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The Acceptance of Utilizing Low-density Polyethylene (LDPE) Plastic in Concrete Brick Among Construction Stakeholders

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Abstract: Concrete bricks are the basic material and an important element for all types of construction. Recently, the problem faced by the construction industry is the demand for concrete bricks is increasing along with the price of the materials. In this study, low-density polyethylene (LDPE) was selected as a substitute for fine sand material in brick making. Recycling features that can use the cost of materials are the main reason for the use of the LPDE. In addition, the use of LDPE will help the source of pollution by the millions of plastic wastes accumulated at landfills. In addition, this material is available with a high degree of durability and weather resistance. This study was conducted to see the potential to produce the replacement of LDPE plastic waste in concrete brick manufacturing in Malaysia. The objective of this study is to identify the factors that influence the choice of materials in brick manufacturing, to investigate the potential acceptance of this product using LDPE plastic waste in brick manufacturing, and to identify the initiative in managing LDPE plastic waste and improving the brick products. An interview has conducted with the parties involved in the recycling of LDPE plastic waste and among the target respondents for this study are individuals who carry out work related to the management of plastic waste recycling and bricks industry manufacturing. Then the results of the interview will be analyzed and formulated to archive the objective of the study. For objective one, shows that have two factor that can be the main factor to influence the choice of materials in brick manufacturing which is factor on cost and technology. Next for objective two, shows that this product using LDPE plastic has the potential to be marketed in industry because the use of waste product material in concrete that is good alternative and environmentally friendly. Last objective shows by reusing the plastic, it can protect our environment and also reduce pollution. This research can contribute to the environment and waste material

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in concrete brick. This is also can suggest the construction stakeholder on the alternative material that potentially replace aggregate in concrete to produce the brick product with eco-friendly.

Keywords: Plastic waste, Low-Density Polyethylene, LDPE, Concrete

1. Introduction

A brick has been around for more than 6000 years, and has been in various shape, sizes and were made from many different types of materials, each of them having their own advantage and disadvantage; and formed the basic structure of many civilizations and was used in a wide range of buildings in centuries from building palaces, housing factories, in tunnels construction, water ways, bridges, making it the oldest manufactured building material (UKEssays, 2018). Concrete brick is a construction material made of a mixture of cement, sand and air which is then insert into the mound according to standard and are presses. It is use as an alternative to brick in constructing walls. Recently, the construction in Malaysia is growing rapidly, so that the need for building materials is increasing. As a result of the continuous increase in the construction industry, the need for building materials such as red bricks are also increases, therefore the need of alternative construction materials for making brick wall to substitute red brick, that is concrete brick. Sustainable concepts have been created in the construction industry due to growing concern about the future of our planet. According to Naik, 2018 with this method of recycling, it will be more beneficial, and environmentally friendly to reduce the impact of the environment in the future. This has created what we call the biggest problem in the world and plastic waste accumulation. Research into new and innovative use of waste materials being undertaken world-wide and innovative ideas that are expressed are worthy of this important subject. To achieve this, major emphasis must be laid on the use of waste plastic from various industries. Concrete brick is a non-structural wall building materials. The main raw material to manufacture concrete brick is cement and sand, however as sand has quite heavy load, so this time it is innovated to replace or substitute the sand into plastic pellets with some variation of mixing. The use of sand in the bricks is reduced with LDPE plastic. The reason for the use of LDPE plastic as substitution of plastic materials is that LDPE plastic have smaller density than sand does, so that it is expect that the brick becomes lighter although consists of the same composition.

1.1 Research Background

In this day the demand for building materials is increasing every day especially in the rapidly growing industrial development. Because of that the price for the materials getting higher by years. Concrete is usually used in construction materials for various types of structures due to its durability. Concrete brick is prepared by mixing cement, sand, coarse aggregate, fine aggregate and water. The expensive cost of this materials concrete brick constituents such as cement, fine aggregate and coarse aggregate has required the need to find for alternative construction materials. Nowadays technology have been taking over the world to improve in construction industry in our daily activities. In this construction industry, many researchers come out with new technology to find out another replacement material in concrete brick which it gives benefit to society such as environmentally friendly and cost saving.

