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The Shape Application and the Arrangement of Waste Containers in Banjarmasin City

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Abstract:- Banjarmasin has a strategic position that makes it grow fast. The development of its population density also supports the city's fast growth. However, the effect of the population density in Banjarmasin takes its toll on the waste problems in the city. As we understand, the more people reside in an area, the more waste they will produce.

The main focus of this research is the waste containers at Temporary Shelter (TPS) on the sidewalk. It has become a problem that the TPS are seen and harm the surrounding, especially during the waste collection and transport process, which often cause traffic jams.

This research aims to change the stigma of waste containers in Banjarmasin from "needed but undesirable" into "needed and desirable to the community and environment." To realize that, we need to optimize the shape of the containers and arrange the collection and transport system.

The shape application and the arrangement are analyzed; therefore, the design must consider the insufficiency of space/area, the flow and the jam, the function and aesthetic, the environment, the amount of waste, disposal patterns by the community, as well as the application of innovations/technology. The design approach is used as a reference to design alternatives that will be applied.

Based on the design approach to the insufficiency of space for the waste containers and their collection and transport system, the layout and plan are designed using a vertical system. The waste containers are designed with block and tackle systems. The containers can be lifted and aligned with the box of the waste disposal trucks, and the waste collectors can easily collect and transport the waste from the containers to the box.

Besides the application of the collection and transport system, the waste container shapes also influence the area's beauty. The supporting elements of the waste container design in this research are rolling door system, panel wall ornaments, decorative plants, channels and control tanks with for leachate management. These waste containers are designed as a prototype of containers in areas with insufficient space and on the main streets.

From the design plan, it is estimated that the cost of one waste container is higher compared to the conventional design. However, the new design and system can reduce the number of employees and the time of the transport process. Furthermore, this new design and system can also solve the problem of insufficient space for collecting and transporting waste. The newly designed containers are also more desirable to the community and environment than the conventional ones.

Keywords:- *waste, waste containers, waste collection, and transport..*

I. INTRODUCTION

Banjarmasin is increasingly experiencing rapid population growth, coupled with the flow of urbanization in line with the function of the City of Banjarmasin as a National Activity Center (RTRW of Banjarmasin City, 2011-2031) [1]. Based on data from the Central Statistics Agency (BPS) of Banjarmasin City in 2015, Banjarmasin has a population of 675,440 people with a density of 6,766 people per square km [2].

The city of Banjarmasin is dominated by the distribution of the population in the medium to high category. The impact of population density will then be directly proportional to the local waste problem. This is because the more people in an area, the more waste (garbage) is produced. This refers to the notion of waste, which is the solid form of the rest of daily human activities and/or derived from natural processes (Law Number 18 of 2008 concerning Waste Management) [3].

Waste management problems that are often encountered in big cities with densely populated areas include the high rate of waste generation [4], widespread human behavior/concern, as well as issues with waste disposal activities, both at the TPS (Temporary Shelter) and TPA (Final Processing Site) which always causes its problems.

The problem that often occurs is that an area's facilities, infrastructure, and overall management system are still considered not to meet the quantity and feasibility of fulfilling the existing waste. As happened in Banjarmasin City, the main problem faced is the amount of waste production per day.

The amount of waste generation per day until 2015 for the City of Banjarmasin is 745,303 m^3 ± 2,042 m^3[5]. The amount of waste transported per day, which is 511,054 m^3 ± 1,400 m^3, only reaches 69% of the transported waste, with an average of 1,200-1,560 m^3 of waste transported per day to the TPA. The household waste generation in Banjarmasin City is 0.26 kg/o/h and 2.08 l/o/h. The composition of the waste is dominated by organic waste (55.89%) then, cloth/textile waste (14.93%), and plastic (12.77%) [6]. In simple terms,

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the current amount of waste transported is around 500 tons per day from the actual waste production of about 700 tons per day (based on the calculation of the number of residents with waste production per capita per day).

Unfortunately, from the amount of existing waste generation, the facilities and infrastructure that support waste management operations in Banjarmasin City are still lacking, considering that only 69% of the waste is handled daily.

One of the waste problems in Banjarmasin City that is often in the spotlight is the existence and capacity of existing waste containers at TPS, including the handling of waste transportation at TPS, especially TPS, which is on the sidewalk of the main road in Banjarmasin City. This can be seen in Figure 1 and Figure 2 regarding the conditions of several TPS in Banjarmasin City (Figure 1) and an example of conditions during disposal and transportation at one TPS, namely TPS Kuripan (Figure 2).

