Waste management as an effort to improve urban area cleanliness and community income (journal review)

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Abstract. The problem of urban waste has reached a point of concern. Population and economic growth are thought to be the cause of increasing the waste generation. The major problem related to this condition is the increasing of waste production which is not balance with the increase of its management capacity. Based on the Law Number 18 of 2008 that waste management starts from the source by applying the 3R approach (Reduction, Reuse, Recycle). This regulation provides a way which expect the waste management can be better, so that, the level of waste service can be improved and load on landfills (TPA) can be reduced.The cost of garbage collection and transport are 85% of the total waste management cost, so if this is optimized, it will optimize the system as a whole. Subsequent research focuses on how to optimize the garbage collection and transport sub-systems by finding the shortest route of transportation to the landfill by developing a Vehicle Routing Problem (VRP) model. The development of an urban area leads to the preparation of the best route is no longer an optimal solution. The complexity of the waste problem is not only related to the technical matters, but also the social and economic problems of the community. So, it is necessary to develop a model of waste management which does not only pay attention to the technical aspects, but also the social and economic. Waste is expected to be no longer a burden, but can also be utilized economically to increase community income.

1. Introduction

Waste is the remaining from human activities. The continuity increasing of population growth factor and accompanied by the consumptive lifestyle are thought to be the causes of the high volume of the waste. The consumptive culture of today's society has a huge part in increasing the types and qualities of the waste [1].

The problem in the management of urban waste occurs due to the imbalance between the production and the capability to manage it; the waste volume continues to increase in line with the population growth, changes in the quality of life and the dynamics of community activities. Waste problem relates to other development issues such as population, social, economic and land acquisition. These issues will have a profound impact on health, public order and security, and others. Therefore, the implementation of management of waste should be in an integrated way with other development issues [2].

In addition, the pattern of urban waste management, particularly in Indonesia, still adopts the system of collecting – transporting – disposing [3] or so called end of pipe system, in which some officers collect, transport and dispose the waste to the determined processing location. These activities will only add larger burden to the final landfill (TPA), while the capacity of the landfill has its limitation.

Moreover, TPA with open dumping system also produces various problems in environment and health. Decomposition of organic material can produce methane gas which can cause fires and explosions, and contribute to global warming. The chemical and biological processes in TPA can produce leachates which can contaminate the surface and ground water. Not yet to mention the process of waste burning which produces smoke and contributes to the air pollution [4].

According to [5] that it requires a pioneer to change the mindset of waste management from the end of pipe system, which dispose waste directly into the TPA, to the principle of 3R which stands for Reduce, Reuse, Recycle.

The enactment of Law Number 18 The year of 2008, as the basis of systematic and sustainable of waste management, expects the waste management system will no longer apply the end of pipe system, but the process of waste management starts from the source level by reducing and managing the waste in an integrated way prior to final disposing to the TPA. Also, there is expectation that waste is no longer a burden, but has economic value which can provide additional income for the community.

This paper focuses to examine the development of existing urban waste problem in Indonesia and take the proper approach to overcome the problem. Plus some literature from several relevant international journals. The literature studies conducted within last 15 years show several approaches by researchers to solve the urban waste problem.

The approach used is the operational waste technique and integrated municipal solid waste management.

2. Operational Waste Technique

The operational waste technique starts from the waste placement, collection, removal, transportation, processing and final processing [3].

According to [6], the cost of collecting and transporting of urban waste is 85% of the total system cost. So, if the sub system collection and transportation can be optimized, then indirectly the overall system is optimized.

Based on the Profile of Depok City Waste Management in [7], the quantity of waste transportation system can absorb financial resources higher than others. So that, the improvement of efficiency, effectiveness, and productivity related to waste transportation system is one of the main keys to reduce the total cost of the waste system.

The reduction of these costs will be obtained based on the determination of the shortest travel time (not only the shortest distance) from the waste transport vehicle on its way to Landfill (TPA). It means that the determination of the waste transportation route which will provide the shortest travel time will be the spearhead to execute this [7].

The approach used to prepare the best route is by using Geographic Information System (GIS) and model of Vehicle Routing Problem (VRP).

2.1. The Preparation of the Shortest Route with Geographic Information System (GIS) Approach

The preparation of the optimum transportation route uses the Geographic Information System (GIS) approach. Before the preparation of waste transportation route, firstly the model of domestic waste volume estimation is made, through a quick bird image interpretation process with the help of *ArcGIS* software [8]. While for the optimum route preparation is used Network Analysis method which is the extension of GIS. One of the advantages of GIS is the network analysis application which has been widely used in daily life. One type of network analysis is determining the route [9].

Consider that there are three variables to determine the optimum route in this network application such as: the length of the road, the width of the road, and the direction of the vehicle movement. Each variable has a level of resistance called impedance. The smaller the impedance value of a variable, the more optimal the results will be. The optimum route will be formed from the shortest part segment, the road width is more than 5 meter, and has the direction of movement toward the final disposal.

