

MAPPING OF CONSTRUCTION WASTE ILLEGAL DUMPING USING GEOGRAPHICAL INFORMATION SYSTEM (GIS)

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Abstract. Illegal dumping of solid waste not only affecting the environment but also social life of communities, hence authorities should have an effective system to cater this problem. Malaysia is experiencing extensive physical developments and this has led to an increase of construction waste illegal dumping. However, due to the lack of proper data collection, the actual figure for construction waste illegal dumping in Malaysia are not available. This paper presents a mapping of construction waste illegal dumping in Kluang district, Johor using Geographic Information System (GIS) software. Information of the dumped waste such as coordinate, photos, types of material and quantity of waste were gathered manually through site observation for three months period. For quantifying the dumped waste, two methods were used which are the first method is based on shape of the waste (pyramids or squares) while the second method is based weighing approach. All information regarding the waste was assigned to the GIS for the mapping process. Results indicated a total of 12 types of construction waste which are concrete, tiles, wood, gypsum board, mixed construction waste, brick and concrete, bricks, sand, iron, glass, pavement and tiles, and concrete at 64 points locations of illegal dumping on construction waste in Kluang. These wastes were accounted to an estimated volume of 427.2636 m³. Hopefully, this established map will assist Kluang authority to improve their solid waste management system in Kluang.

Keywords: mapping, illegal dumping, construction waste, geographic information system (GIS)

1. Introduction

Solid waste is a major concern that is similar to air and water pollution [1]. Under the Malaysia Solid Waste and Public Cleansing Management Act 2007 (Act 672) solid waste are categories into public waste, import waste, household waste, institution waste, special waste, commercial waste, industrial waste and construction waste [2]. Construction waste can be defined as any by-product materials of human and industrial activity that has no residual value [3, 4]. Construction waste generates by construction activities including renovation, infrastructure development, demolition, earthworks and land clearing. The types of waste produced are including concrete, wood, iron bricks, plastic and are mixed between them [5]. Waste produced at construction site can be divided into two types which are physical and non-physical waste. Physical waste is mainly from broken concrete, bricks, metals and packaging waste while non-physical waste are cost overrun and time delays [5, 6].



Construction waste generation is becoming a pressing issue in Malaysia and this generation is concurrent with rapid development in the construction industry [7, 8, 9]. Demand on houses and major infrastructure projects make the amount of construction waste increased [11,12]. Various waste management strategies including; reduce, reuse, and recycle of construction waste, reduce liability, keep the construction sites cleaner and safer, and conserve valuable landfill space have been adopted in construction industry [15]. However, the rapid construction waste generation is still not controlled as desired by [16] and causing illegal disposal in unpermitted area [13,14]. Illegal dumping causes risk to human health and the environment [10, 17, 18]. Based on statistics, there are 11,824 illegal dump sites found in Malaysia with 3226 of them has verified positive to mosquito breeding ground in which leads to dengue [19]. Therefore, an effective management of illegal dumping will reduce the environmental risk and making the construction operation more resource-efficient [20]. Hence, it is a vital to have proper management system to tackle illegal waste dumping [21]. Before implementing and selecting an effective system, it requires appropriate database on characteristics of the waste (demography and intensity) so as the implementation will benefit all parties. [9, 22,23].

2. Methodology

This study focused in Kluang district which is located in the center of Johor state that covers key urban areas includes Kluang town, Paloh, Kahang, Renggam, Machap, Simpang Renggam and Layang-Layang [24]. These location was chosen for mapping the illegal construction waste dumping based on a study by [25] which indicate that there are 46 illegal dumping sites. Thus this study was carried out by site observation approach to collect data for illegal dumping in Kluang district every week for 3 months' duration. During the observation, the collected details of the illegal dumping are coordinate of waste locations, photos and type of waste materials. Coordinate of waste locations is decided using smartphones global positioning system (GPS) application as Figure 1.

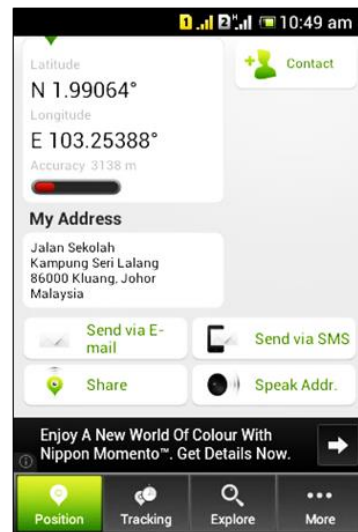


Figure 1. GPS Application from Smartphones.

