Kern, A.P., Dias, M.F., Kulakowski, M.P., Gomes, L.P. "Waste generated in high- rise buildings construction: a quantification model based on statistical multiple regression". Waste Manag. 39, (2015), 35e44

[11] Kolaventi, Swarna Swetha; Tezeswi, T. P. "Urbanization Challenges in Emerging Economies", 11, (2006). 11–20.

[12] Kaliannan.S, Nagapan.S, Abdullah, A.H, Sohu, S. "Determining Root Cause of Construction Waste Generation : A Global Context", 4(11), (2018), 2539–2547.

[13] Poon CS, Yu ATW, Wong A, Yip R. "Quantifying the impact of construction waste charging scheme on construction waste management in Hong Kong". J Constr Eng Manag; (2013), 139:466– 79.

[14] Yuan, H. P., & Shen, L. "Trend of the research on construction and demolition waste management". Waste Management, 31(4), (2011), 670–692.

[15] Nikmehr, B., Hosseini, M. R., Oraee, M., & Chileshe, N, "Major factors affecting waste generation on construction sites in Iran", (2015), 528–536, 2015

[16] Nagapan, Sasitharan, Suaathi Kaliannan, Abd Halid Abdullah, Samiullah Sohu, Rafikullah Deraman, Muhammad Fikri Hasmori,

and Nor Haslinda Abas. "Preliminary Survey on the Crucial Root Causes of Material Waste Generation in Malaysian Construction Industry." Engineering, Technology & Applied Science Research 8, no. 6 (2018): 3580-3584..

[17] Chen, X., & Lu, W. “Identifying factors influencing demolition waste generation in Hong Kong”. Journal of Cleaner Production, 141, (2017), 799–811. https://doi.org/10.1016/j.jclepro.2016.09.164

[18] Menegaki, M., & Damigos, D. “A review on current situation and challenges of construction and demolition waste management”. Current Opinion in Green and Sustainable Chemistry, 13, (2018), 8–15. https://doi.org/10.1016/j.cogsc.2018.02.010

[19] Najafpoor, Asghar ; Zarei asma ; Jamali-behnam, F. “A study identifying causes of construction waste production and applying safety management on construction site”. Iranian Journal of Health Sciences, 54, (2014),49–54.

[20] Khaleel, T., & Al-zubaidy, A. “Major factors contributing to the construction waste generation in building projects of Iraq”, 02034, (2018), 1–6.

[21] Ikau, Roseline, Corina Joseph, and Rudy Tawie. "Factors influencing waste generation in the construction industry in Malaysia." Procedia-Social and Behavioral Sciences 234 (2016): 11-18.

[22] Adnan, N.F. A study of construction waste generation at site project in Batu Pahat, Johor,Univeriti Tun Hussein Malaysia : Master thesis, (2012)

[23] Bekr, Ghanim A. "Study of the causes and magnitude of wastage of materials on construction sites in Jordan." Journal of Construction Engineering 2014 (2014).

[24] Pakhare, M. S., A. B. More, and N. V. Bhalerao. "To identify the root causes for wastages of construction materials." International Journal of Advance Research and Innovative Ideas in Education 3, no. 4 (2017): 2137-2139.

[25] Nagapan, Sasitharan, Ismail Abdul Rahman, and Ade Asmi. "Construction waste management: Malaysian perspective." In International Conference on Civil and Environmental Engineering Sustainability (IConCEES), Malaysia, vol. 2, pp. 299-309. 2012.

[26] Polat, Gul, Atilla Damci, Harun Turkoglu, and Asli Pelin Gurgun. "Identification of root causes of construction and demolition (C&D) waste: The case of Turkey." Procedia engineering 196 (2017): 948-955. https://doi.org/10.1016/j.proeng.2017.08.035

[27] Adewuyi, T. O., and I. A. Odesola. "Factors affecting material waste on construction sites in Nigeria." Journal of Engineering and Technology (JET) 6, no. 1 (2015): 82-99.

[28] Fadiya, Olusanjo O., Panos Georgakis, and Ezekiel Chinyio. "Quantitative analysis of the sources of construction waste." Journal of Construction Engineering 2014 (2014).

[29] Taylor, B., Sinha, G., & Ghoshal, T. Research Methodology. “A guide researches in management & social sciences”. New Delhi: PHI Learning Private Limited. (2009)

[30] Sohu, S., A. Halid Abdullah, S. Nagapan, A. Fattah, I. Latif, and K. Ullah. "Causative factors of cost overrun in highway projects of Sindh province of Pakistan." In IOP Conference Series: Materials Science and Engineering, vol. 271, no. 012036, pp. 1-6. IOP Publishing, (2017). https://doi.org/10.1088/1757-899X/271/1/012036

[31] Wahab, A. B., and A. F. Lawal. "An evaluation of waste control measures in construction industry in Nigeria." African Journal of Environmental Science and Technology 5, no. 3 (2011): 246-254.

[32] Zhao, Ying, and David KH Chua. "Relationship between productivity and non value-adding activities." In Proceeding of the 11th annual conference of the international group for lean construction, Blacksburg, Virginia, USA. (2003).

[33] Lu, Weisheng, and Hongping Yuan. "A framework for understanding waste management studies in construction." Waste management 31, no. 6 (2011): 1252-1260.

[34] Wang, Jia- Yuan, Xiang- Ping Kang, and Vivian Wing- Yan Tam. "An investigation of construction wastes: an empirical study in Shenzhen." Journal of Engineering, Design and Technology (2008).

[35] Urio, Angela Flavia, and Alan C. Brent. "Solid waste management strategy in Botswana: The reduction of construction waste." Journal of the South African Institution of Civil Engineering= Joernaal van die Suid-Afrikaanse Instituut van Siviele Ingenieurswese 48, no. 2 (2006): 18-22.

[36] Rattray, Janice, and Martyn C. Jones. "Essential elements of questionnaire design and development." Journal of clinical nursing 16, no. 2 (2007): 234-243.

[37] Field, Andy. Discovering statistics using IBM SPSS statistics. sage, 2013.

[38] Hof, Melanie. "Questionnaire Evaluation with Factor Analysis and Cronbach's Alpha An." (2012).

[39] Ruscio, John, and Brendan Roche. "Determining the number of factors to retain in an exploratory factor analysis using comparison data of known factorial structure." Psychological assessment 24, no. 2 (2012): 282. DOI: 10. 1037/a002569

[40] Maskey, Reenu, Jiangang Fei, and Hong-Oanh Nguyen. "Use of exploratory factor analysis in maritime research." The Asian journal of shipping and logistics 34, no. 2 (2018): 91-111. https://doi.org/10.1016/j.ajsl.2018.06.006