LEVEL OF ACCEPTANCE IN APPLYING SLUDGE AS CONSTRUCTION RAW MATERIALS AMONG RESIDENTS

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ABSTRACT

New technology has been introduced to the construction industry, which allowed to the reuse of sludge from wastewater treatment plant as raw material in manufacturing construction products such as concrete, brick, and aggregate. Previous studies in Germany showed that the authority introduced several measures to improve the level of acceptance of the use of sludge in the construction industry. Rather than the quality and performance of the application of sludge in the construction industry, this study is emphasizing on residents' acceptable level of sludge as part of the materials in constructing their houses. The data came from a questionnaire survey of 170 residents in Penang and the study revealed that level of acceptance in applying sludge as construction raw material is relatively low. Only 8% of the residents agreed to apply sludge as one of the construction raw materials and half of the respondents were not willing to purchase a house that constructed by using sludge materials even though if the selling price of the house is cheaper than conventional houses. This study showed that there is urgency to improve the acceptance of the use of sludge as the replacement raw material and scientists always need to be alert with the using of material when developing new products.

Keywords: sludge, construction material, level of acceptance

Introduction

Sludge is a semi-solid by-product discharged from domestic and industrial wastewater at sewerage treatment plants that contains pollutants and unstable pathogen content which leads to health and environment hazards (Barrera-Diaz, Martinez-Barrera, Gencel, Bernal-Martinez, & Brostow, 2011; Harrison & Oakes, 2002). Malaysia produces 5.3 million cubic metres of domestic sludge yearly and is estimated at 10 million cubic metres per year by 2035. Sewerage treatment plants in Malaysia nowadays are being used excessively and more land is required to house the sludge holding and treatment facilities (IWK, 2016; Spinosa, 2011). From the report of a global overview of the current status and future prospect, one of the most critical environmental issues in Malaysia is the management of sludge from sewer water treatment facilities (Spinosa, 2011).

The most popular final disposal method of sludge is through landfill; however this method is not environmentally friendly, because if the sludge is not treated properly and entirely, it will bring along side effects to the surroundings such as air pollution, contamination and degradation of the urban landscape (Balasubramanian, Sabumon, Lazar, & Ilangovan, 2006; Moreno, Rubio, & Martinez-Echevarria, 2011; Barrera-Diaz, Martinez-Barrera, Gencel, Bernal-Martinez, & Brostow, 2011). Landfilling also the major option for the members of Europe countries, but due to the decreasing public acceptance, the members established stricter legislation in controlling the landfilling and therefore the landfilling of sewage sludge has been declined drastically (Smol, Kulczycka, Henclik, Gorazda, & Wzorek, 2015). It is reported by the Department of Environment (DOE) that there is an increase amount of waste from wastewater treatment plant annually and the disposal of waste has become a major problem in Malaysia (Rosenani, Kala, & Fauziah, 2004). However, in Malaysia, recycling is not of primary importance, hence landfilling has been a popular sludge disposal way. For the sludge with limited pollution by toxic compounds, it will be reclaimed in agriculture and forestry as composting and soil amendment (Spinosa, 2011).

With the concept of sustainability become important today, the voice to dispose sludge safely and beneficially is elevated. Complaints and arguments to stop landfilling due to environmental issues and land availability are always being debated. Due to the high heavy metal content in the sludge, dry sludge is not normally permitted to be submerged in soil or applied as agricultural fertilizer (Harrison & Oakes, 2002; Moreno, Rubio, & Martinez-Echevarria, 2011; Kartini, Dahlia Lema, Dyg. Siti Quraisyah, Anthony, Nuraini, & Siti Rahimah, 2015). In Korea, due to industrial expansion and growing in population, the sludge

discharged from sewage and water treatment plants has been increasing annually. Thus Korea prohibited a direct reclamation of the sludge since June 2003 and also forbade its ocean disposal throughout the world in accordance with the London Dumping Convention (1975). Therefore more sustainable disposal remedies for the sludge are urgently needed and many researches have been extended away to find out innovative ways to utilize sludge (Mun, 2007).

Consequently, a new technology has been introduced to the construction industry, which allows reuse of sludge from wastewater treatment plant as a replacement for raw material in manufacturing building products (Mun, 2007; Cusido & Cremades, 2012; Jamshidi, Jamshidi, & Mehrdadi, 2011; Liu, et al., 2011). By the implementation of advanced sludge treatment technologies, sludge disposal practices can be more innovative to ensure human health and environmental protection (Alexandros & Athanasios, 2012). Since hundred years ago, the sludge was used in constructing houses. There was a village named Sa Sak located in Lombok in Indonesia, their floor was made of clay mixed with buffalo dung and straw ash. This type of mixtures had the potential to make the ground floor as hardened as cement (Agra, 2016).