Photos of the waste were taken to identify types of waste material according to Solid Waste Management and Public Cleansing Corporation (SWCorp) standard guideline [26]. The amount of waste was quantified using volume method adopted from [5]. In volume method the waste can be divided into 2 shapes either pyramidal or rectangular (refer Figure 2 and Figure 3). The length, width and height of the waste were measured to calculate its volume. For pyramidal shape, the formula use is;

$$V_s = \frac{1}{3} \times B \times L \times H \quad \dots\dots\dots(1)$$

For rectangular shape, the formula use is;

$$V_g = L \times B \times H \quad \dots\dots\dots(2)$$

where L is the length,

B is the width, and

H is the height of the waste.

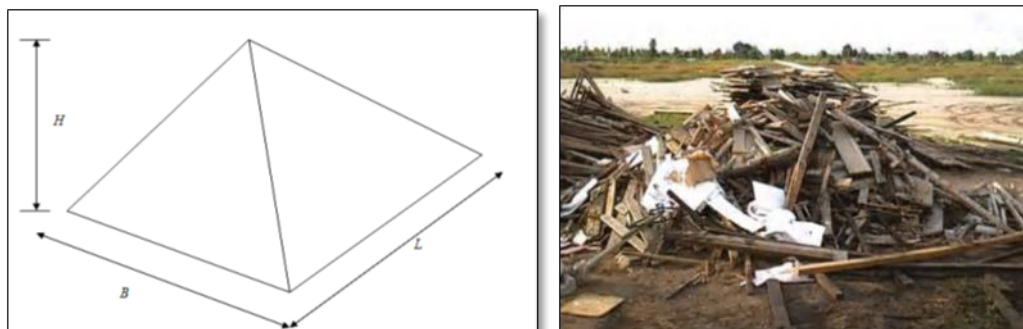


Figure 2. Pyramidal Shape Waste.



Figure 3. Rectangular Shape Waste.

However for scattered waste, the waste was weighted in unit kg and converted to volume in unit m^3 using density provided by Solid Waste Management and Public Cleansing Corporation (SWCorp) standard guideline [26].



Figure 4. Scattered Waste.

Figure 4 shows an example of scattered waste found in Kluang. Three random similar samples were weighted and averaged, then multiply by the number of waste stack as equation below;

$$\text{Average weight} = (\text{Stack sample 1} + \text{Stack sample 2} + \text{Stack sample 3})/3 \dots\dots\dots(3)$$

$$\text{Total weight} = \text{Average weight} \times \text{total number of stack} \dots\dots\dots(4)$$

After that, the details were inserted in GIS. Data collected was plotted and mapped to develop database mapping for illegal dumping of construction waste in Kluang.

3. Database Mapping Development

In this study, ArcGIS software was used to develop the database mapping. The database mapping requires changing of coordinate reading from android application to RSO format using coordinates transformation in GIS. All collected data is compiled in one folder in basemap before opening ArcGIS software. Database mapping was developed by choosing blank map together with database and adding the collected data at the specific location of the base map. Figure 5 shows the details data in GIS mapping for illegal dumping of construction waste in Kluang.

