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# Waste Management in Pekanbaru City, Riau Province, Indonesia Using Normative System Modeling

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**Abstract:** Waste is a waste product that is produced from various kinds of human activities which if not managed properly will result in pollution of the physical, biological and ecological environment. In an effort to realize a clean city management system, then developed a normative model of the municipal waste management system, trying to incorporate all significant factors that could affect the management system and management system itself. Based on this normative model approach, so from the standpoint of the modeling concept analysis management system, has been explored several sub-steps can be effective in the treatment of municipal waste in Pekanbaru city, Riau province, Indonesia, namely (1) Waste Lug, (2) Waste Collection, (3) Waste Transfer, (4) Waste Transportation and (5) Final Disposal. Through these steps, the hope of making the clean and beautiful city of Pekanbaru can be realized optimally, of course with the support of the Pekanbaru city government, as well as the participation of the local community independently in an effort to achieve a clean and sustainable city.

**Keywords:** Sustainability, Naturally, Modeling of Management Systems, Urban Planning, Cognitive Models, Pekanbaru City Waste

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## 1. Introduction

As a waste product that is produced from various activities, if the waste is not managed properly, it will cause pollution and environmental damage both physically, biologically, and ecological [1]. Garbage can be derived from domestic activities [8], trafficking [9], agriculture [10], as well as the production process of an activity of industry [11]. Each waste produced has different characteristics depending on the origin of the waste produced. This waste consists of the results of household activities, the results of trading activities, the results of activities of public facilities, educational facilities, offices and others etc. [12].

The position of the city of Pekanbaru as a city of Metropolis was demanding the provision of various facilities and accommodations. This is one of them can be the causes of urbanization are quite heavy to city this [13]. The mobility of the population is getting tighter and its influence is luring the flow of people and goods from outside the city as a result of the terrain being overwhelmed by the development of the city of Pekanbaru. This progress is indeed beneficial from the economic aspect, but from the aspect of cleanliness will

cause problems that are quite complex [14]. With more growth and development of street traders in various places in the corner of the city of Pekanbaru, this can be an indicator of the presence of the disorder progresses Pekanbaru city seen from the aspect of cleanliness and beauty of the city Pekanbaru.

With a willingness to create City Pekanbaru clean and free from garbage city, then in this study try to present solutions goal achievement waste management system in the city of Pekanbaru by reviewing all variables into a constituent of the management system and other related aspects, through modeling approaches Normative. This model is actually a model that describes how interrelations should occur between input variables and output variables. As a qualitative model that develops concepts in general and emphasizes cognitive aspects, the model that will be produced is a conceptual model of a macro that is not a model that contains details.

The Research aims to determine the most important variables that can affect the process of waste management in the city of Pekanbaru, Riau, Indonesia. Then the existing waste management system is still not optimal and it is necessary to propose a future development plan by means of

integrated waste management. This study is considered important and useful because it can provide input to the municipality of Pekanbaru to further improve and advance the waste management system, which would have included community participation is very important that cannot be ignored, which is part of a program processing of municipal solid waste that is comprehensive, so that it can provide various benefits, such as: (1) Able to stimulate the emergence of community self-help which will be very meaningful in supporting a municipal solid waste treatment program, (2) Able to improve motivation and community skills, and (3) Does not create dependence on the government. Analyze system analyst for the transport and processing of urban waste, more to the subjective data to produce a normative model so that it can provide an alternative solution to the relevant agencies.

## 2. Methodology

Some stages of the methodology used in this research include: Introduction stage, include disclosure of the background of the problem and goal setting system that is creating Pekanbaru city clean and healthy, free from municipal waste [16]. Data collection and processing stage, where this stage is carried out after the theoretical basis according to literature studies that can support the achievement of the objectives of the management system [17]. Through the Normative model, a conceptual model is produced which describes the interrelationships between management system variables and is able to synergize the related variables which will ultimately be able to support the achievement of the objectives of the management system in general [18]. Stage analysis result is the normative model design phase in achieving the goals that have been set based on the elaboration of a variable - a variable system that has been described in the previous stage [19]. The result, which is the final stage of the research activity in summarizing the conclusions of the objectives of the management system and giving advice to those who have authority in making changes to the existing management system [20].

