

CHAPTER IV

COST AND TIME DESIGN

4.1 Introduction

The design of Cost and Time is start after Super Structure and Sub Structure design is finished. The aim of this chapter is to determine cost and duration of the project. In this cost and time design, it will start from creating Work Breakdown Structure (WBS) and technical specification, work volume analysis, work unit price analysis, work duration analysis, relationship between work analysis, creating network diagram, creating bar chart and s-curve as shown in figure below.

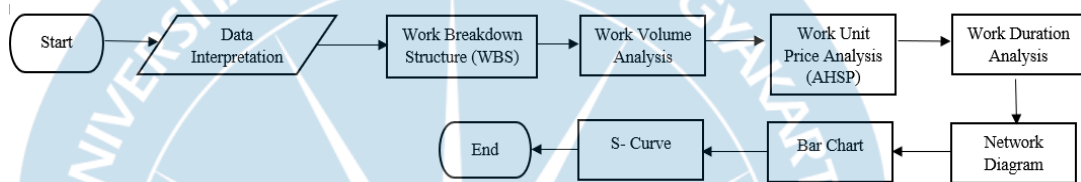


Figure 14. Cost and Time Design Flowchart

4.2 Creating Work Breakdown Structure (WBS)

Work Breakdown Structure (WBS) is a clustered task in a specific group such as related activities. In this design, Work Breakdown Structure start with preparation work in project such as land clearing, temporary fence installation, bouw plank installation, project name board and construction sign installation and temporary office and storage. Temporary office is used as briefing place for workers and engineer in project site and also place where workers and engineer rest. Temporary storage used as place to store the material and equipment in the work site so the mobilization of material and equipment is easy. Because fence, office and storage is only temporarily needed, in this design the fence, office and storage is rented.

then continue to advance work such as soil and land work, such as soil excavation, land fill, sand fill, excess soil and elevation levelling. Because often in the project, the elevation of the soil is not equal, in some part it very high and some part it very low. After soil and land work is completed, then proceed to foundation installation. In this design, the foundation design is bore pile foundation, so to install it, first drill the soil where the foundation will be constructed, then pile cap installed, and in the end bore pile installed from the precast bore pile.

After preparation, soil, and foundation work done, we construct the rebar in Library, Co-working and Fly Over building. The work is divided in first floor, second floor, third floor and and roof. For first floor, The rebar in Library will be constructed in sloof installation, column installation, slab installation and confinement bar. For rebar in Co-working, it will be constructed in column installation, beam installation, slab installation and confinement bar. And for the rebar in Fly Over, it will be constructed in column installation and confinement bar. Beside it, because there is stair construction from first floor to second floor, stair bar also will be installed. Then proceed to electrical installation such as AC electrical input, then indoor and grounding electrical installation. After that, proceed to plumbing installation, which is divided into 3 different installation, clean water, wastewater and sanitary. Waste water come from toilet and also sanitary. Biking installation also mandatory for super structure installation in first floor, which is sloof , column , beam , slab and stairs. After biking installation is done, the work in first floor is casting the super structure in first floor, which is sloof casting, column casting, beam casting, slab casting and stairs casting.

For second floor, The rebar in Library will be constructed in column installation, beam installation, slab installation and confinement bar. For rebar in Co-working, it will be constructed in column installation, beam installation, slab installation and confinement bar. And for the rebar in Fly Over, it will be constructed in column installation, beam installation, slab installation and confinement bar. Beside it, because there is stair construction from second floor to third floor, stair bar also will be installed. Then proceed to electrical installation such as AC electrical input, then indoor and grounding electrical installation. After that, proceed to plumbing installation, which is divided into 3 different installation, clean water, wastewater and sanitary. Waste water come from toilet and also sanitary. Biking installation also mandatory for super structure installation in second floor, which is column , beam , slab and stairs. After biking installation is done, the work in first floor is casting the super structure in second floor, which is column casting, beam casting, slab casting and stairs casting.