Fig. 1: Some TPS conditions in Banjarmasin

Fig. 2: An example of conditions during disposal and transportation at TPS Kuripan

The problem of incompatibility of waste capacity with the fulfillment of existing facilities is not only solved by adding facilities such as TPS and TPST (Integrated Waste Management Site), but it is necessary to consider and impact various other aspects of the addition of these facilities (technical, operational, economic, socio-cultural, aesthetic, environmental health aspects and society). The existence of TPS is necessary and, at the same time, considered to have a negative impact on the community/the surrounding environment (required but not desirable).

The existence of TPS with TPA/TPST differs in their impact on these aspects because the average TPS placement is in strategic locations and dramatically affects the surrounding environment. The fulfillment of daily waste capacity at the TPS can be reduced by the feasibility and capability of the TPA/TPST, which is considered to be able to fulfill the garbage collection for the entire community of Banjarmasin City. A study of the design and management of TPS located on the sidewalk of the road is also essential. It can be expected to impact waste management in Banjarmasin City as a whole positively.

The problem of storing and adding waste is not only solved by adding TPS facilities but also supported by socialization related to changing people's mindsets to be able to reduce their respective waste by implementing 3R (Reuse, Reduce, Recycle), reducing waste sources in collaboration with Garbage Bank available in Banjarmasin City. However, regarding the existing TPS facilities, especially in strategic areas that have limited land and cause traffic jams in the vicinity, special attention and handling should still be given.

Special handling of TPS (TPS engineering as part of the management and waste management system of Banjarmasin City) is expected to increase the value and change the stigma of TPS so far, namely from "necessary, but not desirable" to "necessary and its existence is still acceptable" by the environment and the surrounding community. In addition, it is expected to be an added value to the Adipura assessment criteria in the category of regional waste management.

II. METHOD

A. Primary Data Colletion

The primary data in this study consisted of data obtained from interviews with informants and field observations. Interviews were conducted on the main issues such as how the informants' opinion on the system and process of waste management and the function and existence of TPS so far, what problems and constraints have occurred, the policies have been taken, and what inputs or suggestions from the informants on improving urban solid waste services. While the observations relate to conditions that describe the process of planning a waste management system, especially the management of TPS in Banjarmasin City. The results of field observations are documented to support obtaining the latest existing conditions for urban waste management in Banjarmasin City.

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B. Secondary Data Collection

Secondary data in this study includes data on waste management in the City of Banjarmasin, which are technical and non-technical in the form of documents or written reports. Technical data consists of the physical condition of the area (geography, topography, study area), regional maps, regional development plan data, spatial planning data, urban waste management planning data (including the number of infrastructure facilities and waste generation data), strategic environmental studies and other data that can support the completeness of the data in this study.

For the institutional aspect, data were obtained on the legal basis, main tasks and functions of each Regional Organizational Unit, regional regulations and policies related to urban solid waste management, as well as human resource data by the Banjarmasin City Government in the waste management [7]. In addition, data on financing for urban solid waste management as well as operational and maintenance costs were also obtained. At the same time, the social aspect includes data on the social, cultural, and economic conditions of the people of Banjarmasin City.

C. Data Analysis

The data collected, both primary and secondary, are then analyzed and discussed so that they can answer the problems faced in determining the design of the TPS and its management system. The approach used in decision-making is a planned approach, combining a scientific method with creativity, intuition, and managerial experience. There are six standard steps in this planned approach: observation, problem formulation, alternative problem solving (design approach) and determination of the best alternative (design results), implementation and control scenarios.

Observational data were analyzed to obtain the existing condition of TPS. This data is used as an approach to designing the form and arrangement of the new TPS. Observation data is also used to classify potential problems based on the existing conditions of several polling stations in Banjarmasin City. Furthermore, an analysis of alternative problem solving and design analysis is carried out. The resulting design is evaluated whether the results of the design can later be implemented/applied.

III. RESULTS AND DISCUSSION

A. Existing condition of TPS Banjarmasin City

Observations were made at 100 TPS out of 147 TPS units in Banjarmasin City [8]. The polling stations observed were located on the edges of roads, markets, offices, and settlements. Then the observation units are grouped by sub-district, which is on the edge of the protocol road, TPS group based on the conditions of each sub-district, and TPS group, which has a significant and relatively large impact on the circulation of motorized vehicles and the surrounding environment. So that not all TPS data from observations are presented in this analysis. Due to the recurring problems between TPS, each group is assumed to represent the TPS similar conditions.