With the rapid development and limited natural resources nowadays, alternative way to develop construction materials from different sources are being explored, including sewage sludge (Smol, Kulczycka, Henclik, Gorazda, & Wzorek, 2015). Many researches had been carried out to manufacture construction materials by using recycled materials such as bricks, aggregate and concrete. Started from Alleman and Berman (1984), they developed a brick called biobrick, using sludge as one of the mixture in it (Johnson, Napiah, & Kamaruddin, 2014). Liu et al. (2009) explored the feasibility of using sludge in the preparation of unfired bricks to reduce the huge amount of dry sludge from wastewater treatment. There were researchers tried to use dried sludge from water treatment plant and agricultural waste together with rice husk ash to produce novel lightweight bricks (Chiang, Chou, Hua, Chien, & Cheeseman , 2009). Cuisido and Cremades (2012) related the environmental effects with clay bricks that produced by using sludge as part of the raw material. In Malaysia, Indah Water Konsortium (IWK) cooperated with University Putra Malaysia (UPM) to carry out research on the application of dry sludge in clay brick (IWK, 2016). Mun (2007) conducted studies on the development of lightweight aggregate using sludge for nonstructural concrete to efficiently treat the sewage sludge. Similarly, Milica et al. (2012) presented results of the possibilities to apply industrial sludge in the masonry industry and also studied the environmental effects (Johnson, Napiah, & Kamaruddin, 2014). A research was also conducted to investigate the usage of sewage sludge in altering road base layers (de Figueirêdo Lopes Lucena, Thomé Juca, Soares, & Portela, 2014). Sewage sludge also is recycled by the researchers in producing cement related product. A recent research by Zbigniew, Danuta, Malgorzata and Grzegorz (2016) showed that lightweight aggregate-concrete can be modified by sewage sludge. Lynn, Dhir, Ghataora and West (2015) assessed the use of sewage sludge ash (SSA) in concrete and the history of applying SSA in concrete since 1983. Besides, Kartini and friends (2015) reported that they used incinerated domestic waste sludge powder as sustainable replacement material for concrete. They replaced cement in the concrete mix and tested for its performance.

However, according to the previous record in Germany, the authorities need to introduce several measures in order to eliminate the negative impact on the acceptance of sludge. A working group on sewage sludge acceptance was set up in June 1996 by the German Federal Ministry of the Environment to improve the level of acceptance of the use of sludge as secondary raw material (Andersen, 2001). Even though many studies able to generate products by using sludge and present significant improvements in quality and sustainability, using sludge as one of the replacement material still attract some amount of prejudgment and low public acceptance because of its sources and fear of contamination (Hall, 1999). Rather than the research on quality and performance for the application of sludge in manufacturing building products, this research is emphasizing on residents' acceptance level of sludge as part of the raw materials in constructing their houses.

Analysis And Discussion

Total 170 sets of questionnaire were distributed by hand in three languages, English, Malay and Chinese to public by using convenience sampling within Penang. Penang was selected because it is a fast grooming state occupied with lots of construction activities and with the highest awareness on environmentally friendly as it is the first state which starts "No Plastic Bag everyday" and uses biodegradable polystyrene in food packing in Malaysia (Poh, 2012). Respondents consisted of male and female, different ethnic groups, age with at least 21 years old above as only this group is eligible to purchase property in Malaysia, different occupations, and from different educational background from primary level to PhD level. All respondents were briefed about what is meant by sludge before answering the close-ended questionnaire. The acceptance level of sludge has acceptable internal consistency, with a Cronbach alpha coefficient reported of .733. Descriptive statistics were applied to generate the report in this study.

Table 1.1: Awareness of Sludge as Raw Materials

Do you aware that some of the products manufactured by sludge as raw material in the market?	Frequency (n)	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
a) Yes, I am aware of it	91	53.5	53.5	53.5
b) No, I never heard about it	79	46.5	46.5	100.0
Total	170	100.0	100.0	

From the collected data in the Table 1.1, it showed that 53.5% of respondents were aware of some products manufactured by using sludge as raw material in the market. The remaining respondents never heard about any products using sludge as raw

material before. Out of these 91 respondents, around 70% with at least diploma education level and approximately 45% were in between 31-40 years old. However, the remaining 46.5% respondents that never aware of sludge products, the majority were the young adult aged 21-30 years old with the education level of primary, secondary and pre-university.

The respondents were being asked whether they will feel angry or not if the product they purchased using sludge as part of the manufacture material but never be informed before purchasing. Surprisingly, the majority of the respondents were not angry as long as the quality of the product was not affected. But 36% of the respondents will feel angry if they had not been advised about it. About 60% of the respondents who felt angry with it were Chinese. It might be due to Chinese more believe in "Feng Shui" and they treat sludge as dirty material that can affect their luck.