### *Steps for Developing a System Model*

The introduction of a system, which can then be developed in a model, requires several stages of developing a model that describes the initial conditions of the system so that the repair solutions can be obtained optimally [21]. The steps to develop the model include:

1. Determine the symptoms of the system.
2. The process of identifying system problems.
3. System approach.
4. Determine the formulation of system problems.
5. The purpose of the system problem.
6. Making a conceptual model.
7. Model formulation.
8. Model analysis
9. Model implementation.

### System Concept

The presentation of the components that make up the

management system in municipal waste management makes a solid definition. The conception of this system is the beginning of a management system study which will then be designed and evaluated [3]. The concept of this system basically tries to answer:

1. What are the elements of the system?
2. What is the purpose of the system?
3. What is done to achieve that goal?
4. What is processed in the system?
5. What is produced (output)
6. What is the measure of the success of the process?

## 3. Results and Discussion

### *3.1. Symptoms and Identification of System Problems*

At the beginning of human life, garbage has not become a problem, but with the development of the population and limited urban space, the more per day the problem of waste becomes bigger and more serious. The city of Pekanbaru metropolis also experienced a process of modernization and technological development, wherein each period of time there has been a significant increase in human activity [15]. The problem of municipal waste may not be a negative influence on the environment if they can be managed properly and safely. However with a high level of urbanization in the city of Pekanbaru and urban mobility, the consequences are often found a pile of garbage in a place that is not guaranteed the level of environmental security, so this is what turns out to be the trigger for the negative impact on the environmental health aspect itself. Basically, these impacts occurring will be very annoying and can lead to complaints and health problems for the people of big cities such as Pekanbaru, such as the:

- a Environmental degradation that may interfere with or cause complaints and as an issue serious public health of the city, such as (a.1). The number of vector diseases such as flies, cockroaches, mosquitoes and others, (a.2). Air Pollution, soil and water, and (a.3). The lack of aesthetic values.
- b The emergence of various types of infectious diseases, such as diarrhea, skin diseases, intestinal worms, dengue fever, scrub typhus, and others. Based on the symptoms of the above system problems, the system improvement process is carried out by looking at the interrelationships between the existing variables and summarizing the entire solution variables that exist if to minimize the system symptoms.

### *3.2. System Approach*

#### *3.2.1. Characteristics of Waste*

The characteristics of waste are waste characteristics which include physical properties, chemical properties and biological properties of waste. Understanding these characteristics is very important in developing an integrated city waste planning and management.

- (i) Trash properties

### Specific Weight of Waste

Specific weight of waste is defined as weight per unit volume (kg / m), because ordinary waste is obtained from trucks, carts, in condensed or not compacted conditions, so in specific weight measurements waste must be mentioned where and under conditions how waste is taken as sampling to calculate the specific weight of waste. Specific weight of waste is influenced by geographical location, location, the season of each year, and length of storage. This is important to know the volume of waste that is processed.

#### (ii) Moisture

Waste moisture can be expressed in two ways, by measuring wet methods and dry methods. In the wet weight method it is expressed in the wet weight percent of the material, and in dry weight, it is stated as a percent of wet-dry weight. This humidity is influenced by the composition of waste, the season each year, weather conditions, especially in the rainy season.

#### (iii) Waste permeability

The hydraulic conductivity of waste is very important to know the movement of liquids and gases in the landfill.

#### (iv) Field Capacity

Field capacity is the amount of water that can be held in waste and can get out of waste due to gravity. This field is very important to know the leachate formation in the landfill because the wastewater is changed to leachate. This Field Capacity varies due to differences in pressure and decomposition of waste.