The results of the analysis show that there are 10 (ten) TPS in the Districts of West Banjarmasin, East Banjarmasin, and Central Banjarmasin, as many as 8 (eight) TPS in South Banjarmasin District, and as many as 6 (six) TPS in North Banjarmasin District TPS which have problems with the surrounding conditions.

Based on the observation data, the potential problems were grouped based on the existing conditions of several polling stations in Banjarmasin City. Waste containers at TPS on the sidewalk cause a sustainable effect (domino effect) because of the limited area. The impact includes the generation of waste that exceeds the container, even a lot of garbage outside the existing TPS bins (due to damaged TPS tanks, not big enough, and complicated access to disposal). These problems will increase while transporting garbage, and the trucks parking along the roadside cause traffic jams.

The problem is dominated by TPS on the side of the road, so the design for this TPS considers alternatives to solving these problems. The design of the TPS is carried out by considering: space requirements, circulation and road jams, function and aesthetics, the potential for environmental pollution, the amount of waste generated, the pattern of people disposing of waste, and TPS' shape innovation.

B. Design Analysis

Limited area and transportation operations affect the determination of the layout of the TPS. The area allowed is only limited to the width of the road shoulder. TPS plan with a box size of 2.5 m x 1.5 m. It is assumed that there is still space left (± 1 m) for the cleaning staff to remain in the garbage truck in the process of transporting it so that the problem of road congestion that arises during the transportation process will be resolved (Figure 3).

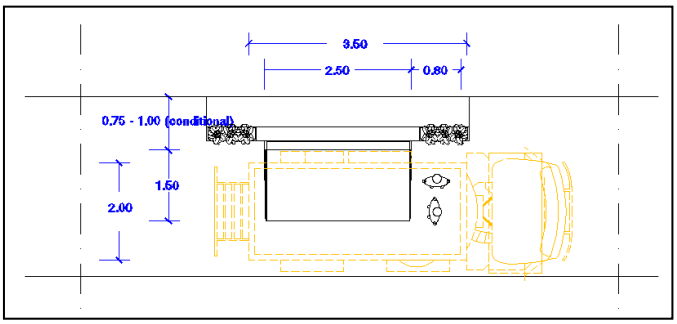

Fig. 3: The layout of the TPS during the transportation process

In the aspect of innovation and technology, it is chosen to adjust the layout that has been made (Figure 4). TPS innovation is a vertical TPS that applies a mechanical system. The pulley system was chosen for solving the mechanical system in the TPS design. The pulley system is simpler than the hydraulic system, which requires a pump engine. The hydraulic system requires electricity and costs more than the pulley system. This is the basis for balancing the system selection.

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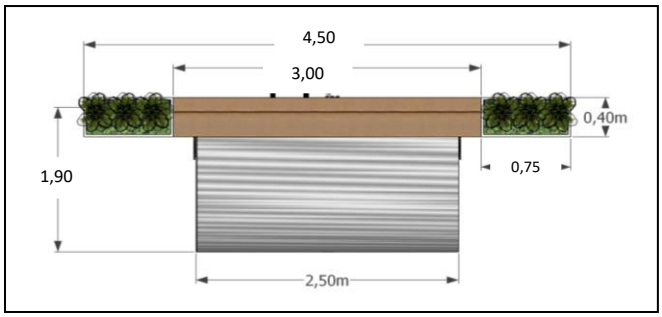

Fig. 4: TPS Layout

The pulley system in this TPS design is also known as the block tackle system (Figure 5). Block and tackle is a system of 2 (two) or more pulleys with ropes or threaded cables between them, usually used to lift or pull loads [9]. The pulley system uses a chain to lift the TPS box.

In addition to the main lifting system in the form of a pulley (chain) system, a stiffener system is needed in the mechanism so that when the box is lifted (a load of waste generation in it, assuming the TPS tank accommodates a maximum of 2 tons of garbage) it does not shake or move, namely using a unidirectional toothed wheel mechanism or Rachet and Pawl Systems [10]. It is also intended to reduce the load when pulling the pulley chain by humans (janitors).

With the TPS box concept using a lifting system, it is necessary to consider the primary material of the concrete box, which is assumed to be lighter than conventional masonry, which is usually the primary material in the existing TPS. In this case, the primary material for the TPS tank in this study is Plate SUS316/316L 5 mm thick. This stainless steel is very popular for use in highly corrosive environments [11]. So it is expected that with the use of this type of plate, in addition to lightweight materials that can withstand the burden of waste generation per unit TPS, which is planned for a maximum of 2-3 tons, but also resistant to weather changes and corrosion due to liquid waste/leachate.