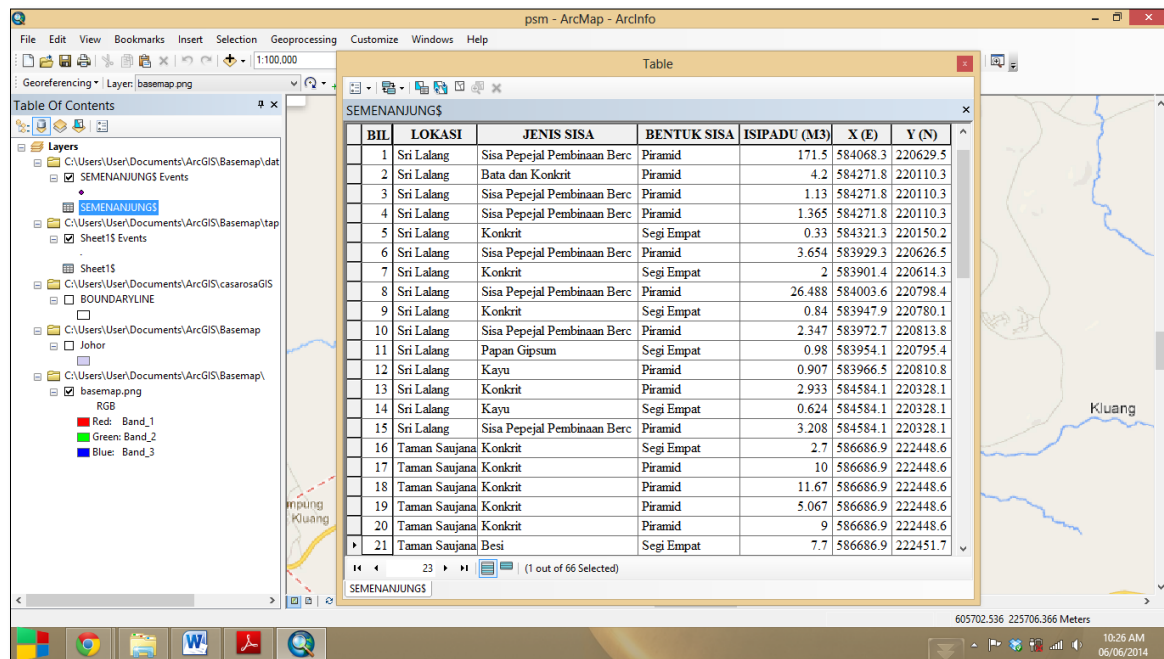


Figure 5. View on details data in GIS.

4. Results and Discussions

Demography of the illegal construction waste dumped in Kluang district is as Figure 6 where it shows the percentage of type of construction waste material dumped. Figure 6 shows 12 types of construction waste with the highest percentage is mix waste with 54.257%, followed by concrete with 20.032% and tiles 8.376%. The least material of construction waste dumped illegally in Kluang was glass with percentage of 0.03% only.

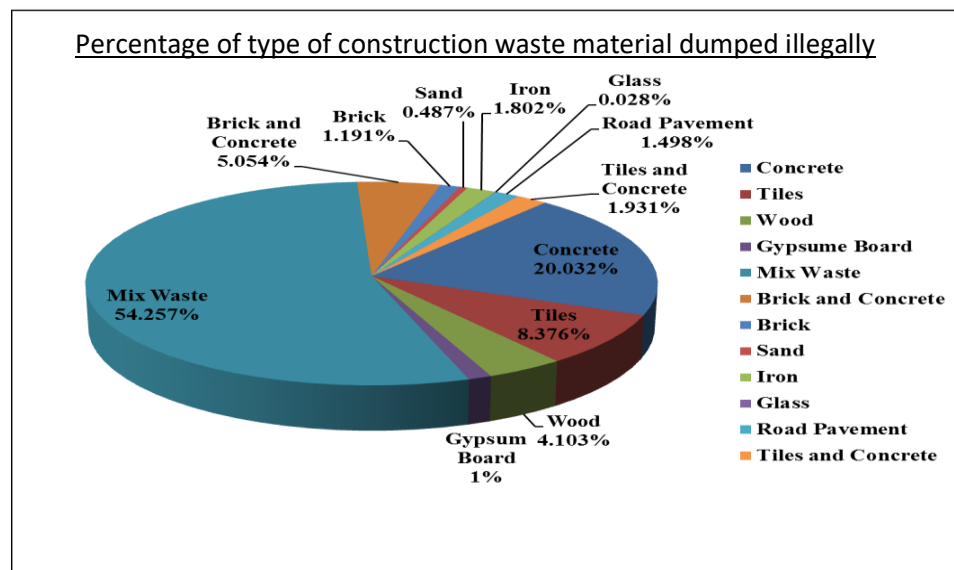


Figure 6. Percentage of Construction Waste illegal dumping in Kluang.

Distribution of these illegal dumping of construction wastes is pictured in Figure 7 showing the developed database using GIS application.