### 3.2.2. Chemical Properties of Waste

Information about the chemical properties of this waste is useful in determining alternative recycle options for waste management, including:

1. Proximate Analysis. The proximate analysis aims to find out which materials are flammable and non-flammable. Usually tested for combustible components, this test is done to determine the amount of combustible volatiles and fixed carbon.
2. Fusing Point of Ash. Fusing point of Ash is the temperature at which ash and waste combustion are produced, which will be in the form of solids by melting or by clumping. The temperature ranges from 1100 to 1200 °C.
3. Energy Content. Energy content and organic components of waste can be determined by Full-scale boiler and Bomb Laboratory. Calorimeter.

### 3.2.3. Biological Properties of Waste

The biological properties of waste are usually related to organic materials in waste, for example:

#### A. Biodegradability

It is the ability to decompose trash, solid volatile content in the waste can be determined by combustion at 550 °C. The average decomposition rate of this component is different, because the components in the waste according to its decomposition ability can be differentiated into materials that can decompose quickly and decompose slowly.

#### B. Odor

Odor can be generated from old waste storage at a place, for example at a collection point, at a transfer station or landfill. This odor arises in hot climatic conditions, and decomposition takes place anaerobically.

### 3.3. Normative System Modeling

#### 3.3.1. Waste Management System

In the implementation of waste management in the city of Pekanbaru, the first step needed is the existence of a clearer working concept and strengthening the work pattern so that the range of goals to be achieved can be formulated more realistic but still efficient and effective. Pekanbaru city waste management system can consist of smaller subsystems, namely: (3.3.1.1). Sub Organization, (3.3.1.2). Operational Sub Engineering, (3.3.1.3). Sub Financing, (3.3.1.4). Community Participation Sub and (3.3.1.5). Organizational Settings Sub.



Figure 1. General system of waste management.

#### 3.3.2. Sub. Management and Organization

Legislative Aspects.

Invitation. This waste handling is a Household affair of the Level II Region or the Municipality, all matters that become autonomy of the Level II Regional Government, are entitled to have the right, authority and obligation to regulate it in the form of regional regulations or decisions to the Regional Aspects of Work Management.

Aspects of Work Management.

In handling waste, the hygiene section has an organizing principle which involves the following functions (a). Carry out the market waste collection and road waste, transport from TPS to TPA, and waste disposal, (b). Building waste facilities and infrastructure, and (c). Organizing public education about environmental cleanliness

Financing Aspects

The source of routine financing is from the Regional Budget (APBD) of Pekanbaru City, Riau.

**3.3.3. Sub. Operational Engineering**

There is a system of inventory which includes (a). Trash cans are placed in each parcel and are provided by the residents themselves. The materials used are varied, some use baskets, used buckets, plastic bags, sacks, and others, (b). "Depo" transfer, provided by the Regional Government, (c). Temporary Disposal Sites, provided by Local Governments, and (d) Temporary Shelter, transfer depots in the form of container bases. Garbage containers are often found in the area around the market or in residential areas that function as temporary containers.

**3.3.4. Sub. Community Participation**

Community participation is indispensable in the waste management process, business efforts that can be carried out by local governments to attract community participation include:

- a Providing counseling to the public about the importance of hygiene for humans and the community's responsibility for environmental hygiene through a) meeting between the cleaning section with the village head/village head at the sub-district level, b) direct evaluation to the community, and c) dissemination slogans about cleanliness and dissemination of posters/pamphlets on cleanliness.
- b The participation of the community in the waste management process includes: a) maintaining the cleanliness of the environment around its place of residence and existing public facilities by not disposing of garbage in any place, b) throwing away the garbage that has been collected in the garbage collection site (TPS) or Depot transfers that have been provided, and c) pay waste fees.