The supporting elements in the TPS design plan are mainly supportive from an aesthetic point of view so that the TPS can be in better shape, in contrast to the consideration of layout/planning plans and the technological system used is more supportive of the arrangement angle. Supporting elements in the TPS design include the cover, panel walls, plants, and leachate drains.

In the design plan for the cover system at TPS, there are 2 (two) alternatives to be considered, namely the fan system and the Rolling Door system. In the fan system, there are weaknesses in terms of being unable to completely closed, as well as the fan structure which has a level of complexity in its implementation. It is related to the connection with the chain pulley system to lift the TPS box.

As for the rolling door system (Figure 5) for the TPS cover, the TPS can be fully closed and make it easier to connect with the pulley system (ratchet and pawl mechanisms can be attached to the side of the box), and the TPS box can be kept neat. The box will be opened based on the time stipulated in the Banjarmasin City Regulation Number 21 of 2016 concerning Waste Management/Cleanliness and Landscaping, which is from 08.01 pm to 05.59 am. Meanwhile, the bin will be closed after the garbage is transferred to the garbage fleet truck. The cleaning staff carries out this open and closed system.

The use of a panel wall to strengthen the formation of the TPS as a whole, as well as as a system camouflage and a supporting wall for the TPS system. TPS steel frame covered with types of wall decorative elements suitable for exterior use.

Another supporting element is the use of odor-reducing plants and aesthetic supports as well as air pollution absorbers, including the use of Chinese dwarf bamboo (*Bambusa multiplex*) trees. Bamboo multiplex can reduce odors and provide a vertical aesthetic. Bungur (*Lagerstroemia speciosa*) and Mahogany (*Swettiana mahagoni*) plants can be used as green plants to absorb pollution, reduce noise and filter vehicle fumes, absorb radiation, and remove odors. The selection of plant species as supporting elements of TPS is based on a limited area. Therefore, the Chinese bamboo plant was chosen, equipped with ornamental vines underneath, such as Ivy arum (*Epipremnum aureum*).

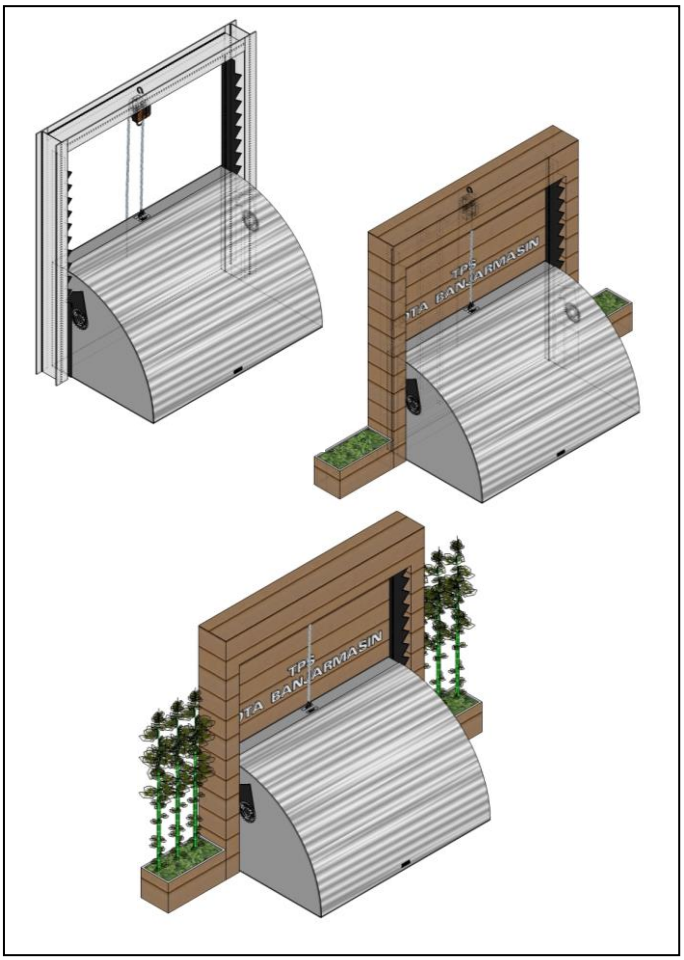

Fig. 5: TPS with block and tackle system and rolling door

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The channels and control tanks are used as a supporting element to treat leachate as leachate management in the TPS area so that the seepage water does not pollute the soil surface or surrounding rivers. Figure 6 and Figure 7 show the scenario and perspective of the waste collection and transport system with a new design waste container at TPS on the sidewalk.

