

Chapter I Introduction

1.1 Background

With the current population growth, the demand for public infrastructure and facilities will also increase. The certain region is lacking in public facilities and infrastructure. Compared to the rapid increase in population, these infrastructures and facilities increase at a much slower rate. They are making it necessary to increase the current operating infrastructure and facilities. It will provide a better living environment for the citizens and improve the region's economy.

The construction of the Mother and Child Hospital in the Seberuang District in Kapuas Hulu, West Kalimantan is a means to increase the necessary medical infrastructure in the said region. In doing so, it will be of help to the citizens living in the area that needs medical attention. Based on this statement, this topic is taken up by the Final Project Infrastructure Design II Team to be reviewed in terms of the respective subject of water engineering aspect, transportation engineering aspect, and construction management aspect.

The designed hospital will have the necessary facility to perform regular medical checkups, surgery, beds and rooms for inpatient and outpatient, and offices for the hospital maintenance and management. Design planning for the hospital will be divided into three phases according to the previously mentioned aspects: water engineering, transportation engineering and construction management. From the water engineering aspect, the hospital's piping system will be designed to properly distribute clean water to all the fixture of the hospital and design the wastewater channel to expel wastewater into a set location so that it will not pollute the environment around the hospital.

After the water planning is concluded, next is the transportation planning. Transportation engineering planning is conducted by performing traffic survey in the hospital's surrounding area. This survey is necessary to obtain important data such as traffic volume, parking area, and the remaining data required for the transportation engineering planning.

Construction management design will cover the necessary cost and material for the works executed in the field to arrange the project's budget plan. By finishing the design, it will be possible to know the estimated budget required to complete the hospital project.

1.2 Project General View

The designed hospital will be located in Seberuang district, Kapuas Hulu, West Kalimantan. The height of the hospital will be 15 m, consisting of the first floor and a second floor for the hospital management. There are notable facilities in the hospital such as the inpatient and outpatient rooms that will be available in the regular service or the VIP service, surgery room, rehabilitation room, Emergency Room (ER) and Intensive Care Unit (ICU). Followed by the polyclinic, laboratory, and pharmacy.

1.3 Statement of the Problem, Objective, and Scope of the Problem

The focus of the planning is on how to design the hospital optimally from the water, transportation, and construction management aspect. Water planning will revolve around calculating the appropriate clean water demand, from there it will lead to the piping system and the design of the rainfall infiltration well. In transportation engineering planning, a parking analysis will be conducted to ensure the parking area requirement is fulfilled and to analyze the road level of service. As for the construction management design, arranging the budget plan will be conducted according to the basic unit price for the West Kalimantan region. To properly arrange the S curve and estimate the cost and schedule of the project.

1.4 Approach and Method Used

During the project execution, an approach for each of the water engineering, transportation, and construction management aspects is conducted. In hospital planning, all the calculations are based on the SNI for the respective data, such as the criteria and the coefficient, this applies mostly in the water planning phase and the construction management planning phase. While the transportation planning phase also uses the SNI

as a guide to fulfill some design criteria, the design also needs to follow the criteria from MKJI for it to be considered as the optimal design.

1.4.1 Water Planning

Water planning covers the piping system, drainage channel design, and infiltration well. The following is the detail for the approach and method taken during water planning:

1. Water Demand Analysis

In order to calculate the water demand at peak hour, first the value of the average water usage (Q_h) calculation is described in the equation 1.1.

$$Q_h = \frac{\text{Amount of Bed} \times \text{Water Usage per People} \times \text{Leakage Anticipation}}{\text{Effective Time of Water Usage}} \dots\dots\dots(1.1)$$

Then for peak hour needs and peak needs can be calculated using the equations 1.2, 1.3, and 1.4 below.

$$Q_{h\text{-max}} = C_1 \times Q_h \dots\dots\dots(1.2)$$

$$Q_{m\text{-max}} = C_2 \times Q_h \dots\dots\dots(1.3)$$

$$\text{Water Needs per Hour} = \frac{\text{Total Needs}}{\text{Effective Time of Water Usage}} \dots\dots\dots(1.4)$$

- Based on Type and Number of Fixtures

Flow / Flow rate is necessary to calculate the $Q_{\text{Effective}}$, so it is calculated using the provided equation 1.5.