People from the construction industry are focusing on reducing the cost of conventional building material and some past researcher there have been put forward. Previous researcher had produced concrete by using many alternative materials commonly waste industrial product such as tyres and rubber, tile and sanitary ceramics, palm oil ash and glass. A few researchers have shown that from experimental results, palm oil ash can be used as a substitute for cement. Samsudin (2006) found that palm oil ash can also provide high compressive strength values.

Other researcher also shows the material tyres rubber pieces that are mounted on vehicle wheels are made of natural rubber, styrene-butadiene, polybutadiene, carbon black and silica, which is used in high-performances tyres. The researcher found that the use of material tyres and rubber waste as fibre showed the result that by increasing the amount of rubber, the performance of concrete decreased (Olivares, 2004). A flexural strength test showed that the concrete samples containing rubber tyre as fiber were stronger by up to 20% compared with the strength of the control samples.

1.2 Problem Statements

The global fossil-based plastics production capacity has increase and grown more than 20-fold since 1964 which is 322 million tonnes in 2015 (Ellen MacArthur Foundation and World Economic Forum, 2014; Plastics Europe, 2017). The statistics presented in the Science journal 2015, estimated that about 8.3 million tonnes had become plastic waste where 9% recycled well, 12% incinerated, and 79% accumulated on the ground. Science magazine published an article warning that by 2050, we'll have produced 26 billion tonnes of plastic waste, half of it will be dumped in landfills and the environment (Guglielmi, 2017). From that amount found, Malaysia produces almost one million tonnes of plastic waste that is not recycled or disposed of properly and the worst part is that plastic waste is harmful because as it is believed to contain highly toxic elements and will take hundreds of years to degrade (Huysman *et al*, 2017).

Besides, the use of clay bricks in Malaysia is very widespread as opposed to lock bricks as it is more synonymous with construction material in this country. Clay bricks are stronger than sand bricks and also the most commonly used brick in Malaysia is clay bricks but its production is very limited because clay cannot be obtained and it is relatively expensive. Therefore, the clay bricks are not sustainable materials in construction since it is non-environmentally friendly materials. This is because the production process involves a high amount of energy consumption that release a huge amount of carbon dioxide gas and lead to environmental imbalance. In addition, its processes also involve the release of large amounts of carbon dioxide gas, leading to environmental imbalance (Ahmad, 2019).

In this study, LDPE plastic waste will be used as aggregates replacement material to reduce the cost of construction material and pollution as well as to improve the lightweight in concrete brick. The reason for choosing this waste material is not only aimed to reduce the material cost in concrete bricks production but it also can be an alternative option to reduce the depleting of waste material. LDPE plastic is also having many benefits such as low cost, low density, ecologically friendly, sustainable and biodegradable resources. Therefore, LDPE plastic waste has the only plastic polymer substance structure, making it exceptionally cheap to process.

1.3 Research Questions

(i) What are the factors that influence the choice of materials in brick manufacturing?
(ii) How does the potential acceptance of this product use LDPE plastic waste?
(iii) What are the bricks manufacture feedback about the potential to produce the LDPE plastic waste?

1.4 Research Objectives

(i) To identify the factors that influence the choice of materials in brick manufacturing.
(ii) To investigate the potential acceptance of this product using LDPE plastic waste in bricks manufacturing.
(iii) To identify the initiative in managing LDPE plastic waste and improving the brick products.

1.5 Scope of the Study

The study is focused on contractors who register with CIDB in Malaysia. The study was conducted on three construction sites that are carrying out construction activities in bricks manufacturing around Malaysia.

2. Literature Review

2.1 Low-Density Polyethylene (LDPE)

Low-Density Polyethylene (LDPE) is an economical plastic material with good chemical resistance. LDPE provides high impact strength at low temperatures. It also exhibits excellent electrical properties. The natural color of LDPE is milk-white. LDPE is thermoplastic, which is a type of plastic that can be processed through heating and cooling. This plastic is made from petroleum that has been produced since 1933. Its characteristics are thin, flexible, clear, and light so it is easy to make a variety of materials or products. LDPE is one of the earliest types of polymers present in the industrial world. Currently, plastic LDPE faces stiff competition with a wide range of new polymer types, including HDPE. LDPE is a softer and more flexible material in comparison to HDPE. While LDPE has a lower tensile strength, it has greater ductility, which refers to a solid material's ability to deform under tensile strength. However, LDPE's superiority remains among business, industry, and household consumers (Lou *et al*., 2007).