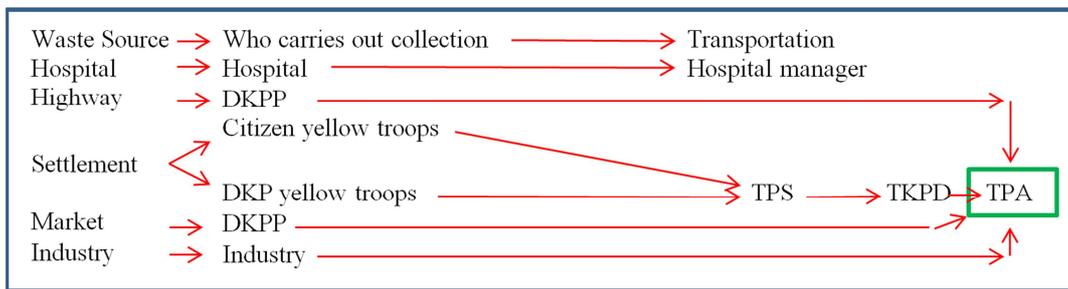


Figure 2. Conceptual model for transporting municipal waste from waste sources to landfill.

**3.4. Waste Processing Process**

**3.4.1. Source - Source of Trash**

These sources of waste are related to the use of built-in areas and the determination of zones. In general, sources of waste:

- (a) Settlements or Households, the waste from this household usually comes from activities such as cooking, called domestic waste,
- (b) Commercial areas, including waste originating from trading activities, such as shops, restaurants, markets, hotels, other service centers,
- (c) Institutions, excuses come from schools, hospitals, office centers, and others,
- (d) Construction and Destruction, waste from building construction activities, road repairs, building ruins,
- (e) City Activities, starting from sweeping roads, parks, and beaches, recreation areas, local cleaning, landscaping,
- (f) Processing facilities, waste comes from clean water treatment activities, wastewater, and processing processes in the industry,
- (g) Industry, waste comes from construction, heavy and light industrial processes, chemical processes, electric power, textile disposal processes, demolition, and

- refining processes,
- (h) Agriculture, based on rice fields, fields, livestock and others

**3.4.2. Waste Generation**

The amount of waste is very dependent on waste generation, and this is very important to know the amount of equipment needed to plan the collection route, recovery facilities and disposal facilities (TPA). The method used to determine the amount of waste generation is the measurement of weight and volume. If you use volume as a method of determination, you must pay attention to the degree of density of the waste, or the specific weight of waste in storage. Weight is also an important measure in determining transport from waste because the amount that can be loaded and transport is usually limited by weight. Weight can also measure the amount of waste generation directly.

**3.4.3. Waste Trash**

Waste storage is part of the management of municipal waste in the source location, garbage both in the household, shop, market, and others. The types of the trash can as a whole can be seen in the following table.

Table 1. Alternative diversity of trash bins.

Type of Trash	Use	Nature / limitations
Paper bags	Shops, housing, and others	More expensive, can be torn by other animals so that scattered, increase the volume

Type of Trash	Use	Nature / limitations
Plastic bags	Housing, commercial, and others - ,	garbage, does not match wet waste. More expensive, can be torn so that the contents are scattered causing problems in the landfill because the plastic is difficult to degrade, increasing the volume of waste collected.
Plastic container	Housing , shops, restaurants, commercial, office and others	Relatively durable, suitable for all types of garbage, getting heavier after being filled with garbage
Metal Container	Housing, shops, restaurants, commercial, office, roadside, etc.	Relatively durable, noisy, heavier after being filled with garbage, after a certain period of damage due to rusting
Open Container for Bata Couple	Solid, commercial and other residential areas	Construction costs are expensive, durable, difficult / eating when taking garbage by the janitor
Container	Source of large volumes of waste, for example markets, commercial, residential complexes as polling stations	After a certain period of time will be damaged, the excess

**3.4.4. Garbage Collection**

Garbage collection is the activity of collecting municipal waste in the source of waste and bringing garbage to the TPS that has been provided. Generally, the transportation equipment used in garbage collection that has been carried out is a garbage cart. Based on the implementation, the activities are divided into two (2) types, namely:

**A. By Door to Door (Individual)**

The collection is carried out by janitors by going to each household. As a collection tool can be divided (a) g waste trash with a volume ranging from 0.5 to 1.0 m and then collected in a temporary shelter or depot transfer before the trash is transported to the landfill, and (b) truck, dump trucks, truck compactor, which is then directly taken/transported to landfills. The areas served in this way are generally residential neighborhoods that have been organized, shopping areas, institutional buildings, public places, roads, and parks.

