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# Green Gross Regional Domestic Product of Hotels in the City of Medan Based on Dynamics System and Sustainable Water Resource Conservation


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**ABSTRACT**

*Gross Regional Domestic Product (GRDP) of hotel sector in Medan continues to increase, but it does not describe the actual condition because the external factors have not been taken into account. This study was intended to determine the cost of externalities as a correction for GRDP to convert into Green GRDP of the hotel sector in the city of Medan. The study used a dynamic analysis using Powersim software of 2005 version. Respondents in this study were managers of star and non-star hotels in Medan. Hotel samples were selected through a stratified sampling method, accounting for 74 hotels. The study results showed that most hotels (81.52%) use groundwater as a water source for the hotels. In addition, none of the hotels in Medan carry out waste management; they still use government services to transport waste to the final disposal. The size of green open space owned by each hotel does not meet the needs that should be available for the hotel. Based on the results of dynamic simulation model made to calculate the green GRDP, the star and non-star hotels have a difference of 1.17 to 3.09% compared to the actual calculation. The resulted test of validity for the dynamic simulation model that has been designed showed that the model is valid and can be used to estimate the value of green GRDP. The correction factor rate for the conventional GDP into green GRDP is 4.75% for the hotel sector in Medan if only the cost of negative externalities (waste water treatment, waste treatment and green space management) is taking into account; while if the cost of both negative and positive externalities (efficient cost of electricity) in the hotel sector in, it is 2.82%. The study result also indicated that the use of large volume of ground water by the hotels and the low cost of retribution or taxes can be an inhibiting factor for the conservation of water resources in the city of Medan.*


**KEYWORDS: green GRDP of hotel, dynamic systems, ground water conservation**

## INTRODUCTION

So far the Gross Domestic Product (GDP) has often been called the conventional GDP (brown) because it only measures the resulted economic activity, without taking into account the environmental dimension in it. Loss of resources and environmental damage (degradation) as a result of exploitation are not considered as the loss (loss) or damage that should have been paid. Brown GDP is less precise and misleading in the calculation of its contribution to the regional or national development (Ministry of Forestry, 2007). This conventional GDP has a lot of drawbacks, such as : (a) only counting marketed products, (b) loss of natural resources and environmental degradation have not been considered as a cost of production, (c) cost of repairing the damaged environment is considered as creating added value (Suparmoko, 2008). Green GDP (environmentally friendly) as a development planning instrument is expected to be able to make the sectoral and regional development better and more accurately planned because the planning is based on the actual performance of economy. The concept of green GDP is relatively new; many have started to formulate such a GDP in order to provide a correction for the conventional calculations of GDP which tend not to consider the environmental damage in the process of production of goods and services.

The conventional GDP of North Sumatra Province continues to increase, in 2000 its value at current prices amounted to IDR 69,154,112 billion, and in 2011 increased to IDR 314,156,937 billion (BPS SU, 2011). The GRDP value of hotel sector in Medan continues to increase, but it does not depict the actual conditions because external factors have not been taken into account in the calculation of GDP. How big is the actual increase in GRDP of the hotel sector in Medan when the cost of replacement of natural resource and environmental repairs is estimated as the result of the hotel sector activities? By knowing these costs, the contribution of the hotel sector activity to the economy of Medan will be able to describe its actual condition. According to Nurrochmat (2009), the formulated green GDP widely used today has one fundamental weakness, namely it contains only the disincentives, i.e. deflation and degradation.

An estimated value of hotel's green GRDP is important because in its calculation the amount of external costs that should be incurred by the hotel must be calculated first. Externality costs are primarily required to process the waste generated by the hotel activities so that it is not harmful to animals or plants and does not pollute the environment when discharged into water bodies. Additionally, the external cost is also required to provide green open space sufficiently to meet the oxygen needs of the guests and hotel workers.

The increased conventional in GRDP of hotel sector in Medan has not yet indicated the actual conditions because the costs to be incurred from the hotel sector activities in order to maintain the sustainability of natural resources and to prevent the hotel sector activities from causing environmental damage have not been calculated. This study and article will discuss the dynamic model for a green GRDP based on its influential factors, namely, the conventional GRDP and external factors.

The dynamic analysis is used to estimate the amount of green GRDP generated by hotels which were used as the research samples within a certain period. With such cost determined, a correction factor can be made to convert the conventional GRDP into green GRDP, and to what extent the influence of external costs on the cost of the hotel sector activities in Medan it can be measured.

## METHODOLOGY

### Location and Respondents

The study was conducted on the hotel industry in the city of Medan in 2011. Medan was selected because: (a) it is very prone to pollution in terms of water, soil and air, which is steadily increasing, (b) its main tourist destination continues to rise, resulting in especially the needs for hotels and other accommodation; (c) as many as 35 hotels (49%) located in Medan with 161 accommodation facilities (20%). Respondents in this research were the managers of star and non-star hotels available in the city of Medan. They were interviewed using a questionnaire. The sampling technique used in this study is stratified sampling, starting from 5-star hotels to non-star class.

In this study the hotel samples account for 74 or 42%. Number of hotel population and samples based on the hotel types can be seen in Table 1 below.