$$\text{Flow / Water Flow Rate} = \text{Amount of Fixtures} \times \text{Water Needs for 1 Fixture} \times \text{Water Usage per Hour} \dots\dots\dots(1.5)$$

After we get the Flow / Water Flow Rate, we can find $Q_{\text{Effective}}$ with equation 1.6.

$$Q_{\text{Effective}} = \text{Flow / Water Flow Rate} \times \text{Usage Factor} \dots\dots\dots(1.6)$$

Then for peak hour needs and peak needs can be calculated using equation 1.7, 1.8, 1.9 below.

$$Q_{h\text{-max}} = C_1 \times Q_h \dots\dots\dots(1.7)$$

$$Q_{m-max} = C_2 \times Q_h \dots\dots\dots(1.8)$$

$$\text{Water Needs per Hour} = \frac{\text{Total Needs}}{\text{Effective Time of Water Usage}} \dots\dots\dots(1.9)$$

- Based on Maximum Number of Fixture Units (UBAP)

For this method, it is necessary to find the data through the graph and table from the SNI 03-7065 (2005).

After getting the estimated water load requirements through the mentioned graph, we can use the provided equation 1.10, 1.11, and 1.12 to find peak hour requirements and peak needs.

$$Q_{h-max} = C_1 \times Q_h \dots\dots\dots(1.10)$$

$$Q_{m-max} = C_2 \times Q_h \dots\dots\dots(1.11)$$

$$\text{Water Needs per Hour} = \frac{\text{Total Needs}}{\text{Effective Time of Water Usage}} \dots\dots\dots(1.12)$$

2. Reservoir Calculation

The amount of service pipe capacity (Q_s) can be calculated by the provided equation 1.13.

$$Q_s = \frac{2}{3} \times Q_h \dots\dots\dots(1.13)$$

The volume of the ground reservoir can be calculated after the pipe capacity is obtained through inputting the pipe capacity data into equation 1.14.

$$\text{Volume of Ground Reservoir} = Q_d - (Q_s \times T) \dots\dots\dots(1.14)$$

The volume of the roof reservoir can be calculated by the following equation 1.15.

$$V_E = [(Q_p - Q_{hmax}) \times T_p - (Q_{pu} \times T_{pu})] \dots\dots\dots(1.15)$$

3. Pump Calculation

The calculation of pump power is carried out using the provided equation 1.16.

$$P = \frac{\rho \times g \times Q \times H}{80\%} \dots\dots\dots(1.16)$$

Calculate the headloss using the Hazen-William equation that is provided as equation 1.17.

$$h_f = \frac{10.666 \times Q^{1.85} \times L}{C^{1.85} \times D^{4.85}} \dots\dots\dots(1.17)$$

Diameter of the pump can be calculated with the following equation 1.18.

$$d = \sqrt{\frac{A \times 4}{\pi}} \dots\dots\dots(1.18)$$

The actual flow velocity in the pump can be calculated using equation 1.19.

$$V = \frac{Q}{A} \dots\dots\dots(1.19)$$

The calculation of friction losses in the pipeline can use the formula as in equation 1.20.

$$HI = 6.05 \frac{Q^{1.85}}{C^{1.85} \times d^{4.87}} \times 10^5 \dots\dots\dots(1.20)$$

Secondary energy loss or minor loss can be calculated using the formula as in equation 1.21.

$$h_0 = k \frac{v^2}{2g} \dots\dots\dots(1.21)$$

After obtaining the head loss and minor loss values, then next calculate the head total which can be calculated by the formula as in equations 1.22, 1.23, and 1.24.

$$H = H_a + H_v + h_f + h_1 \dots\dots\dots(1.22)$$

$$H_v = \left(\frac{v^2}{2 \times g} \right) \dots\dots\dots(1.23)$$

$$H_f = 6.05 \times \left(\frac{Q^{1.85}}{C^{1.85} \times D^{4.97}} \right) \times 10^5 \dots\dots\dots(1.24)$$

For the pump power can be calculated by the formula as in equations 1.25.

$$P = \rho \times g \times Q \times H \dots\dots\dots(1.25)$$

4. Rainfall Calculation

Average rainfall (\bar{x}) can be calculated using equation 1.26.

$$(\bar{x}) = \frac{\sum x_i}{n} \dots\dots\dots(1.26)$$

Using the average rainfall data, the standard deviation can be calculated using equation 1.27.