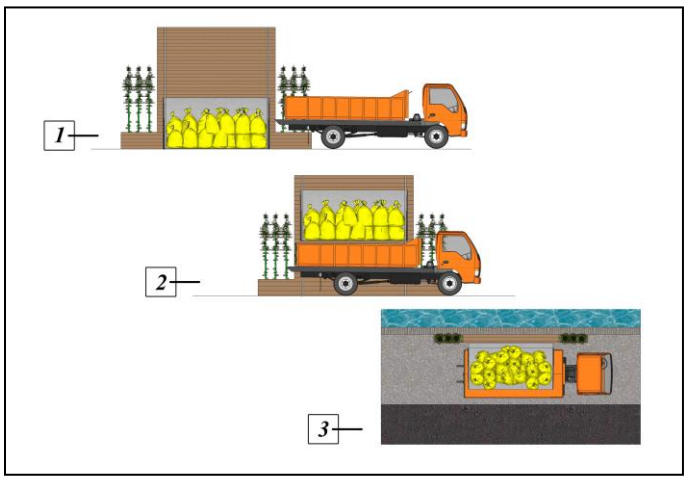

Fig. 6: Scenario illustration of transferring the waste from TPS into the garbage truck

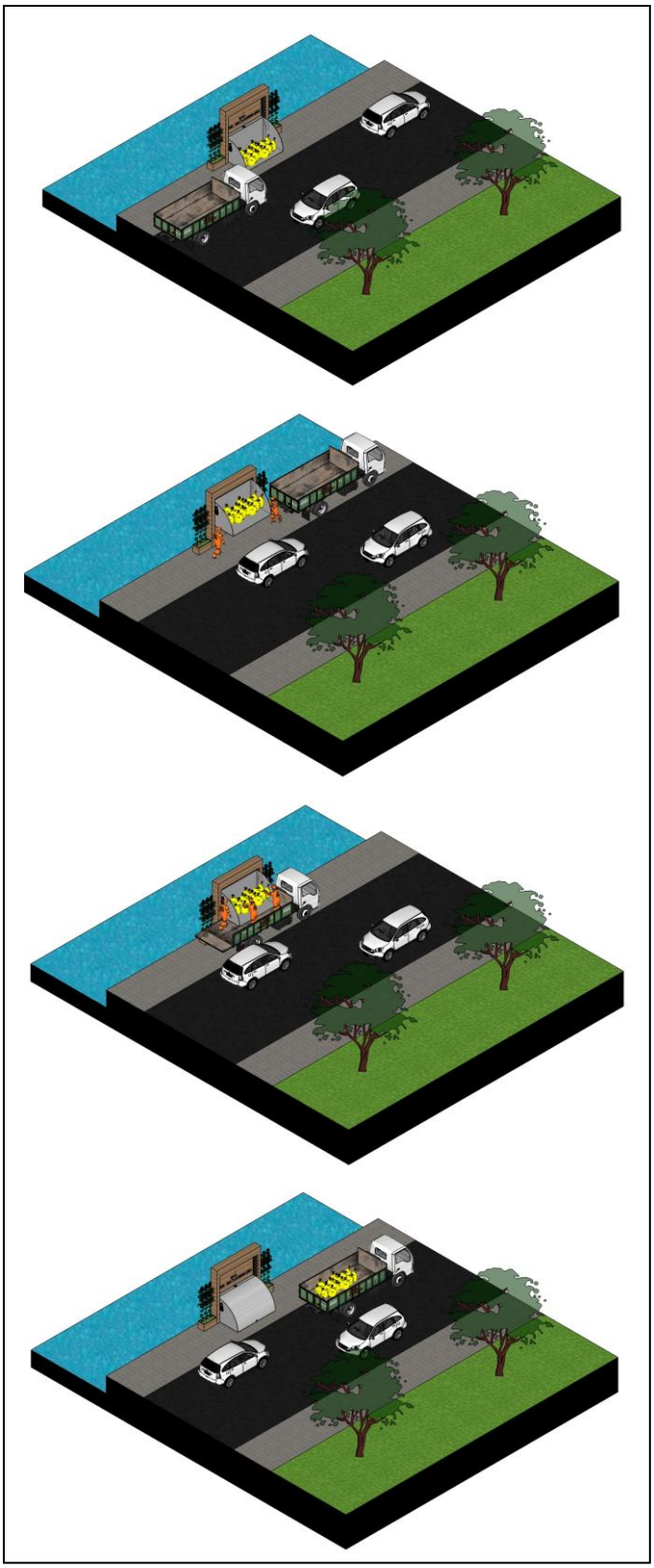

Fig. 7: Perspectives and Illustrations of transferring the waste from TPS to the garbage truck

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A design will be considered successful if it can be applied. Several aspects will serve as a reference regarding the implementation of the results of the design and evaluation of the existing conditions (Figure 8).