**Table 1. Number of hotel population and samples by hotel types in Medan in 2011**

| No. | Hotel Types | Number* | Number of Sample |
|---|---|---|---|
| 1. | Five Stars | 7 | 4 |
| 2. | Four Stars | 9 | 5 |
| 3. | Three Stars | 9 | 6 |
| 4. | Two Stars | 4 | 3 |
| 5. | One Stars | 8 | 8 |
| 6. | Other Accommodations | 138 | 48 |
| Total | | 175 | 74 |

*: Source: Central Bureau of Statistics, North Sumatra Province

### Data Types and Sources
The data used in this study is of primary and secondary types. The primary data were obtained by direct interviews with the samples of hotel managers. Questions and answers given by respondents were recorded into the questionnaire already provided. The secondary data were from the Central Bureau of Statistics, North Sumatra Province.

### Techniques of Data Collection
The techniques of collecting primary data used in this study were interviews and observation. The information gathered by interviews and recorded in the questionnaire includes among others: (a) the source of water and the average water used per month; (b) management of hotel liquid waste and its processing cost per month; (c) hotel waste management and its processing cost per month; (d) size of green open space and its management cost per month; (e) number of hotel rooms and the number of rooms sold per month; (f) hotel room rates per night; (g) number of guests staying at the hotel per months; (h) hotel income and expenses per month; (i) structure of intermediate cost and primary costs of hotel.

Observation was conducted to see the condition of the hotel and wastewater processing carried out by the hotel. Then the cost of processing spent by the hotel was calculated.

### Data Analysis
In this study the method of calculating the green GRDP was a direct method by subtracting the value of conventional GRDP by the total cost of externalities (Ratnaningsih at al. 2006). Mathematically, the calculation of green GRDP can be written as follows:

$$Green\ GRDP = GRDP - \Delta Q$$

$$Green\ GRDP = GRDP - Q_1 - Q_2 - Q_3 + Q_4$$

$$\frac{Green\,GRDP}{GRDP} = \frac{GRDP}{GRDP} - \frac{\Delta Q}{GRDP}$$

$$\frac{Green\,GRDP}{GRDP} = 1 - \pi$$

$$Green\ GRDP = (1 - \pi)GRDPB$$

**Notes:**
*Green GRDP* = Green GRDP of hotel sector
*GRDP* = Conventional GRDP of hotel sector
$Q_1$ = Cost of wastewater processing by hotel
$Q_2$ = Cost of organic and non-organic waste processing by hotel
$Q_3$ = Cost of green open space management by hotel
$Q_4$ = Cost of electricity saving by hotel
$\Delta Q$ = Total cost of wastewater, waste and green open space management and electricity saving by hotel
$\Pi$ = Coefficient of external costs

Analysis of the external costs for the Gross Regional Domestic Product for a sustainable development of the hotel sector in Medan, North Sumatra Province uses the software Powersim of 2005 version.

## RESULTS AND DISCUSSION
### Water Source and Wastewater Treatment
Water sources used by the hotels and other accommodation facilities are entirely (100%) using water from artesian wells and Water Company (PAM). Water availability greatly affects the convenience of guests staying in the hotel. Although the tap water from the water company is used, but it is relatively small in volume. Water source is mostly from wells, accounting for 81.52% of the total volume of water used (Table 2). In 4- and 5-star hotels, the water from the artisan reaches 80.77%, in 2- and 3-star hotels 82.72%, and in 1-star hotels and non-star hotels 82.65%, not much different. The large volume of water used from the wells for hotel activities in Medan can affect the availability of underground water, so a good management is necessary to maintain the availability of the underground water sources. A management of wastewater coming from hotel activities becomes very important so that it can be determined whether the hotels in Medan have already implemented water resource conservation well.

**Table 2. Water source, Wastewater and Garbage Treatment by Hotels in Medan (2011)**

| No. | Hotel Types | Water source | Wastewater Treatment | | Garbage Treatment | Green open space not meet the needs |
|---|---|---|---|---|---|---|
| | | Wells &PAM | Yes | No | Disposed by others | |
| 1. | 5-Star | 4 | 4 | 0 | 4 | 4 |
| 2. | 4-Star | 5 | 3 | 2 | 5 | 5 |
| 3. | 3-Star | 6 | 2 | 4 | 6 | 6 |
| 4. | 2-Star | 3 | 0 | 3 | 3 | 3 |
| 5. | 1-Star | 8 | 0 | 8 | 8 | 8 |
| 6. | Other accommodation | 48 | 0 | 48 | 48 | 48 |
| Total | | 74 | 9 | 65 | 74 | 74 |
| Source: Data after processing | | | | | | |

The results showed only 12.16% of the selected hotels and other accommodation facilities in Medan treated the resulted wastewater before being discharged into water bodies. Mostly it is directly discharged into water bodies such as rivers or water drainage of the city. Looked at based on the classification of hotels, 5-star hotels was in the highest percentage to process the wastewater before discharging into water bodies. This percentage decreased with the lower class of the hotel. For example, 2-star hotels, 1-star hotels and non-star hotels as well as other accommodation facilities had no wastewater treatment facilities. This is so because 5-star hotels have a stronger capital compared to the lower class hotels. Besides, the strict requirements to get a 5-star hotel category force the hotels to have a sewage treatment plant to process its wastewater. The persons in charge of hotel activities have not yet implemented the liquid waste management required by the Decree of the Minister of Environment No. 52/1995 on quality standards of wastewater from hotel activities.