$$s = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}} \dots\dots\dots(1.27)$$

The Slope Coefficient (Cs) is a comparison that can be used to find out the distribution model to be used with equation 1.28.

$$C_s = \frac{n \sum (x_i - \bar{x})^3}{(n-1)(n-2)s^2} \dots\dots\dots(1.28)$$

Coefficient Variation (Cv) is the ratio between standard deviations to the average rainfall. The slope coefficient can use the equation 1.29.

$$C_v = \frac{s}{\bar{x}} \dots\dots\dots(1.29)$$

The Coefficient of Extinction (k) is the degree of dilution of a form of distribution, the Coefficient of Extinction can use the equations 1.30 and 1.31.

$$C_k = \frac{a}{s^2} \dots\dots\dots(1.30)$$

$$C_k = \frac{n^2 \sum (x - \bar{x})^4}{(n-1)(n-2)(n-3)s^4} \dots\dots\dots(1.31)$$

To obtain the calculation result of the standard deviation on the type of distribution log person III can use the formula in equation 1.32.

$$\text{Standard deviation (S log x)} = \frac{\sum_{i=1}^n (\log x_i - \log \bar{x})^2}{n-1} \dots\dots\dots(1.32)$$

To obtain the result of the calculation of the coefficient of inclination in the type of distribution of person III logs can use the formula in equation 1.33.

$$\text{Slope coefficient (Cs log x)} = \frac{n \sum_{i=1}^n (\log x_i - \log \bar{x})^2}{(n-1)(n-2)s^2} \dots\dots\dots(1.33)$$

The next step is to calculate the average rainfall of the day an which is calculated using the Mononobe method as formulated in equation 1.34.

$$I_t = \frac{R_{24}}{24} \left(\frac{24}{t}\right)^{\frac{2}{3}} \dots\dots\dots(1.34)$$

Then a calculation is carried out to calculate the rainwater discharge that will be received by the building area or called the plan discharge. To calculate the plan discharge can be used equation 1.35.

$$Q = \frac{C \times I_t \times A}{3.6} \dots\dots\dots(1.35)$$

5. Infiltration Well and Drainage Channel Planning

Calculating the volume of flood share using equation 1.36

$$V_{ab} = 0.855 \times C_{tadah} \times A_{tadah} \times R \dots\dots\dots(1.36)$$

Calculates the volume of pervasive rainwater using equation 1.37. Followed by the effective rainfall duration calculated using equation 1.38.

$$V_{rsp} = \frac{t_e}{2.4} \times A_{total} \times K \dots\dots\dots(1.37)$$

$$t_e = 0.9 \times \frac{R^{0.92}}{60} \dots\dots\dots(1.38)$$

For the walls of infiltration wells that are not impermeable, then the equation of value K is written in equation 1.39.

$$K_{average} = \frac{K_v \times A_h + K_h \times A_v}{A_{total}} \dots\dots\dots(1.39)$$

Calculating the volume of the shelter can use equation 1.40

$$V_{storasi} = V_{ab} - V_{rsp} \dots\dots\dots(1.40)$$

After obtaining the reservoir volume, it is necessary to calculate the total height of the infiltration well which can use equation 1.41.

$$H_{total} = \frac{V_{storasi}}{Luas Dinding} \dots\dots\dots(1.41)$$

After getting the total high value of the infiltration well, then calculate the number of infiltration wells using the equation 1.42.

$$n = \frac{H_{total}}{H_{sumur}} \dots\dots\dots(1.42)$$

Pipes are the main factor in draining water that falls on the roof to be then channeled into drainage channels and infiltration wells. For pipeline planning can use 2

methods, namely with the Hazen-Williams equation or based on SNI 8153-20015. In SNI 8153-2015.