2.2 Types of Plastic

Plastic is a major component in the manufacture of materials such as mineral water bottles, combs, pipes, and others. However, the differences between the types of plastics are divided according to the code of the Plastic Industry Association (SPI) as shown in Figure 1. SPI has made a classification to provide exposure to consumers etc. Knowledge of the types of plastics is very important consumers can use plastics wisely without polluting the environment.

Plastics can be divided into 7 types:

(i) SPI 1: Polyethylene Terephthalate (PETE or PET)
(ii) SPI 2: High-Density Polyethylene (HDPE)
(iii) SPI 3: Polyvinyl Chloride (PVC)
(iv) SPI 4: Low-Density Polyethylene (LDPE)
(v) SPI 5: Polypropylene (PP)
(vi) SPI 6: Polystyrene or Styrofoam (PS)
(vii) SPI 7: Other (includes: polycarbonate, polylactide, acrylic, acrylonitrile butadiene, styrene, fiberglass, and nylon)

2.3 Advantages of Using Plastic

Plastics tend to be very flexible with a range of properties. Basically, plastics are relatively light, cheap, strong, and durable; hence the widespread use. These are some advantages and properties of the plastics shown below. Some peculiar advantages of plastic usage over other materials are:

a. Plastics show durability, lightweight, strength and reduce cost over other materials, like paper, glass, wood, metal and etc.
b. Plastic application is developed as based on the characteristics offered by the specific plastic; hence restricting it to that plastic

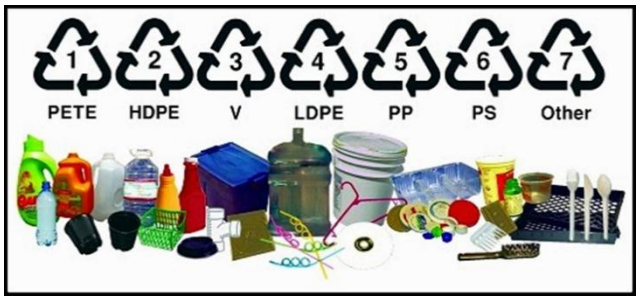

Figure 1: Code Plastic (The Society of Plastics Industry, 1988)

2.4 Other Replacement Using Waste Material in Concrete Brick

From this literature study, there are many researchers who used waste materials as the aggregate and sand replacement in concrete brick. While replacing such a hard and inert material one should consider all the strength characteristics and properties of replacing the material.

2.4.1 Bamboo Fiber

Bamboo is a natural and renewable resources (Figure 2). Bamboo is non-polluting and does not have crusts or parts that can be considered waste. Instead of adding to the problems of polluting land-fills like conventional building waste, any part of the bamboo that is not used is recycled back into the earth as fertilizer or can be processed as bamboo charcoal. Bamboo fibres are natural fibres that are extracted from the bamboo tree and are focused as one of substitution for natural plant fibre having many advantages such as low cost, low density, ecologically friendly, sustainability and biodegradability.

Bamboo can be use as building component such as pole, beam, floor, celling, roof and others. Then, bamboo is also be as building material has high compressive strength and low weight has been one building material as support for concrete (Brajesh *et al*,.2016). Bamboo fibre has a potential to use in concrete mixture, this is in line with the statement from Gargi *et al*,. (2016) state that bamboo fibre can be used as filler in road construction or any for making concrete structure such as slab and retaining structures. Bamboo pieces may also be some effectiveness as partial replacement to aggregates in the concrete applications to decrease weight of structures.

Figure 2: Bamboo Fiber after grinding process

2.4.2 Sugarcane Fibre

The sugarcane fibre is the result of the residue of the cane after it is destroyed and the water has been dried. Swamy (1984) has defined "residuals" as the following: “Bagasse is the fibrous residue which is obtained in cane-sugar production after extraction of the juice from the cane stalks”. Dust is also categorized in grass clusters. It can grow up 6m high. However, it also depends on the species and area the plants. Cane grows in high humid tropics. After the cane put into the machine, it will produce residue containing fibre prime (50 - 55%), moisture (15 - 20%), crushed residue (30 - 35%) and a few ingredients dissolved the rest (4 - 6%). However, it also depends on the type of sugarcane, cane maturity, harvesting techniques as well as the efficiency of the grinding machine used.