### Waste Management
Apart from wastewater, the waste resulted from hotel activities can also have negative impacts on the environment. If it is not managed properly, it can cause health problems, stop water flow, causing flood and waterlogged soils. None of the hotels in Medan treat the waste generated by the hotel, of both organic waste and inorganic waste. All hotels and other accommodation facilities still use the government services, in this case from Medan City Sanitation Department, to transport solid waste generated by hotels and dump it into final landfills (TPA) in Deli Serdang Regency. This is due to the economic value of the waste. The hotel will only be charged for retribution, the amount of which is less than the manufacture of waste treatment facility. If the hotel provides its own waste treatment facility, it should provide enough land and manpower specialized for waste processing. In addition, the waste treatment facility may cause bad smell, so it will reduce the aesthetic value.

All waste produced by the people of Medan, disposed to the final landfill, is the waste from households, housing estates, colleges / schools, offices, plaza, hotels, hospitals, restaurants, factories / non B3industries, markets, public roads, public facilities, terminals, train stations, amusement parks, etc. It includes organic waste (48.2%), consisting of leaves (32%) and food (16.2%), and inorganic waste (51.8%), consisting of paper (17.5%); plastics (13.5%); glass (2.3%), wood (4.5%), and other non-organic materials 14% (Sinaga. 2008). The composition of the waste generated by the people of Medan consists of 68.8% organic waste and 31% inorganic waste (Zulfi. 2000). This composition changed to 46.83% organic waste and 53.17% non-organic waste (BALITBANGSU. 2009 and Sinaga. 2008).

**Table 3. Composition of Waste in Medan in 2008**

| No. | Waste Types | Percentage |
|---|---|---|
| (1) | (2) | (3) |
| 1. | Leaves | 32,0 |
| 2. | Paper | 17,5 |
| 3. | Food | 16,2 |
| 4. | Plastic | 13,5 |
| 5. | Wood | 4,5 |
| 6. | Glass | 2,3 |
| 7. | Other non-organic | 14 |
| Total | | 100 |
| Source: Sinaga, 2008. | | |

Waste produced by hotels and other accommodation facilities in Medan is mostly organic waste (82.60%), and the remaining is non-organic waste. Based on the hotel classification, the higher the hotel class, the more inorganic waste would be in the hotels. Non-organic waste of 5-star hotels reached 17.15%, while non-star hotels produced only 16.82%. This is consistent with the study by Rafael et al (1993) on the handling of waste from public areas and households in the city of Kupang and its surrounding areas, where 83.71% was organic waste. The high amount of organic waste from hotel activities is supported by the supply of food and beverages from the kitchen, rooms, bathrooms and bars. Hotel kitchen produces organic waste such as vegetable scraps, food waste and other waste such as paper or leaf wrapper, whereas non-organic waste such as bottles of shampoo or liquid body cleanser, beverage bottles, hardboard, plastic, paper, and others. The waste composition from hotels and other accommodation can be seen in Table 4.

**Table 4. Composition of Waste from Hotels and other Accommodation in Medan in 2011**

| No. | Hotel Types | Average Percentage | | Total |
|---|---|---|---|---|
| | | Organic | Non Organic | |
| 1. | 5-Star | 82,85 | 17,15 | 100,00 |
| 2. | 4-Star | 81,59 | 18,41 | 100,00 |
| 3. | 3-Star | 81,49 | 18,51 | 100,00 |
| 4. | 2-Star | 84,49 | 15,51 | 100,00 |
| 5. | 1-Star | 83,21 | 16,79 | 100,00 |
| 6. | Other accommodation | 83,18 | 16,82 | 100,00 |
| Total | | 82,59 | 17,41 | 100,00 |
| Source: Data after processing | | | | |

Viewed from the hotel classification, a higher class of hotel would demand more facilities provided by the hotel, including the facility of soft drinks in the hotel rooms and body cleanser in the bathroom, which is commonly packaged in plastic bottles. It is this that makes a higher class hotel produce more non-organic waste.

**Green Open Space of Hotel**

Most hotels and other accommodation services in Medan have green open space (GOS) to produce the oxygen needed for workers and hotel guests. However the green space available is less than it should be (Table 5). In comparison between the green space available and the holding capacity of existing hotel rooms, no hotel in Medan has enough green space. According to Wisesa (1988), the oxygen need of every human being is equal to 600 liters per day (equivalent to 857.14 grams), so it takes an area of 8.47 $m^2$ green open space to meet the oxygen need.