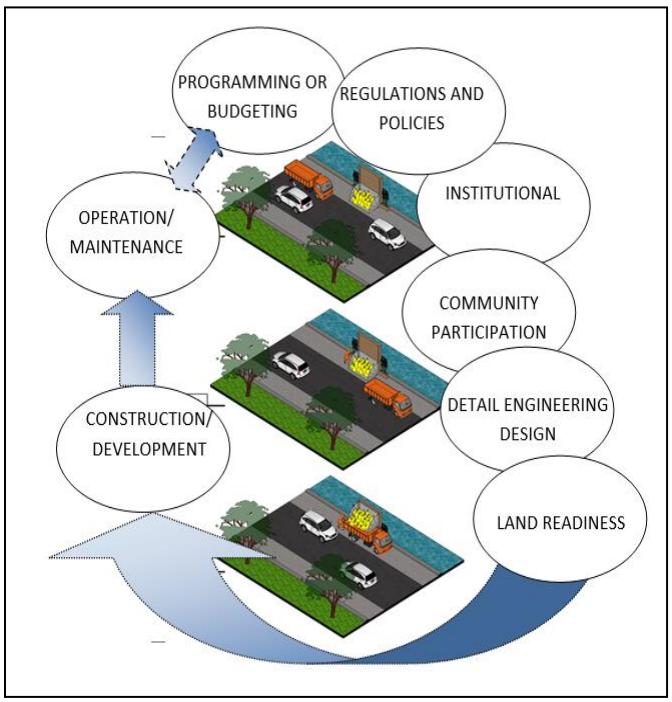

Fig. 8: Schematic of applied and evaluation aspects of the TPS design results

From the results of the TPS design, the estimated Cost Budget per TPS unit is Rp. 75,000,000.00 (not including operation/maintenance and procurement of special truck beds that can be opened), so that each year it is expected that this new TPS construction activity can be budgeted for at least 1 unit per year per sub-district, with the assumption that in the following year it can continue to increase in number.

Although the construction cost of this new TPS is more expensive (estimated from Rp. 75,000,000.00 to Rp. 100,000,000.00 per unit with the main dimension of 2.5 x 1.5 m) than the conventional type TPS with dimensions of 2 x 3 m which is only Rp. 55,000,000.00. However, the mechanical system used with the pulley system and the gear wheel system is a simple choice of technology and innovation and is still cheaper than the hydraulic system, which of course, makes it easier to carry out waste transportation at TPS.

Regarding the calculation of the Equivalent Annual-Worth Comparison, the new TPS system has a lower annual cost of Rp. 138,305,201.00, with a difference of Rp. 29.731.120.00 against the conventional TPS system, which has an annual fee of Rp. 168.036321.00 so that the new TPS system has the feasibility of investing in future projects.

IV. CONCLUSION

The conclusion of this study is an existing problem of waste containers in Banjarmasin City is mainly caused by the TPS on the sidewalk. Problems at TPS are not only about the amount of waste and the improper form of TPS but also during the waste collection and transport process, which often cause traffic jams. The design and arrangement of the TPS resulted in a new design as a prototype for TPS at the existing TPS location on the sidewalk with limited area and transportation operations. These waste containers are designed as a prototype of containers in areas with insufficient space and on the sidewalk. The design is a vertical TPS that applies a Block and Tackle System as a mechanical system and a Ratchet and Pawl system as a stiffener system, the primary material for the TPS tank in this study is stainless steel Plate SUS316/316L 5 mm thick, with supporting elements include the rolling door for the cover, panel walls, plants, and leachate drains. It is estimated that the cost of one waste container is higher compared to the conventional design. However, the new design and system can reduce the number of employees and the time of the transport process. Furthermore, this new design and system can also solve the problem of insufficient space for collecting and transporting waste. The newly designed containers are also more desirable to the community and environment than the conventional ones. The new TPS system has the feasibility of investing in future projects.

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