2.4.3 Palm Oil Ash

In Malaysia, the annual production of the oil palm shell in the industry is approximately 4 million tons (Manan, 2001). To dispose of the palm oil wastes poses risks to the environment, therefore the Malaysian government is researching on ways to reduce the waste or determine a usage for the waste. One of the possible waste utilizations is to use the Palm Oil. There are several researchers had begun research on the palm oil clinker as lightweight aggregate. In those researches, tests were conducted on full replacement of OPS as fine and coarse aggregates in the concrete mix. It was found that the density of such replacement will produce concrete with density ranging from 1800 to 1920 kg/m3. The compressive strength of the oil palm clinker concretes is found to be within the range of l7 to 40 MPa after 28 days of curing, which is satisfies the requirement if used as structural lightweight concrete (ASTM- C330 2004).

From the previous research, it was suggested that the palm oil clinker concrete is suitable to be used as structural lightweight concrete since it has sufficient density and acceptable compressible strength. In the lower density ranges lightweight concrete does not develop the compressive strength of plain concrete. This may be a disadvantage in plain concrete applications, but it is an advantage in a lightweight concrete application. It should be considered that lightweight concrete and plain concrete are typically used for different types of applications. Each form of concrete exhibits a unique family of performance characteristics. Each should be utilized in the appropriate type of project. But a high strength of 33 Mpa could be achieved with high cement content OPS mix (ASTM C 330). Figure 3 shows the palm fruits and raw palm oil ash.

Figure 3: Palm fruits (left) and raw palm oil ash (right)

3. Research Methodology

3.1 Research Framework

In conducting this study, qualitative methods are used to make this study successful. Qualitative research is the study of a situation and individual to obtain detailed and in-depth data on the study that is being conducted. This qualitative method will explain more clearly about something that is being studied. The respondents will provide the verbal response regarding the questions and the researchers directly write or record the information (Chua, 2011). The data obtained through this method is by using the method in an interactive and face to face, in other words is through conversation and observation to get the data to be obtained. The interview question is including in Appendix section in short of the instrumentation must consider the limits of the study to make the study complete successfully.

3.2 Data Collection Methods

The selection of methods in the collection of research data should be done systematically and effectively so that the results of the study obtained meet the requirements of the objectives and goals of the study to be achieved. In this study there are two data that will be obtained, namely from the collection of primary data and secondary data.

3.2.1 Primary Data

Primary data is data obtained through original data or directly without the use of intermediaries such as reading journals or architects and so on. Primary data is data collected specifically to answer the questions for the study conducted that is data collected by the researcher himself to obtain the information needed in the study. In this waste recycling study, the primary data used is a case study and to obtain information on this study is to use instruments such as semi-structured interview.

3.2.2 Secondary Data

Secondary data is data obtained through printed materials or appropriate sources such as articles, reference books, journals, the internet and appropriate writing materials. Through these data, it will give a clear picture of the facts of the study conducted. Examples of such facts are in terms of theory and definition.

3.3 Design of Research Questions

As mentioned earlier, one of the instruments used is in the form of a semi-structured interview. This method is used because it is easier to obtain information directly and face to face and even in accordance with the objective in this study which is to identify the factors that influence the choice of materials in brick manufacturing, to investigate the potential acceptance of this product using LDPE plastic waste in bricks manufacturing and to identify the initiative in managing LDPE plastic waste and improving the brick products.

To achieve the objectives of the study, the set of questions for the semi-structured interview was divided into several sections.

(i) Section A: Respondent Background
(ii) Section B: The Factors That Influence the Choice of Materials in Brick Manufacturing
(iii) Section C: The Potential Acceptance of This Product Using LDPE Plastic Waste in Bricks Manufacturing
(iv) Section D: The Initiative to Improving the Brick Product Using LDPE Plastic Waste

3.4 Data Analysis Methods

The method of data analysis will be carried out after the data collection process is done. Next, the data that has been transcribed earlier will go through five stages of data analysis and content analysis, categorizing and encoding data, compile data in grid analysis, and follow-up studies. For this method of data analysis, the content analysis method is used to get data. According to Schreier (2012), content analysis is one method to systematically explain the meaning of qualitative material.