**Table 5. Need for Green Open Space (GOS) based on Hotel Types**

| Hotel Types | GOS Need | | Current GOS | | Difference for GOS need | |
|---|---|---|---|---|---|---|
| | Area ( m2 ) | % | Area ( m2 ) | % | Area ( m2 ) | % |
| 4-and 5-Star | 676.173 | 100,0 | 7.464 | 1,1 | 668.709 | 98,9 |
| 2- and 3-Star | 245.391 | 100,0 | 2.940 | 1,2 | 242.451 | 98,8 |
| 1-Star and non-star | 539.820 | 100,0 | 16.224 | 3,0 | 523.596 | 97,0 |
| Total | 1.461.384 | 100,0 | 26.628 | 1,8 | 1.434.756 | 98,2 |

Source: Data after processing

To meet the needs of guests or workers in the hotel requires green space area of 1,461,384 $m^2$, while the present availability is only 26 628 $m^2$ (2%) of the requirement that should be available. The available area of green open space against the required need of the 4- and 5-star hotels is less than that of 1-star and non-star hotels. The green open space that should be available at 4- and 5-star hotels is 676 173 $m^2$, and currently only available 7,464 $m^2$ or 1.1%. At 2- and 3-star hotels it is available only 1.2% of the requirement, and at 1-star and non-star hotels it is available only 3.0%.

Physically green open space (GOS) can be divided into natural green space in the form of natural wildlife habitats, protected areas and national parks, and non-natural or built green open space in the form of parks, sports fields, and flower gardens. The green open space has ecological, social, cultural, architectural, and economic functions. Ecologically, it can improve the quality of groundwater, prevent flood, reduce air pollution and lower the temperature of the city. Architecturally, it can increase the value of beauty and comfort through the presence of parks or gardens. The existence of green open space at hotels ecologically can reduce air pollution and increase the value of beauty and comfort for the hotel guests. Therefore, green open space should be available at hotels according to their needs.

**Dynamic Model for Green GRDP**

Dynamic model for green GRDP is based on the factors that influence the conventional GRDP and external factors.

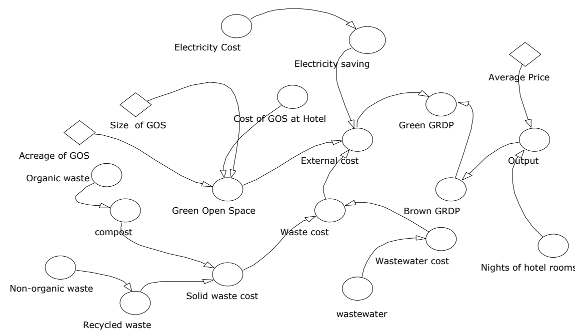


**Figure 1. Flow Diagram of Externality Model for Hotel Sector**

The amount of conventional GRDP is strongly influenced by the number of guests reflected in the room occupancy rate and the hotel rates indicated in the variable of hotel room average price. Negative externalities factors included in the dynamic model are the wastewater and garbage (solid waste) as well as the hotel costs of processing green open space. The amount of hotel's solid waste treatment cost is very dependent on the composition of organic and non-organic waste generated by the hotel, whereas the cost of wastewater treatment and green open space is influenced by the amount of hotel wastewater and the size of its green open space hotel. Positive externalities factor included in the dynamic model is efficient cost of electricity in the hotel sector. Based on the factors that affect the amount of green GRDP, as explained above, Figure 1 is the dynamic model used in this study.

**1. Model Validity**

The validity of a model is usually determined by its ability to explain the existing diverse values (the dependent variable) and its ability to predict the variable value for the future (Juanda, 2009). Therefore, the validity of the resulted dynamic model can be seen by comparing the value of green GRDP calculated manually with the resulted calculation using a dynamic simulation. The following is the comparison of the value of green GRDP from manual calculation with the results from the dynamic simulation model for the star and non-star hotels as well as the whole hotels (star and non-star).

### a. b. 4- and 5-Star Hotels

Profile of green GRDP values for the 4- and 5-star hotels based on both actual calculation and the resulted calculation by the simulation model can be seen in Figure 2 below.

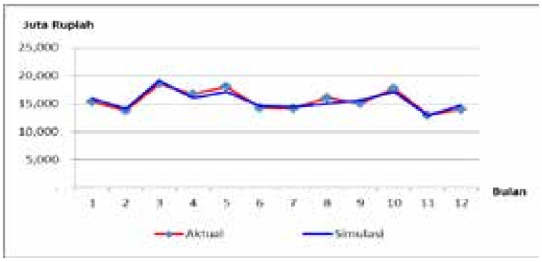


**Figure 2. Profile of Green GRDP for 4- and 5-star Hotels**

The resulted Green GRDP by actual calculation and by the calculation of the simulation model was not much different. Although, the result from the calculation by the simulation model tends to underestimate or lower, the overall difference between the actual calculation and the calculation by the simulation model is only 1.17%. It means that the formulated simulation model is very valid in calculating green GRDP for the 4- and 5-star hotels in Medan.

### c. 2- and 3-Star Hotels

The profile of green GRDP values for the 2- and 3-star hotels by both actual calculation and the calculation of simulation model can be seen in Figure 4 below. It is not much different from the calculation of green GRDP for the 4- and 5-star hotels. The result of actual calculation compared with that of the simulation model calculations for the 2- and 3-star hotel has only a little difference. The result of the simulation model calculation also tended to underestimate throughout the study period (March 2011 - February 2012). Overall, the difference between the actual calculation result and the result of simulation model calculations is 1.27%.