6. Drainage Canal Planning

In making drainage planning can use trapezoidal cross-sectional forms. To calculate the planning of drainage channels can use equation 1.43.

$$Q = h^2 \sqrt{3} \times \frac{1}{n} \left(\frac{h}{2}\right)^{\frac{2}{3}} S^{\frac{1}{2}} \dots \dots \dots (1.43)$$

To determine the dimensions of the trapezoidal drainage channel can be using equation 1.44.

$$B = \frac{2}{3} h \sqrt{3} \dots \dots \dots (1.44)$$

After the width of the channel base is obtained, it then calculates the wet cross-sectional area, the circumference of the wet channel, and the hydraulic radius using the equations 1.45, 1.46, and 1.47.

$$P = 2h \sqrt{3} \dots \dots \dots (1.45)$$

$$A = h^2 \sqrt{3} \dots \dots \dots (1.46)$$

$$R = \frac{A}{P} \dots \dots \dots (1.47)$$

Then calculate the height of the channel guard based on the water rate with the equation 1.48.

$$V = \frac{1}{n} R^{\frac{2}{3}} S^{\frac{1}{2}} \dots \dots \dots (1.48)$$

1.4.2 Transportation Planning

According to Binkot (1997) from the Manual Kapasitas Jalan Indonesia (MKJI), transportation engineering planning concludes of the traffic volume calculation using data from the traffic survey, trip generation and pull, and parking analysis. Transportation planning for the hospital planning uses MKJI (1997) as the guide along the process. The purpose for transportation planning is to ensure that the parking space requirement for the hospital is fulfilled and to make sure that congestion won't occur on the road around

where the hospital is built. The following is the approach and method used during transportation planning :

1. Traffic Survey

A traffic survey is an observation of when a vehicular or pedestrian traffic count that passes through certain points, intersections, roads, and paths during a specific time interval according to Salisu & Oyesiku (2020). There are several implementation methods for traffic surveys, one of which is the manual method. The manual traffic survey method is a method that is quite often used because it does not require complicated preparation and tends to be able to eliminate errors caused by the behavior of drivers in Indonesia who tend to be undisciplined in driving in their lanes.

In the hospital planning, the author decided to use the manual traffic survey method. The tools used in the manual traffic survey method are simple tools, such as meters, ropes, cameras, and applications on mobile phones to help count vehicles, and stationery. In this method, vehicles are divided into 5 types, namely passenger cars, motorcycles, buses, trucks, and bicycles. The observation period was carried out 3 times in 1 day where each observation had an interval of 15 minutes in 1 hours.

The following are the steps carried out in the manual traffic survey method carried out by the author:

- Preliminary

This is done before conducting a direct survey of the location, the purpose of this activity is to determine the location whose traffic conditions and environment are similar to the location of the original project located in Kapuas Hulu.

- Field Survey

Field surveys are carried out by directly plunging into the field to make several observations such as the volume of the vehicle, the time needed for the vehicle within a distance that has been determined by the author, and side obstacles. This survey needs to be done because the data obtained from observations needs to be used.

The number of vehicles obtained within the 15 minutes interval during the 1 hours period will be multiplied by the unit of passenger car (SMP), in doing so, the following equation 1.49 is obtained.

$$\text{Volume} = \text{total vehicle} \times \text{SMP} \dots\dots\dots(1.49)$$

Once converted, the traffic volume of the peak hour of one type of vehicle during the observation period can be obtained.

2. Road Capacity Analysis

During road capacity analysis depending on the type of parameter, certain data will be put into the calculation, that is why in order to complete the analysis first the parameters need to be identified. The following are identification if the parameter:

- The first parameter is the base capacity, following the characteristic of the hospital road.
- Another parameter is the widening cause factor, which is based on the road type along with the road width.
- The third parameter is determined by measuring the course separation of the road.
- Next parameter is identified by measuring the effective roadside and by the road type.
- Fourth parameter is obtained by knowing the city size by the amount of million citizens, for the hospital project.

With all the parameters set, to find the capacity of the road, they will then be calculated using the following equation 1.50.

$$C = C_0 \times FC_W \times FC_{SP} \times FC_{SF} \times FC_{CS} \dots\dots\dots(1.50)$$

3. Parking Space Requirement (KRP)

To calculate the parking space requirement, first it is necessary to know the SRP value of the passenger cars and motorcycles. For the hospital, SRP calculation will be based on the number of total beds available, while the management room for the hospital will use the effective area to get the SRP value. The calculation for SRP can be seen in the equation 1.51 below.

$$\text{SRP} = V_p \times \text{Parking Space Need} \dots\dots\dots(1.51)$$

Parking space requirement is obtainable by multiplying the planned parking space unit and peak vehicle volume that parks based on the accumulated data that is obtained from the following equation 1.52 below.

$$\text{KRP} = V_p \times \text{SRP} \dots\dots\dots(1.52)$$

The KRP value obtained for both the hospital and hospital management room will then be added up to get the total KRP for the project

1.4.3 Construction Management Planning

For the construction management planning it covers the process of arranging the budget plan that is based on the basic unit price from Pergub No.89 for the West Kalimantan region in the year 2020. Further into the planning, it also focuses on developing the project scheduling, activities duration, and S Curve of the activities.