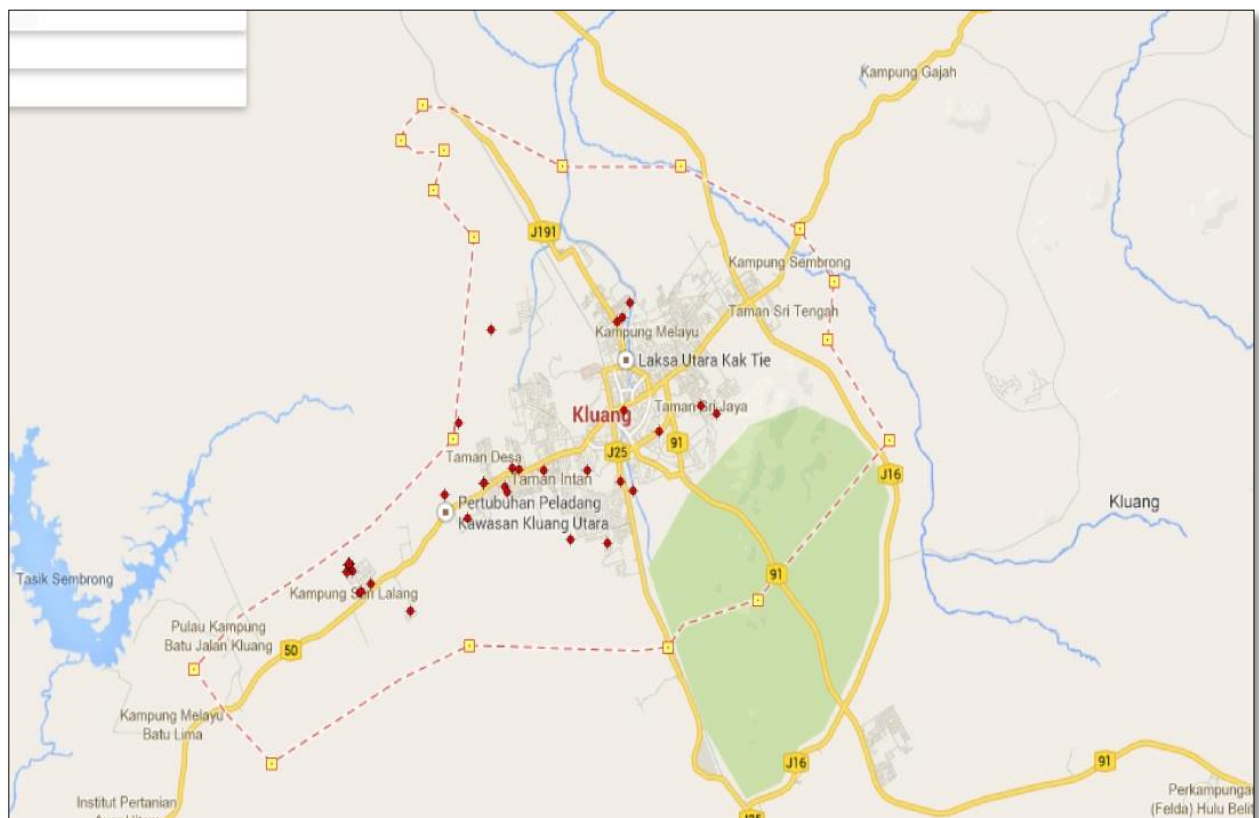


Figure 7. Database of Illegal Construction Waste.

From this database as Figure 7 indicates 64 point locations of construction waste illegally dumped in Kluang. The point of the location showed in red color. The most illegal dumping locations were found in Kampung Sri Lalang with a total of 15 points followed by 9 points in Taman Desa and 7 points in Taman Saujana respectively. This is maybe because Kampung Sri Lalang is among the biggest and the oldest housing area in Kluang [27] and many renovation of houses was in progress. The least point is 1 at Kampung Betong, Taman Delima, Taman Intan, Mengkibol, Kampung MIC, Kampung Bharu Yap Tau Sah and Taman Sunrise. Almost all areas that have 1-point location of illegal dumping are new house areas.

5. Conclusions

This study has described the importance of database in handling illegal dumping of construction waste. It shows how relevant data was acquired and gathered to develop the database which includes information concerning the mapping, type of material, photos and quantification of illegal dumping of construction waste. The developed system will be able to assist local authority in monitoring illegal dumping especially in Kluang district.

6. Acknowledgements

This project is funded by Ministry of Higher Education under Fundamental Research Grant Scheme (FRGS). The authors are thankful to Universiti Tun Hussein Onn Malaysia and Ministry of Higher for financial support and providing necessary infrastructure to carry out research work.

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