**B. By Communal Way**

Garbage collection is carried out individually by each household to the place provided. These places can be (a) Communal container, with a volume of 6 - 8 m, (b) Communal cart, then the janitor is collected in a temporary shelter before being transported to the final disposal site, and (c) compactor a communal truck, then immediately taken to the final disposal site.

**3.4.5. Transfer Process**

The transfer system used is the depot transfer and container facilities are located in residential areas, markets, offices and “depot” transfer areas and these containers as a collection point for a collection that is transported from the settlement or from the market.

**3.4.6. Transportation Process**

The waste in the TPS is removed using two methods (a) TPS that use containers are transported by transporting containers. Containers are transported hydrolytically (mechanically), then vehicles according to TPA, and (b) s at the polling station in the form of a depot are transported using a dump truck. The loading of garbage from the depot to the truck is done manually (human power) and then the vehicle goes to the landfill.

**3.4.7. TPA (Final Disposal Place)**

Garbage after the collection and collection process needs to be lifted to the place where the processing/disposal is immediately disposed of to a safe landfill and does not disturb the environment. At the Pekanbaru Landfill, the waste disposal system uses a controlled Landfill system. The waste that enters the landfill is leveled and compacted by using a bulldozer every 2-3 days while the land cover is done every 3 months.

**3.4.8. Waste Utilization**

The purpose of processing waste is to reuse objects that have economic value that is discarded or wasted and to utilize fertilizer. In general, the city waste management system model can be arranged sequentially as shown in Figure 3.

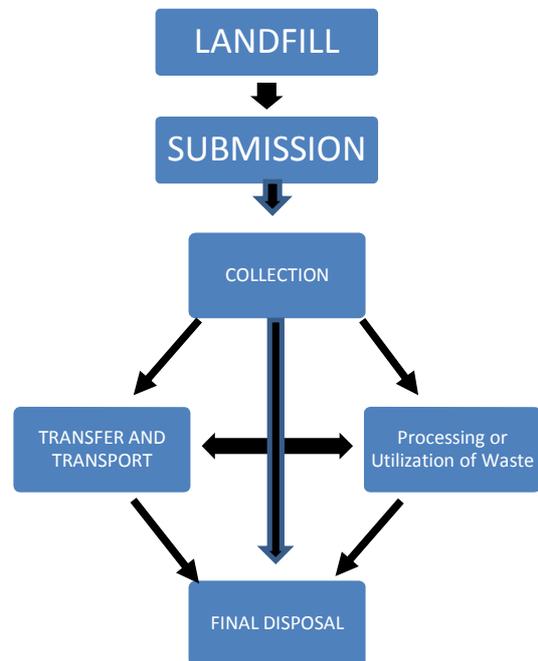


Figure 3. Conceptual model of integrated waste management system.

Based on the conceptual model of handling municipal solid waste that has been described, then through integrated waste management and consistent policy implementation, the hope of Pekanbaru city is clean and beautiful can certainly be

achieved. By doing proper coordination between sub-compilers of the urban waste system and also the waste management process based on the concept of integrated waste management, it is very helpful for local governments in realizing clean urban areas.

#### 4. Conclusion

1. The waste processing system consists of sub-systems that are interrelated with one another, integrated with each other to form a unit for handling municipal solid waste, the sub-system includes (1) Sub-Organizations, (2) Operational Sub-Engineering, (3) Sub-Financing, (4) Community Participation Sub-roles and (5) Sub-Arrangements.
2. The Waste Processing Process can be described as several main management steps, namely as follows: (1) Waste Garbage, (2) Garbage Collection, (3) Garbage Displacement, (4) Garbage Transport and (5) Final Disposal.
3. The cause of non-optimal service from the city sanitation and gardening service is work management that is not well coordinated between relevant agencies in urban waste management, and the limited authority of the agency.

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