For third floor, The rebar in Library will be constructed in column installation, beam installation, slab installation and confinement bar. For rebar in Co-working, it will be constructed in beam installation, slab installation, confinement bar and ring balk. And

for the rebar in Fly Over, it will be constructed only in column installation. Then proceed to electrical installation such as AC electrical input, then indoor and grounding electrical installation. After that, proceed to plumbing installation, which is divided into 3 different installation, clean water, wastewater and sanitary. Waste water come from toilet and also sanitary. Biking installation also mandatory for super structure installation in third floor, which is column , beam , and slab After biking installation is done, the work in third floor is casting the super structure in first floor, which is column casting, beam casting, and slab casting.

For roof work, The rebar only installed Library, which will be constructed in beam installation, slab installation, confinement bar and ring balk. After that proceed into plumbing installation which divide into 3 different installation, clean water, waste water and sanitary. There is also biking work in roof, such as beam and slab. There is casting work in roof, such as beam casting and slab casting. Beside it, roof light steel and galvalume roof is installed and roof water drainage for both in Library and Co-working.

Beside first floor, second floor, third floor and roof work, there is also wall work, in this design it will be divided into light weight brick installation, plastering for Library and Co-working, installation of aluminium frame, glass door, wood frame and the last acian. To make the building is safe after construction, normal lock, toilet lock, window lock, door hinge, window hinge, door closer, door holder, door stopper, glass 12 mm and glass 5mm is installed. Flooring and top installation also done in this design.

To complete sanitary work, some material is installed such as Monoblock, urinary, washtafel, dish wash and floor drain. For interior work, lamp switch, box and painting is completed. And last, after all work from preparation work until interior work is completed, cleaning the site is important to make sure any leftover equipment and material secured.

4.3 Work Volume Analysis

After creating Work Breakdown Structure (WBS), work volume analysis is done because a detailed and comprehensive volume is needed in each work related to the construction. The work volume analysis is divided from preparation work until interior work. The volume is obtained by following formula:

Volume = dimension of material in work * number of materials needed in work

Preparation work is divided into land clearing which have volume of 1482 m³, bouw plank installation which have volume of 254 m, temporary fence installation which have volume of 350.56 m, temporary office which have volume of 20 m², temporary storage which have volume of 50 m². For project name board and construction sign, the total volume is gathered from total unit that needed for this design, which both of project name board and construction sign need 2 unit.

For soil and land work, is divided into soil excavation which have volume of 1038 m³, land fill of 467.1 m³, sand fill which have volume of 51.9 m³, excess soil which have 519 m³ and elevation which have volume of 1005 m³. The excess soil is taken out from the site and the elevation make the soil in the site is even. For foundation installation, because in this design used bore pile foundation, the drilling have volume of 229.2106 m that follow the bore pile installation which is 229.2106 m³. Pile cap installation also installed in volume of 519 m³ and followed by precast bore pile which have volume of 1680 m.

For first floor, the rebar work in Library is divided into sloof installation which have volume of 8283.15743 kg, column installation which have volume of 8937.18048 kg, slab installation which have volume of 10985.3676 kg, and confinement bar which have volume of 7433.36214 kg. for Co-working rebar work, is divided into column installation which have volume of 2640.80299 kg, beam installation which have volume of 3391.15386 kg, slab installation which have volume of 12358.372 kg, and confinement bar which have volume of 2747.59963 kg. and the last rebar work in fly over, is divided only in column installation which have volume of 644.553025 kg and confinement bar which have volume of 157.2127077 kg. Stair bar installation for stair from first floor to second floor have volume of 1406.66145 kg.

Beside it, electrical installation in first floor also has AC Electric input volume of 210 m, indoor and grounding electrical installation volume of 348 m and 344 m. for plumbing installation, the work is divided into clean water that have volume of 47.5 m, wastewater which have volume of 22 m and sanitary which have volume of 45 m. for bikeisting work, the sloof have volume of 952.8 m², column which have volume of 789.3 m², beam that have volume of 386.4 m², slab which have volume of 2010 m² and stairs which have volume of 11.39422 m². And the last work in first floor in casting, which have sloof casting volume of 103.26 m³, column casting has volume of 84.73275 m³, beam casting volume of 42.18 m³, slab casting which have volume 120.6 m³ and stairs casting which have volume of 1.709133 m³.