1. Unit Price Analysis Calculation

The unit price calculation using equation 1.53, uses West Kalimantan Pergub No.89 for the year 2020 as the guide for the unit price of the materials and workers.

$$AHSP = \text{coefficient} \times \text{unitprice} \dots\dots\dots(1.53)$$

2. Volume of Work Calculation

a. Work in units of lump sum - ls

The volume calculated cost needs for 1 month multiplied by the approximate number of months of completion of the work, For example, following equation 1.54 working water and work electricity work is calculated payment of working water and work electricity for 1 month multiplied by how many months the work was completed.

$$\text{Volume} = \text{Unit Price} \times \text{Total month of work} \dots\dots\dots(1.54)$$

b. Work in units of length – m1

The volume is calculated using equation 1.55 based on the length of the construction according to the drawing of the plan by observing the scale on the drawing. Because cost is the multiplication of volume by unit price, it is necessary to pay attention to the unit price analysis where the analysis is carried out every 1 m1 (one meter of length).

$$\text{Volume} = \text{Total of length} \dots\dots\dots(1.55)$$

- c. Volume of work in units of area – m² uses the following equation 1.56.

$$V = p \times l \dots\dots\dots(1.56)$$

Description:

V = Volume

p = Length

l = Width

- d. Calculating for volume of work in units of volume – m³ uses equation 1.57.

$$V = p \times l \times t \dots\dots\dots(1.57)$$

Description;

V = Volume

p = Length

l = Width

t = height/ depth of excavation

- e. While volume of work in units – bh will use the total material needed as the volume of work by using equation 1.58.

$$\text{Volume} = \text{total of materials needs} \dots\dots\dots(1.58)$$

3. Estimated activity duration

When estimating the work duration of 1 worker in 1 day, by using the coefficient from AHSP Bidang Cipta Karya (2022), the duration can be calculated using equation 1.59 :

$$\text{Duration} = \text{worker} / \text{worker coefficient} \dots\dots\dots(1.59)$$

While for coefficient ManHour the equation used is equation 1.60:

$$\text{Duration} = \text{Volume of Work} / (\text{Duration of Work in 1 day} \times \text{number of workers}) \dots\dots\dots(1.60)$$

4. Approaching the progress of work at planned cost

The calculation used in order to approach the progress of work at planned costs is equation 1.61.

$$\text{Value} = (\% \text{ completion}) \times \text{Cost} \dots\dots\dots(1.61)$$

5. Calculation of work weight

To be able to generate the bar chart, each work need to have the weight of work calculated. This can be achieved by using equation 1.62.

$$\text{Weighting} (\%) = (\text{Cost of each job} / \text{Total cost}) \times 100\% \dots\dots\dots(1.62)$$

6. Bar chart

For generating the bar chart after obtaining the weight of each work in order to generate the s curve the following equation 1.63 is applied to the weight of each work.

$$\text{Result} = \text{Weight of works} / \text{Duration} \dots\dots\dots(1.63)$$

7. Progress

After the bar chart is generated, the divided weight of work in each chart is added up following equation 1.64 in order to track the progress of the project.

$$\text{Result} = \text{total of (weight of works/duration per week)} \dots\dots\dots (1.64)$$

With the total progress, it will then be possible to calculate the cumulative progress for each week by using the equation 1.65.

$$\text{Result} = \text{total weekly plan progress} + \text{plan progress per week} \dots\dots\dots(1.65)$$

1.5 Final Project Outline

Chapter I is the preface which consists of the background of the hospital planning, problem, objective and scope of the problem, approaches and methods used for the planning. Chapter II focuses is the discussion about the water planning which focuses on the clean water piping system and drainage channel that covers the calculation for pipe size for the fixture unit load (UBAP), drainage channel, and infiltration well. Chapter III revolves around the discussion of the transportation planning where it emphasizes on parking analysis to determine the parking capacity, and ensuring so that congestion will

not occur in the road surrounding the hospital. Chapter IV is where the report will discuss the construction management planning, specifically the cost and time to determine the project schedule and budget plan.