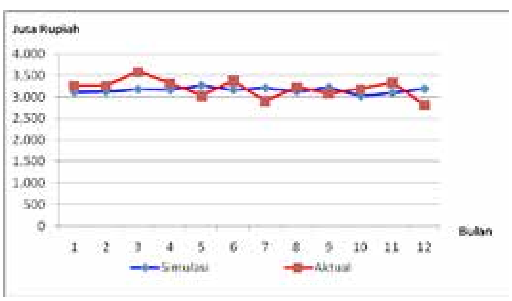


**Figure 3. Profile of Green GRDP for 2- and 3-star hotels**

### d. 1-Star and Non-Star Hotel

The profile of green GRDP values for 1-star and non-star hotels by both actual calculation and the calculation of the simulation model is shown in Figure 4 below.

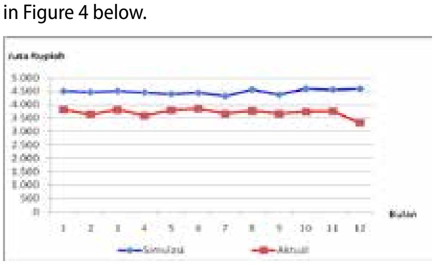

**Figure 4. Profile of Green GRDP for 1-Star and Non-star Hotel**

The value of green GRDP by the calculation of simulation model tends to overestimate compared to the value of green GRDB by the actual calculation. The difference between the value of green GDP by the actual calculation and the resulted largest value by the simulation model occurred in February 2012, that is, 4.70%. Overall, the difference between the actual calculation and that of the simulation model is 3.09%.

### d. All Hotel Samples

The profile of green GRDP values for the entire sample hotel, from both actual and simulated calculation is shown in Figure 5. In general, the difference between the actual calculation and the simulated calculation is only 2.61%. It means that the simulation model that has been made is very valid in calculating the green GRDP of hotels in Medan.

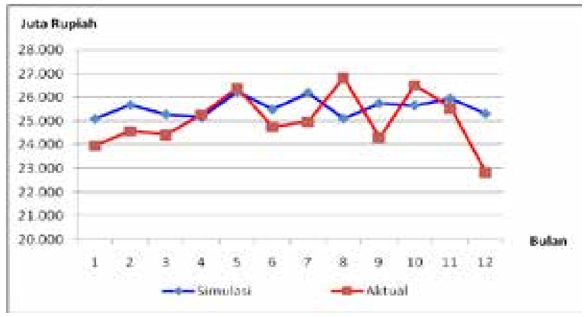


**Figure 5. Profile of Green GRDP of Hotel**

In addition to comparing the manual calculation results with those of the dynamic simulation models, the validity of the dynamic model could also be tested using a statistical method. This was done by comparing three values resulting from the simulated dynamic model with those of the manual calculation, namely:

1. Test of Absolute Mean Error (AME)
2. Test of Absolute Variation Error(AVE)
3. Test of Suitability (*Kalman Filter/KF*)

The following is the description of the three values based the study results.

### 2. Test of Absolute Mean Error (*AME*)

This test was conducted to compare the deviation of mean values in both actual data and simulated data of the dynamic models. Below are the resulted calculations of AME from the study.

$$\overline{Si} = \frac{\sum Si}{N} = \frac{25.104.800.424,00 + 25.679.664.419,72 + \ldots + 25.313.335.349,57}{12} = 25.577.750.909,77$$

$$\overline{Ai} = \frac{\sum Ai}{N} = \frac{23.962.959.296 + 24.574.190.414 + \ldots + 22.818.488.324}{12} = 25.028.439.424,07$$

$$AME = \frac{\overline{Si} - \overline{Ai}}{\overline{Ai}} = \frac{25.577.750.909,77 - 25.028.439.424,07}{25.028.439.424,07} = |0,021947492|$$

**Notes:**

$\overline{Si}$ = Mean of simulated values

$\overline{Ai}$ = Mean of actual values

### 3. Test of Absolute Variation Error (*AVE*)

This test was carried out by comparing the standard errors from the actual values with those of dynamic simulation. The standard error values were calculated by the square root of the number of all differences between the data with their mean values. Below is the calculation of the AVE values in the study.

$$Si = \sqrt{\frac{\sum (Si - \overline{Si})^2}{N-1}}$$

$$Si = \sqrt{\frac{(25.104.800.424,00 - 25.577.750.909,77)^2 + \ldots + (25.313.335.349,57 - 25.577.750.909,77)^2}{12-1}}$$

$$Si = 802.457.396,40$$

$$Sa = \sqrt{\frac{\sum (Ai - \overline{Ai})^2}{N-1}}$$

$$Sa = \sqrt{\frac{(23.962.959.296 - 1.160.357.429,02)^2 + \ldots + (22.818.488.324 - 1.160.357.429,02)^2}{12-1}}$$

$$Sa = 835.457.348,90$$

$$AVE = \frac{(Si - Sa)}{Sa} = \frac{802.457.396,40 - 835.457.348,90}{835.457.348,90} = |0,039499267|$$

**Notes:**

*Ss* = Mean of dynamic simulation values

Sa = Mean of actual values

**4. Test of Suitability (*Kalman Filter/KF*)**

Suitability test was done by comparing the variation values between the actual values and those of the dynamic simulation. The variation value is calculated by summing the squares of the difference of the entire data and their average values. Below is the resulted calculation of the KF values in the study.