For second floor, the rebar work in Library is divided into column installation which have volume of 8585.6061 kg, beam installation which have volume of 7565.35975, slab installation which have volume of 13783.3137 kg, and confinement bar which have volume of 21868.2019 kg. for Co-working rebar work, is divided into column installation which have volume of 2688.74495 kg, beam installation which have volume of 3391.15386 kg, slab installation which have volume of 12358.372 kg, and confinement bar which have volume of 5797.37973 kg. and the last rebar work in fly over, is divided in column installation which have volume of 692.494985 kg, beam installation which have volume of 1226.36719 kg, slab installation which have volume of 4261.5076 kg and confinement bar which have volume of 2001.04971 kg. Stair bar installation for stair from second floor to third floor have volume of 1406.66145 kg.

Beside it, electrical installation in first floor also has AC Electric input volume of 272 m, indoor and grounding electrical installation volume of 512 m and 564 m. for plumbing installation, the work is divided into clean water that have volume of 18.5 m, wastewater which have volume of 22 m and sanitary which have volume of 45 m. for bikeisting work, column which have volume of 746.1 m², beam that have volume of 396.6 m², slab which have volume of 2784 m² and stairs which have volume of 11.39422 m². And the last work in second floor in casting, which have column casting has volume of 83.10375 m³, beam casting volume of 217.11 m³, slab casting which have volume 167.04 m³ and stairs casting which have volume of 1.709133 m³.

For third floor, the rebar work in Library is divided into column installation which have volume of 8841.29655 kg, beam installation which have volume of 7565.35975, slab installation which have volume of 13783.3137 kg, and confinement bar which have volume of 22034.667 kg. for Co-working rebar work, is divided into beam installation which have volume of 3391.15386 kg, slab installation which have volume of 12358.372 kg, confinement bar which have volume of 5797.37973 kg and ring balk which have volume of 0.48181821 kg. and the last rebar work in fly over, is only in confinement bar which have volume of 1812.62042 kg.

Beside it, electrical installation in first floor also has AC Electric input volume of 138 m, indoor and grounding electrical installation volume of 396 m and 516 m. for plumbing installation, the work is divided into clean water that have volume of 14 m, wastewater which have volume of 12 m and sanitary which have volume of 30 m. for bikesting work, column which have volume of 564.3 m², beam that have volume of 1524.6 m² and slab which have volume of 2784 m². And the last work in second floor in casting, which have column casting has volume of 61.32375 m³, beam casting volume of 111.03 m³ and slab casting which have volume 480 m³.

For roof work volume, The rebar only installed Library, will be constructed in beam installation which have 7565.35975 kg, slab installation which have volume of 15914.0675 kg, confinement bar which have volume of 19624.3905 kg and ring balk which have volume of 1.63818192 kg. After that proceed into plumbing installation which divide into 3 different installation, clean water which have volume of 10 m, waste water which have volume of 4 m and sanitary which have volume of 4 m. There is also bikesting work in roof, such as beam that have volume of 1130.4 m² and slab that have volume of 2268 m². There is casting work in roof, such as beam casting which have volume of 83.32 m³ and slab casting which have volume of 136.08 m³. Beside it, roof light steel and galvalume roof is installed which have volume of 70.8112 m² and 888.94 m². There is also roof water drainage installation for Library and Co-working that have volume of 138 m and 68 m.

Beside first floor, second floor, third floor and roof work volume , there is also wall work volume, in this design it will be divided into light weight brick installation which have volume of 3745.247 m², plastering for Library and Co-working which both have volume of 3105.852 m² and 639.395 m², installation of aluminium frame which have

volume of 36.456 m², glass door which have volume of 93.75 m², wood frame which have volume of 25.3272 m² and the last acian which have volume of 3745.247 m². To make the building is safe after construction, normal lock which have volume of 65 unit, toilet lock which have volume of 21 unit, window lock which have volume of 81 unit, door hinge which have volume of 178 unit, window hinge which have volume of 162 unit, door closer which have volume of 68 unit, door holder which have volume of 68 unit, door stopper which have volume of 68 unit, glass 12 mm which have volume of 163.84 m² and glass 5mm which have volume of 37.2 m² is installed. Flooring that has volume of 3441 m² and top installation that volume of 3918 m² also done in this design.