In the research by [10] using the GIS approach with the help of Route view Pro. Software in the

preparation of the route, not only paid attention to the shortest route in the waste collection and transportation, but also noted the number of turns whether to the right or left. In this research, turned to the right took more time from left, so that, the optimum route produced a smaller number of turns to the right.

While in the research by [8] the prepared spatial model could estimate the domestic waste volume. While for the transporting route was obtained 52 optimum routes from 52 temporary landfill (TPS) toward the final landfill (TPA). The route preparation by using *ArcGIS 9.3* software with Network Analysis extension facility.

2.2. The Vehicle Routing Problem (VRP) Model Approach
According to [11], waste management is part of supply chain and green logistic management. And according to [12] distribution issues involve several considerations. Including the vehicle routes, vehicle fleets, to the scheduling of vehicles. These problems then become the issues of *Vehicle Routing Problem* (VRP). VRP has several types of goals associated with minimizing distribution costs. The functions of the goals include minimization of the number of vehicles, the travel time, mileage, and other purposes by the characteristic of the issues.

According to [12] stated that the problem of VRP could be defined as the problem of finding the route with the minimum cost from a depot to a customer scattered with the number of different requests. The route is made in such a way that each customer is only visited by one vehicle. The entire routes start and end at the depo, and the number of request should not exceed the vehicle capacity in one–way route.

The purpose of preparing this VRP model in addition to obtain the most optimum route, also can be used to improve urban waste service. Because one of the problems of waste service is the ineffectiveness of transportation (waste collection and transportation) from settlement to landfill which is caused by the maximum function of the temporary landfill (TPS) regarding current location [11].

To design the optimum route model of waste transportation, it needs several stages, namely identification of decision variable, formulation of the objective function, and identification of constraints. The model can be used to find the solution of optimum objective function [13]. The mathematical model formed becomes the basis to construct waste transportation route algorithm [12].

Several types of research used VRP model, such as performed by [12] in Bandung, which developed Vehicle Routing Problem model by adding Intermediate Facility at the end of the route, that is the final landfill (TPA). This model is referred to as *Vehicle Routing Problem With Multi Trips and Intermediate Facility* (VRPWMTIF) and solved by using *sequential insertion* algorithm. In this research was obtained 28 tours for West Bandung, 41 tours for Central Bandung, and 68 tours for East Bandung.

So is the research was done by [14] which used ant colony algorithm to optimize the waste transportation route in Yogyakarta. It was obtained 12 routes optimum for waste transportation in Yogyakarta.

While [11] did not conduct the route preparation based on the existing temporary landfill (TPS) but compiled first the temporary landfill (TPS) then prepared the waste transportation route from the TPS toward TPA by using *Vehicle Routing Problem* (VRP) model. So that, it was obtained a better network of waste logistic.

These two approaches, both GIS and VRP model focus on the preparation of the waste vehicle route, to obtain the optimum route. The goal is to reduce travel time so that the number of release becomes more and reduce the transportation cost.

The study of operational waste technique includes both approaches.With the increasing of city development complexity, also, the unpredictable of the traffic jam, repairing the transportation route is not the optimum solution. Moreover, the capability of TPA is increasingly limited. So it is needed to find other solution which is more comprehensive and sustainable.

3. The Integrated Waste Management

With the issuance of Law Number 18 The year of 2008 concerning waste management, the government has already a legal umbrella to improve the waste management system which was initially used the pattern of the end of pipe to an integrated and sustainable management pattern. This system allows involving all elements to improve the role in solving the urban waste problem.

The integrated waste management is a comprehensive program to prevent the waste generation, recycling, composting and final disposal. An effective system of waste management considers how to prevent, recycle, and manage waste in the most effective way to keep community's health and environment. It involves the evaluation of local needs and condition, then selects management activities that best this condition [4].

In practice, health and safety have become the concern in the waste management. Waste should be managed to reduce the risk to human health. Today, communities want more, not only safe, but also the waste management should be sustainable. Sustainable development is the development which meets the current needs without sacrificing the ability of future generations to meet their own needs [15]. It identifies the synergies among economic development, social equity and environment, therefore, the sustainable waste management should meet three requirements :

1. Affordable economically
2. Accepted socially
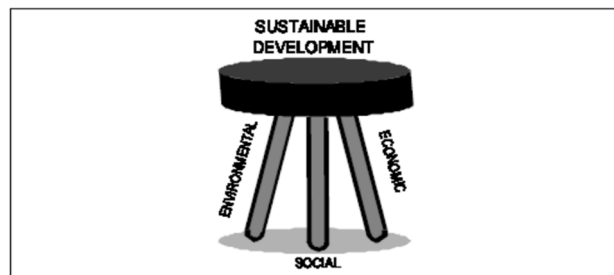3. Effective environmentally

Figure 1. Three pillars of sustainable development

It takes the same attention for each pillar because otherwise there will be an imbalance of the system as a whole.