$$Vs = \frac{\sum (Si - \bar{S}i)^2}{N-1}$$

$$Vs = \frac{(25.104.800.424,00 - 25.577.750.909,77)^2 + \ldots + (25.313.235.349,57 - 25.577.750.909,77)^2}{12-1}$$

$$Vs = 804{,}922 \times 10^{18}$$

$$Va = \frac{\sum (Ai - \bar{A}i)^2}{N-1}$$

$$Va = \frac{(23.962.959.296 - 25.028.439.426,07)^2 + \ldots + (22.818.488.524 - 25.028.439.426,07)^2}{12-1}$$

$$Va = 942{,}500 \times 10^{18}$$

$$KF = \frac{Vs}{(Vs + Va)} = \frac{808.922 \times 10^{18}}{(808.922 \times 10^{18}) + 942{,}500 \times 10^{18}} = 0{,}460633968$$

**Notes:**

*Vs* = Variant value of simulation

*Va* = Actual variant value

Recapitulated statistical test of *AME*, *AVE*, and *KF* can be seen in the following table:

**Table 6. Statistical Test of *AME*, *AVE*, and *KF***

| No. | Description | Values |
|---|---|---|
| 1. | Simulated values ($\bar{S}i$) | 25.028.439.426,07 |
| 2 | Actual means ($\bar{A}i$) | 25.577.750.909,77 |
| 3 | Standard deviation of simulated values (Ss) | 835.457.348,90 |
| 4 | Standard deviation of actual values (Sa) | 802.457.396,40 |
| 5 | Variant value of simulation (Vs) | 804,922 x $10^{18}$ |
| 6 | Actual variant value (Va) | 942,500 x $10^{18}$ |
| 7 | AME | 0,021947492 |
| 8 | AVE | 0,039499267 |
| 9 | KF | 0,460633968 |

Meanwhile, the resulted validity test of the model can be seen in the following table.

**Table 7. Test of Model Validity**

| No | Validation Method | Critical Limit | Value of Statistical Test | Results |
|---|---|---|---|---|
| 1 | Test of Absolute Mean Errors (*AME*) | < 5% | 0,021947492 | Valid |
| 2 | Test of Absolute Variation Error (*AVE*) | < 5% | 0,039499267 | Valid |
| 3 | Test of Suitability (*KF*) | 45 % - 55 % | 0,460633968 | Valid |

**Sustainability of Water Resources Conservation**

Conservation of water resources is intended to maintain the continuity of supporting capacity, carrying capacity and function of water resources (Law No. 7/2004 on Water Resources, Chapter 20, Article 1). Article 2, water resources conservation referred to in Article 1 is done through the protection and conservation of water resources, water preservation, and management of water quality and water pollution control with reference to water resource management patterns assigned to each river region basin. Thus, the conservation of water resources and protection include water conservation, water preservation and water quality management as well as water pollution control. According to Asdak (2010), water conservation can be done by (A) managing two components, namely surface water hydrology and ground water, and (B) increasing the efficiency in the use of irrigation water. The management of surface water and ground water is aimed to utilize both hydrological components more efficiently. The management of surface water includes (1) the control of surface, (2) water tapping, (3) increasing the infiltration capacity of the soil, (4) soil cultivation, (5) the use of land stopper and water repellent, and (6) lining the waterways.

Groundwater includes renewable natural resource although it requires a long time up to tens or thousands of years. If the ground water has been damaged in terms of quantity and quality, the recovery process takes longer and high costs with complicated technology, but it may not return to its original state (Freeze. 1979). The study results showed that the use of ground water in the hotel sector in Medan reached 81.52% of the total volume of water used, and the remaining 18.48% was from the water company, PDAM (Table 8).

**Table 8. Volume of Water Use by Sources (March 2011 – February 2012)**

| No | Hotel Types | Volume of Water Use ($M^3$) | | Total |
|---|---|---|---|---|
| | | Ground water | PDAM Water | |
| 1 | 5- and 4-Star | 416.295 | 99.117 | 515.412 |
| 2 | 3- and 2-Star | 159.310 | 33.282 | 192.592 |
| 3 | 1- and non-Star | 114.203 | 23.976 | 138.179 |
| | Total | 689.808 | 156.375 | 846.183 |

In the Regional Regulation of Medan No. 27/2002 on Levy of Permits for Management, Deployment, Retrieval and Utilization of Underground Water in the city of Medan, Chapters 14, 15 and 16 describe the method of measuring the degree of services use. The service use is determined based on the number of drilled wells and the volume of underground water used (Chapter 14). The principles and objectives in establishing the levy are intended to cover the costs of administration, printing of forms, supervision, and guidance for the management of underground water. Article 2 of Chapter 16 mentions the amount of levy for the permits of tapping and utilizing underground water per month: (a) IDR 500,000 for 0 - 2 liters per second, (b) IDR 1,000,000 for 2 -10 liters per second, (c) IDR 2.000.000 for 10 - 25 liters per second, (d) IDR 3000,000 for over 25 liters per second.

If the tapping of ground water is conducted for six hours per day, then its levy on average can be seen in Table 9.