4. Results and Discussion

The data collection and analysis are based on three case studies that have been implemented. The study was conducted using qualitative methods, and the instrument used by the researchers was a semi-structured interview. The design of the study was done for the method of research conducted as well as the method of data collection designed to obtain information and methods to analyze the data. During the interview process, the researchers recorded voice using a smartphone and recorded important data in writing. Researchers use both methods, with the aim of making certain data more accurate and clearer.

4.1 Background Study

In this study, the researchers placed three respondents who needed to be interviewed. The three respondents must be registered as Bumiputera Contractors to achieve all the objectives of the study focusing on Bumiputera Contractors. Table 1 lists the backgrounds of the respondents involved in the interview process:

Table 1: Background of Respondents Involved in the Study

Respondent	Age	Position	Company Name	Type of Brick
R1	43	Manager	Brick Dotcom Sdn Bhd	Clay Brick
R2	40	Manager	Kilang Bata Azimat Ent	Sand Brick
R3	38	Manager	Malek Ridz Resources	Smart Brick

All respondents are active in housing projects. In addition, the respondents interviewed were Bumiputra contractors who are active in the field of development in Malaysia based in the state of Perak. This data collection is from three respondents in brick manufacturers as a case study is an activity that uses different types of bricks consisting of sand bricks, clay bricks, and IBS smart bricks. The data obtained is the contractor carried out which is a building development project in Malaysia. Projects involving housing projects, business buildings, and trade development. Researchers have constraints for interview contractors from other states because the Covid-19 outbreak makes it difficult for researchers to cross the state.

4.2 Analysis Data

At this stage, the data received by each respondent will be analyzed in more depth to get a clear explanation. Meanwhile, data analysis methods have been used in this process. The result of data which are the factors that influence the selection of brick making in Table 2.

Table 2: The Factors That Influence The Choice Of Materials In Brick Manufacturing

Factors	R1 (Clay brick)	R2 (Sand brick)	R3 (Smart brick)
Expertise	No	Yes	Yes
Material availability	Yes	Yes	Yes
Cost	Yes	Yes	Yes
Machinery	Yes	Yes	Yes
Location	No	Yes	Yes
Technology	Yes	Yes	Yes

Among the most widely used factors in the choice of materials in brick manufacture are the price of bricks and the technology. In this case, approaching the three respondents answered with those factors because technology is very important in producing bricks given at a low price value. The price of material selection in brick manufacture is very important to produce the best quality of brick products and also in the needs of customers and high demand.

To achieve the second objectives , the researcher focused on the potential acceptance of this product using LDPE plastic waste in the brick manufacturing has been studied and analyzed its data. The findings of this objective study are described in Table 3:

Table 3: The Potential Acceptance of This Product Using LDPE Plastic Waste in Bricks Manufacturing

Category	R1 (clay brick)	R2 (sand brick)	R3 (smart brick)

The comment about product (LDPE plastic waste)	The occurrence of strength differences according to the percentage of LDPE waste material replacement.	The highest strength value is less than 20%.	The less percentage (15%) of LDPE waste gives a high strength to the product.
Have the respondent ever heard of this product?	Yes	Yes	Yes
The potential product to be marketed in the industry in the future	Has potential	Has potential	Has potential
Can the product be accepted in the construction industry?	No	No	Yes
What the factors that influence market acceptances	Quality product Price product	Price product Environment	High demand

In the second objective, the researchers focused on interview questions to see if this product has potential acceptance to brick manufacturing in Malaysia. The results of the study found that the compressive strength of the product using LDPE waste less than 20% which is 15%. All three respondents have heard about this product but they stated that this product is difficult to accept in the construction industry in Malaysia due to several factors which is state in objective one. Furthermore, this product may also have the potential to be marketed in the future in the construction industry.