According to [15], in the past the economic cost of the waste management system is the major controlling factor in the decision-making process, while environmental consideration plays a more role in the current decision-making process. The inclusion of social aspects in the decision-making process in the waste management system, though it is not a new concept, has been the topic of research on how to calculate social awareness that has just begun.

3.1. The Integrated Waste Management Approach

The identification of waste management as integral to sustainable urban development is increasingly recognized by the international aid and development community. The United Nations Conference on Environment and Development stressed that solid waste production should be minimized, reuse and recycling, maximized, environmentally sound waste disposal and treatment promoted and waste service coverage extended. [4].

For the waste management in Indonesia, according to [16] argued that community assessment on the regional government commitment in waste management is relatively less. The related offices in responding waste management always return to the technical problems such as budget, the lack of infrastructure, without speaking the human and cultural aspect. Therefore, the solution made by the regional government does not only prepare the master plan of drainage arrangement, but also the

human and cultural aspects which hold the important role to be noticed, without minimizing technical aspects.

With the issuance of Law Number 18 The year of 2008, the government is not the only party who should be responsible for the waste management. Communities as the source of waste generation should be involved actively. According to [4] in a prosperous country, the ultimate motivation for reducing waste related to high–cost problem and scarcity of area to be the landfill as well as the condition of the environment degradation caused by poisonous material in the collected waste. The same consideration applies to the metropolitan cities in developing countries surrounded by jurisdictions of other residents.

Also, the burden borne by the relevant agencies who responsible for urban waste is very heavy. So that waste management effort should start from household by gradually reducing waste and separating the waste they produce. This separation will support the program of 3 R (Reduction, Reuse, Recycle) as mandated by Law Number 18 The year of 2008.

3.2. The Integrated Waste Management and Local Wisdom
Integrated solid waste management (ISWM) is a comprehensive waste prevention, recycling, composting, and disposal program. An effective ISWM system considers how to prevent, recycle, and manage solid waste in ways that most effectively protect human health and the environment. ISWM involves evaluating local needs and conditions, and then selecting and combining the most appropriate waste management activities for those conditions [4].

In other words, local approaches are needed to make the waste management system work effectively. They are commonly referred to as local wisdom. As an example of the local wisdom of Minangkabau community in Padang. [17] has developed a model of social awareness participation in waste management in Padang City based on the local wisdom *"adat basandi syarak, syarak basandi kitabullah"*. In this research is argued that there are two causes of waste management problems in Padang City, first is the limited facilities and infrastructure and second is the low awareness of social behavior of society in waste management.

While in Purwokerto City, the government reactivated the local wisdom of *"kerigan"* patterns to increase the community participation to manage the household waste. Also, other policy strategies from the government to support the efforts of the realization of a green city that has been done, among others: the formation of green community, waste banks, pilot tree banks, set up some green open spaces [16].

3.3. Management of Household Waste and Increasing Community Income
With the development of cities, population and economy, the waste production also increase. This high waste production has advantages and disadvantages. The advantages of waste can still be utilized and have economic value. While the shortcomings are when not managed properly, waste can cause community health problems and environmental damage.

With the implementation of 3R program: Reduction, Reuse and Recycle, communities together with the government can utilize the waste they generate to be a source of income. There are at least 3 (three) things obtained from the utilization of waste and economic value. First, the making of compost fertilizer from organic waste and the producing of methane gas with anaerobic digestion method. Second, recycling anorganic waste such as plastic, metal, and others. The third, process of burning waste by using incinerator can be utilized to become electrical energy.

As has been done by Purwokerto Municipal Government by running Waste Bank program [16], this program encourages communities to separate self – contained waste in their homes by separating organic and inorganic waste. They sold the recycling waste to the waste bank, and recorded the sales proceeds in their respective savings books, while the organic waste was processed to be the compost.

4. Conclusion
Community waste production will continue to increase in line with the growth of population and urban

economy. Particularly the developing countries like Indonesia, waste management does not meet the expectations, so it can pose a risk to the community such as health problems and environmental damage.

The approach to solve waste problems still applies the old paradigm of focusing on the *end of pipe* or the haul and dump approach. It only provides a temporary solution that is transporting the waste from residential areas. Another problem arises, the capacity of the landfill has its limitation.

An integral approach in waste management is expected to be a long – term solution to solve waste problems. Although theoretically it has been described the integrated waste management steps, in practice, it is adapted to local needs and conditions and selected the most likely combination (feasible) to be applied under these circumstances.

Through an integrated approach also, waste is not the only burden for waste stakeholders, but can also have economic value which can increase community income.

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