**Table 9. Average Price of Ground Water in Medan**

| Average volume of tapped ground water (liter/second) | Volume of ground water per month ($M^3$) | Levy per month (IDR) | Average Price of ground water (IDR/$M^3$) |
|---|---|---|---|
| 1 | 648 | 500.000 | 772 |
| 6 | 3.888 | 1.000.000 | 257 |
| 17 | 11.016 | 2.000.000 | 182 |
| 25 | 16.200 | 3.000.000 | 185 |
| Total | 31.752 | 6.500.000 | 205 |

Source: Data after processing

The low levy of underground water utilization compared with that of tap water (PDAM) will cause groundwater use continue to increase. The difference between the ground water levy and the tap water rates of Tirtanadi Water Company in Medan will inhibit groundwater preservation effort as stated in Article b of Chapter 10, North Sumatra Provincial Regulation No. 4 /2013 on Groundwater Management. The large volume of ground water use with low cost charges is very profitable for hotel businesses in the city of Medan. With the groundwater usage charge of IDR 205 on average per $m^3$ compared to Tirtanadi water rates, the study results showed a highly significant difference between the costs spent by the hotels and costs that should be incurred to support the preservation of ground water (Table 10).

**Table 10. Cost of Ground Water Use in Hotel Sector based on Water Price (March 2011 – February 2012)**

| No. | Hotel Types | Volume of ground water use ($M^3$) | Cost of Ground Water Use (Million IDR) | | Difference (Million IDR) |
|---|---|---|---|---|---|
| | | | Average Cost of Levy | Water Cost of PDAM | |
| 1. | 5- and 4-Star | 416.295 | 85,34 | 2.285,16 | 2.199,82 |
| 2. | 3- and 2-Satr | 159.310 | 32,66 | 868,24 | 835,58 |
| 3. | 1- and non-Star | 114.203 | 23,41 | 550,46 | 527,05 |
| Total | | 689.808 | 141,41 | 3.703,86 | 3.562,45 |

Source: Data after processing

The rate of groundwater levy in column 4 is the average tariff based on Medan City Regulation No. 27/2002, that is, IDR 205 per $m^3$. The water rate in column 5 is based on Tirtanadi (Water Company) rates: IDR 5,450 per $m^3$ for 5-& 4-star hotels and 2-& 3-star hotels, but IDR 4,820 per $m^3$ for 1- and non-star hotels.

Table 10 above shows a big difference in he costs incurred for the use of groundwater in the hotels. The results of the study on 74 hotels in Medan showed that the costs spent by the hotel on the use of ground water for one year amounted to IDR 141.41 million only. If to meet the water need, the hotel used tap water, then the cost to be incurred for a year would amount to IDR 3.56 billion, or about 25 times more expensive than the cost of ground water. Such condition will encourage hotel businesses to continue using groundwater as a water source in the future hotel activities. Meanwhile, in terms of the effort of North Sumatra provincial government to conserve ground water, the low cost of groundwater levy in the city of Medan is one factor that can inhibit soil water conservation in this area. This is consistent with the results of the study by Sa'diyah (2012) that the water allocation for tourism sector shows that hotel business takes more benefit by using groundwater to meet its water needs, while restaurants are more profitable by using tap water (PDAM). The cost incurred to take ground water per $m^3$ is IDR 1,643, much lower than the price of tap water in Lombok, IDR 5000 per $m^3$.

The effect of groundwater use in Jakarta can be used as guidelines for the conservation of water resources in the city of Medan. Approximately 70% of the water in Jakarta still relies on the ground water (BPS Jakarta. 2008). The resulted analysis of ground water quality in groundwater basins in Jakarta in 2010 showed that there are specimens of ground water that meets the requirements of drinking water quality, either dug wells, pumped wells, drilled production wells, as well as monitored drilled wells as the sources of drinking water. The groundwater quality in the groundwater basin (CAT) in Jakarta based on the storage and retrieval system (STORET) starting respectively from bad, worse and the worst is lower confined aquifer, upper pressured aquifer and unpressured depressed.

Effort in the groundwater preservation in North Sumatra province is based on the North Sumatra Provincial Regulation No. 4 /2013, Chapter 12: the preservation of ground water as referred to in Chapter 10, Article b, is done by (a) restricting and/or reducing the use of groundwater; and (b) efficient use of groundwater; (c) recycling, and (d) prioritizing the use of surface water. Reuse of wastewater generated by the hotel sector is in line with the Regulation No. 4 /2013, Chapter 12, Article c, i.e. the preservation of ground water is done by recycling. This is important because only 12.16% of the hotels and other accommodation facilities selected as samples in the study process wastewater. Most directly discharge wastewater into water bodies such as rivers or city drainage. The 5-star hotels are in the highest percentage, which is lower with the decreasing class of the hotels

In an environmentally sustainable development of water resources, the hotel sector in the city of Medan has a quite active role, especially the reuse of waste water generated by the hotel activity so that it does not cause negative effects on the environment that would interfere with the continuity of water resources availability in the future, in line with Sukobar (2007). The results of the study on the sample of 74 hotels in Medan showed that wastewater generated for a year accounted for 638,095 $m^3$, involving 5- and 4-star hotels with wastewater of 378,645 $m^3$, 3- and 2-star hotel with wastewater of 148,451 $m^3$, and 1- and non-star wastewater of 110, 999 m3.