To complete sanitary work, some material is installed such as Monoblock which have volume of 31 unit, urinary which have volume of 20 unit, washtafel which have volume of 26 unit, dish wash which have volume of 2 unit and floor drain which have volume of 41 unit. For interior work, lamp switch has volume of 163 unit, box has volume of 40 unit and painting which have volume of 8285.4222 m² is completed. And last, after all work from preparation work until interior work is completed, cleaning the site which have volume of 3201 m³ is important to make sure any leftover equipment and material secured.

4.4 Work Unit Price Analysis (AHSP)

Work unit price analysis (AHSP) is used to know in advance the expected cost at different phases of the project. AHSP usually created by Dinas Pekerjaan Umum dan Perumahan Rakyat (PUPR) in every district/regency in Indonesia. AHSP is the standard that used to analyse the work unit price in detail such as the material price, the human resource price and the equipment price. Usually, AHSP also contain the coefficient of the material and human resource for duration analysis later. In this design, the Work unit price analysis (AHSP) is taken from AHSP Magelang district and AHSP Yogyakarta district. AHSP Magelang is mostly used for this design, and some addition from AHSP Yogyakarta.

Preparation work is divided into land clearing which have has unit price of Rp 11,000, bouw plank installation which have unit price of Rp 188,749, temporary fence installation which have unit price of Rp 69,715.75, temporary office which have unit price of Rp 588,178.25, temporary storage which have unit price of Rp 446,395.75.

For project name board and construction sign, both of project name board and construction sign has unit price of Rp 231,364.10 and Rp 192,830.00.

For soil and land work, is divided into soil excavation which have unit price of Rp 111,268.56, land fill has unit price of Rp 41,507.95, sand fill which have unit price of Rp 218,680.00, excess soil which have unit price of Rp 1,709.00 and elevation which have unit price of Rp 183,847.95. The excess soil is taken out from the site and the elevation make the soil in the site is even. For foundation installation, because in this design used bore pile foundation, the drilling have unit price of Rp 491,992.72 that follow the bore pile installation which has unit price of Rp 1,023,350.00. Pile cap installation also installed has unit price of Rp 596,600 and followed by precast bore pile which have unit price of Rp 291.483.

For First floor rebar work, which is in Library, Co-working and Fly Over, for sloof installation, column installation, beam installation, slab installation and confinement bar have same unit price which is Rp 37,479.63. Stair bar installation also have same unit price of Rp 37,479.63.

Beside it, electrical installation in first floor also has AC Electric input has unit price of Rp 100,00, indoor and grounding electrical installation has unit price of Rp 21,000 and Rp 10,000. for plumbing installation, the work is divided into clean water that have unit price of Rp 48,795.22, wastewater which have unit price Rp 60,505.28 and sanitary which have unit price of Rp 33,115.28. for bikesting work, for sloof, column, beam, slab and stair have a same unit price which is Rp 383,443.94. And the last work in first floor in casting, which have sloof casting, column casting, beam casting, slab casting and stair casting has same unit price of Rp 963,968.12.

For Second floor rebar work, which is in Library, Co-working and Fly Over, column installation, beam installation, slab installation and confinement bar have same unit price which is Rp 37,479.63. Stair bar installation also have same unit price of Rp 37,479.63.

Beside it, electrical installation in first floor also has AC Electric input has unit price of Rp 100,00, indoor and grounding electrical installation has unit price of Rp 21,000 and Rp 10,000. for plumbing installation, the work is divided into clean water that have unit price of Rp 48,795.22, wastewater which have unit price Rp 60,505.28 and

sanitary which have unit price of Rp 33,115.28. for bikeesting work, for sloof, column, beam, slab and stair have a same unit price which is Rp 383,443.94. And the last work in second floor in casting, which have sloof casting, column casting, beam casting, slab casting and stair casting has same unit price of Rp 963,968.12.

For Third floor rebar work, which is in Library, Co-working and Fly Over, the column installation, beam installation, slab installation, confinement bar and ring balk have same unit price which is Rp 37,479.63.