Table 1.2: Angriness of Respondents if Sludge is Raw Material in a Product without Informing

Will you feel angry if a product manufactured by sludge as part of the raw material but never informs you?	Frequency (n)	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
a) Yes, I will angry	61	35.9	35.9	35.9
b) No, as long as the quality is not influenced	109	64.1	64.1	100.0
Total	170	100.0	100.0	

Only about 8% of respondents had an opinion that sludge can be used as construction material as per Table 1.3. Nevertheless, 33.5% of respondents confirmed that the sludge should not be used as construction material. More than half of the respondents unsure with this statement as they were unfamiliar with any sludge products.

Table 1.3: Sludge Should Not Be Used as Construction Materials

Do you agree that sludge should not be used as construction material?	Frequency (n)	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
Strongly agree	9	5.3	5.3	5.3
Agree	48	28.2	28.2	33.5
Nether agree nor disagree	100	58.8	58.8	92.3
Disagree	13	7.7	7.7	100.0
Strongly disagree	0	0	0	
Total	170	100.0	100.0	

By referring to the Table 1.4, it is shown that the residents doubted on the quality of houses being constructed by sludge products. Only 20% of the respondents concurred that the quality of the house using sludge material is equally with conventional house. 40% of the respondents did not agree about it. However, the remaining 40% of the respondents which majority came from lower education group were undetermined about this statement because they never come across with sludge products before.

As displayed in Table 1.5, it was found that half of the respondents were unwilling to purchase a house that constructed by using sludge products. Among the 87 respondents, it can be noticed that 58% of them were from Chinese ethnic group who did not accept the idea to buy a house using sludge as part of the raw material. From the 87 respondents who were not willing to purchase a house that constructed by using sludge as replacement raw materials, almost 60% of respondents were not confident with the quality of houses constructed by using sludge products. The result was consistent with the earlier analysis in Table 1.4 indicating that the majority of the respondents was not convinced with the sludge products. However, there were still 40% of the respondents did not prefer to buy a house constructed by sludge products due to dirty, bacteria and smell issue.

Table 1.4: Quality of House Using Sludge Products

Do you think that quality of houses constructed by sludge products same with conventional house?	Frequency (n)	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
a) Yes, it is same with conventional house.	34	20.0	20.0	20.0
b) No, it is not same	68	40.0	40.0	60.0
c) No idea with it	68	40.0	40.0	100.0
Total	170	100.0	100.0	

Table 1.5: Willingness to Buy Houses Using Sludge Products

Are you willing to buy a house constructed by sludge products?	Frequency (n)	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
a) Yes, I will.	83	48.8	48.8	48.8
b) No, I will not.	87	51.2	51.2	100.0
Total	170	100.0	100.0	

Table 1.6: Reasons Do Not Prefer To Buy House Using Sludge Products

What is the main issue that you do not prefer to buy a house using sludge as replacement raw materials?	Frequency (n)	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
Smell issue	3	3.4	3.4	3.4
Bacteria issue	16	18.4	18.4	21.8
Dirty issue	16	18.4	18.4	40.2
Quality issue	52	59.8	59.8	100.0
Total	87	100.0	100.0	

Again, the respondents were being asked whether they are willing to buy a house constructed by sludge products if the price of the house is much cheaper than a conventional house. 52.9% of respondents said yes, which was only slightly increased from the earlier analysis as shown in Table 1.5. Only about 4% of respondents will change their mind to buy a house constructed by sludge products when the price is a lot more inexpensive than the conventional house. The rest kept their decision of unwilling to stay in a house constructed by sludge products showed that monetary value is not an attraction for them to alter their minds.

Table 1.7: Willingness to Buy a House Constructed by Sludge Products if The Price is Cheaper

Are you willing to buy a house constructed by using sludge products if the price is much cheaper than conventional house?	Frequency (n)	Percent (%)	Valid Percent (%)	Cumulative Percent (%)
Yes	90	52.9	52.9	52.9
No	80	47.1	47.1	100.0
Total	170	100.0	100.0	

Conclusion

Many researches carried out research by applying sludge as part of the replacement raw material without considering the acceptance level of consumers. Since the boom of information technology, the speed and width of spread of information on the internet are undeniable. Consumers can easily find out the contents of a product, no secret can be kept from them. If referred to this survey, it can be concluded that the acceptance level of the respondents is low because the majority of them did not agree to apply sludge as part of the replacement raw material. Many of them found not confident with the products produced by sludge as quality has been always their main concern when using sludge as replacement raw material. Thus, the government needs to educate the public about the advantages in recycling sludge and reveal the procedure of processing sludge into a product in order to raise the understanding and the acceptance level of the public before developing technology to better reuse and recycle sludge from wastewater treatment plant as raw material in manufacturing construction products.

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