If this hotel wastewater is reused for cleaning services, cooling tower, gardening, laundry and others, then efficient water resource use for one year in the 74 selected hotel samples in Medan city can save 258,428 m3, consisting of 5- and 4-star hotels with 153,351 $m^3$, 3- and 2-star hotels with 60,123 $m^3$, and 1- and non-star hotels with 44 954 m3.

The recycled wastewater generated in the hotel sector is in line with the North Sumatra Provincial Regulation No. 4/2013, Chapter 12 Article c, i.e., the preservation of ground water is done by implementing recycling. This is so because as most activities oh hotel sector in the city of Medan take clean water from ground water using drilled wells. According to Setiadi (2012), wastewater can be recycled of approximately 40.5% for the purposes of cleaning service (1.4%), cooling tower (14.3%), gardening (8.0%), laundry (16.1%) and other (4.7%).

According to Sanim (2011), the protection and preservation of water resources are implemented vegetatively or technically through social, economic and cultural approaches. Vegetative protection is carried out by planting trees or plants that are appropriate to the watershed or water catchment area. Meanwhile the technical method involves technical engineering such as the construction of sediment resistant, terracing (swales) and strengthening water resources cliff. According to Sanim (2011), there are three (3) principles to support the development of healthy future with water sector: conservation. This means using only water just enough to satisfy the actual needs, without waste. Effective conservation usually includes a package of leakage control, the use of water saving equipment, tariff that prevents inefficiency, and a campaign to encourage consumers to be more aware of the effect of the inefficient use of water.

In the context of sustainable water resource conservation, sustainability can be defined as the efforts and activities undertaken to supply water continuously for the benefits and services to the user community. Sustainability should be viewed as a system consisting of development of infrastructure, operation, maintenance, management and development of water services for the communities. Some aspects of sustainability to consider are (a) financing, (b) engineering, (c) environment and (d) institution. According to Munasinghe (1993), sustainable development has three pillars, namely economic, ecological and social. Economic pillar emphasizes on acquiring income based on efficient utilization of resources. Ecological approach focuses on the importance of biodiversity protection that will contribute to the balance of the world's ecosystems, while social approach emphasizes on maintaining stable socio-cultural system, including avoidance of conflicts of justice, both among the present generation and future generations. Sustainable development combines three important aspects (environmental, social and economic) into a single integrated perspective (Bebbington, 2001 and Van Dieren, 1995 in Bahri, 2012). The integration of the three pillars of sustainable development leads to the concept of ecosystem efficiency, ecological equity and social efficiency as presented in Figure 6.

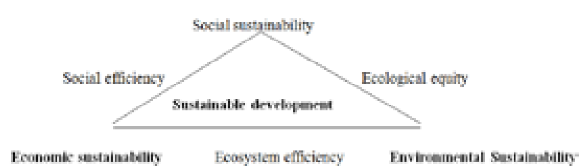


**Figure 6. Three pillars of sustainable development**

Sustainable development contains two key concepts, namely: (1) essential needs to sustain human life and (2) technological and organizational limitations related to the environmental capacity to meet the needs of the current and future generations. Thus, the concept of sustainable development actually begins with the anthropocentric concept which views man as its central theme (Fauzi, 2004).

**CONCLUSION**

**From the study results it can be concluded as follows:**

1. The dynamic model for the green GRDP of hotels is formulated from the conventional GRDP and external factors. The external factors involved are the treatment costs of wastewater, solid waste,

and GOS (green open space) of hotels. Only 12.16% of hotels and other accommodation facilities in the selected samples processed wastewater. 5-star hotels have the highest percentage, which decreases with the lower class of hotels. All waste produced by the hotel (82.60% of organic waste) is transported to the final landfill. The higher the class of the hotel, the more non-organic waste would be produced by the hotel. The need for GOS is 1,461,384 $m^2$, whereas it is available only 26,628 m 2 (2%). 4- and 5-star hotels are smaller than 1-and non-star hotels.

2. Validity test of the dynamic simulation model indicates that the model is valid and can be used to estimate the value of Green GRDP. The model that has been designed to calculate the Green GRDP of star and non-star hotels has the difference of 1.17 to 3.09% compared with the actual calculation.
3. The correction factors to convert the conventional GDP to Green GRDP can be divided into two, namely: (1). one is 4.75 %, which only takes into account the cost of negative externalities (wastewater treatment, waste treatment and management of urban green space) in the hotel sector in the city of Medan, (2). the other is 2.82%, which takes into account the negative and positive externality costs (electrical energy cost efficiency) in the hotel sector of Medan city.
4. Conservation of water resources in this study is through the management of hydrological components, that is, surface water and ground water for more efficient use. This is consistent with (a) the regulation of Medan number 27/2002 concerning Permits of Management, Distribution, Retrieval and Utilization of underground water in the city of Medan, (b) groundwater preservation effort that is regulated by the law of North Sumatra province number 4 /2013 , Chapter 12: the preservation of ground water, as referred to in Chapter 10 Article b, is done by (a) restricting and / or reducing the use of groundwater, and (b) efficient use of groundwater; (c) recycling, and ( d) prioritizing the use of surface water.

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