Therefore, there are several appropriate initiative methods to improve this product in brick manufacturing. To achieve the objectives of the final study, Table 4 shows the findings of the study:

Table 4: The Initiative to Improving the Brick Product Using LDPE Plastic Waste

Question	R1 (Clay brick)	R2 (Sand brick)	R3 (Smart brick)
What are the best ways to improve this product?	Suggest to keep on more research and trying the easier process of the waste.	Try to improve the way you process the LDPE waste and then it cut cost to produce the product.	This product is valid and has the potential to produce in the future in order to reduce pollution in Malaysia.
Do you agree that product quality is important in long-term revenue and profitability?	Yes	Yes	Yes

How did you market your product? Advertisement? Which platform?	Social media	Social media	Social media
The government should provide subsidies in order to improve the quality of bricks in Malaysia.	Yes	Yes	Yes
Do you think reusing this waste material (LDPE plastic waste) works to contribute to the protection environment?	Yes	Yes	Yes
In your opinion, can all the features help improve products that use LDPE plastic waste.	Yes	Yes	Yes

Based on the findings of the study, all respondents agreed and gave the opinion that the replacement material in concrete bricks is not a new thing today but less applied in the construction industry, especially brick manufacturing in Malaysia. Therefore, the products marketed must get support from the government by providing subsidies in improving the quality of brick products to be marketed. All three respondents use social media platforms to market their products because nowadays social media such as Facebook, WhatsApp, and Instagram are used for businesses to be marketed. In addition, to achieve this third objective, researchers found that using LDPE waste can reduce the problem of pollution in Malaysia.

4.3 Discussion

The results in this study have discussed in detail the results of interview data obtained from respondents. All three respondents gave a good feedback in the interview section and having good respond about the product in this study. This product (LDPE waste) has the potential to be marketed by looking at the material selection factors that are very important to produce high-quality brick products. Next, when the item selection factor is listed then the researcher studies the acceptance of this product whether it has the potential to be marketed. Finally, in the third objective, researchers can achieve that objective by knowing the best way to increase quality and improve products for acceptance in the brick market in Malaysia.

5. Conclusion

In conclusion, all three objectives of the study have been successfully achieved. As a result of the analysis of interview data, the findings for objective one show that based on the results of the study, the findings for objective one show that there have two factor that can be the main factor to influence the choice of materials in brick manufacturing which is factor on cost and technology. Cost effective materials are a collection of strategies that use innovative materials in brick. Technologies are to the

effect, savings without compromising the strength, durability and comfort and elegance of making and has made contemporary bricks more efficient and has improved the overall quality of the brick products. Technologies factors also use to process plastic waste materials to become granules in brick materials in replacement sand in concrete brick.

Further, the researchers found in the second objective that this product using LDPE plastic has the potential to be marketed in industry because the use of waste product material in concrete that is good alternative and environmentally friendly. Besides, in the brick manufacturing industry in Malaysia, there are still not many brick manufacturers that use the concrete brick mixture with other materials like waste material and natural aggregate because as stated in the first objective, the use of advanced technology is still not many brick factory operators can afford. In fact, there are still many bricklayers using traditional technology in brick making such as clay brick and sand brick.

Although the third objective that can be achieved in this study is found, by reusing the plastic, it can protect our environment and also reduce pollution. It also helps in order it will further enable improvement in recovery rates of plastic waste and diversion from landfills. Recycling is one of themost important actions currently available to reduce these impacts and represents one of the most dynamic areas in the plastics industry today. Recycling provides opportunities to reduce oil usage, carbon dioxide emissions and the quantities of waste requiring disposal. Moreover, the government needs to provide support in the construction industry in Malaysia, especially to small operators to improve the quality of products. The use of these bricks can also reduce environmental pollution because the process of removing plastic takes a long time. Therefore, the idea of recycling plastic materials (LDPE) can reduce the problem of pollution in Malaysia.

Lastly in this study, the focus is on the acceptance of utilizing LDPE plastic in concrete brick which is the recycling of LDPE plastic. As we know the waste plastic is available everywhere and it may be reuse in give effective use in brick manufacture. This product can be used for insulation and should be more sufficiently economical with the potential to be market in the future. It also easy to recycling the waste and can be under submerged conditions in the order they should be last much longer. Overall, this product has the potential to be acceptance of utilizing in concrete brick among construction stakeholders and it will be reduced in cost.

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