Beside it, electrical installation in first floor also has AC Electric input has unit price of Rp 100,00, indoor and grounding electrical installation has unit price of Rp 21,000 and Rp 10,000. for plumbing installation, the work is divided into clean water that have unit price of Rp 48,795.22, wastewater which have unit price Rp 60,505.28 and sanitary which have unit price of Rp 33,115.28. for bikeesting work, for sloof, column, beam, slab and stair have a same unit price which is Rp 383,443.94. And the last work in third floor in casting, which have sloof casting, column casting, beam casting, slab casting and stair casting has same unit price of Rp 963,968.12.

For roof work volume, The rebar only installed Library, the column installation, beam installation, slab installation, confinement bar and ring balk have same unit price which is Rp 37,479.63.

After that proceed into plumbing installation which divide into 3 different installation, clean water that have unit price of Rp 48,795.22, wastewater which have unit price Rp 60,505.28 and sanitary which have unit price of Rp 33,115.28. There is also bikeesting work in roof, such as beam that have unit price of Rp 963,968.12 and slab that have unit price of Rp 963,968.12. There is casting work in roof, such as beam casting which have unit price of Rp 963,968.12 and slab casting which have volume unit price of Rp 963,968.12. Beside it, roof light steel and galvalume roof is installed which have unit price of Rp 190,609.10 and Rp 216,996.03. There is also roof water drainage installation for Library and Co-working that have same unit price of Rp 139,222.60

Beside first floor, second floor, third floor and roof work volume , there is also wall work volume, in this design it will be divided into light weight brick installation which have unit price of 135,631.10, plastering for Library and Co-working which both have

unit price of Rp 159,678.20 and Rp 242,178.20, installation of aluminium frame which have unit price of Rp 12,946.56, glass door which have unit price of 3,110,880.74, wood frame which have unit price of Rp 21,502,186.75 and the last acian which have unit price of Rp 24,000. To make the building is safe after construction, normal lock which have unit price of Rp 326,048.80, toilet lock which have unit price of Rp 57,583.90, window lock which have unit price of Rp 24,679.60, door hinge which have unit price of Rp 36,595.90, window hinge which have unit price of Rp 26,777.30. door closer which have unit price of Rp 109,191.50, door holder which have unit price of Rp 82,346, door stopper which have unit price of Rp 30,552, glass 12 mm which have unit price of Rp 411,105.20 and glass 5mm which have unit price of Rp 180,308.70 is installed. Flooring that has unit price of Rp 469,094.34 and top installation that has unit price of Rp 58,649.36 also done in this design.

To complete sanitary work, some material is installed such as Monoblock which have unit price of Rp 817,674.07, urinary which have unit price of Rp 996,853, washtafel which have unit price of Rp 262,130.88, dish wash which have unit price of Rp 154,708.40 and floor drain which have unit price of Rp 17,332.80. For interior work, lamp switch has unit price of Rp 61,106.10, box has unit price of Rp 72,017 and painting which have unit price of Rp 10,000 is completed. And last, after all work from preparation work until interior work is completed, cleaning the site which have unit price of Rp 12,000 is important to make sure any leftover equipment and material secured.

4.5 Work Duration Analysis

From AHSP that used in this design, which is AHSP Magelang and AHSP Yogyakarta, contain code and coefficient for the material and human resource. That coefficient is used to determine the duration of a specific work, using formula below:

$$\text{Duration} = \text{Coefficient} + \text{Number of Workers}$$

For the coefficient, every specific work is different although the human resource is same.

For number of workers, in this design it is an assumption as long as for every specific work, the number of the workers is no more than 50 and the number of foreman is no

more than 2. The carpenter, stone worker, machinery operator, welder, cement mixer, aluminium worker, glass worker, steel worker, electrical worker, and painter must no more than 25, also the head of the carpenter, stone worker, machinery operator, welder, cement mixer, aluminium worker, glass worker, steel worker, electrical worker, electrical worker and painter must no more than 2.

4.6 Network Diagram

Network diagram is a flow chart of all work in a project from the beginning until the project is finished. The chart in network diagrams represent the relation from one work to another. Network diagram made from collection of specific work because sometimes some works are dependent on others works. From network diagrams, we can establish work that must completely alone or can be done simultaneously with others work, because it can shorten the duration of a project happen. In this design, the method of network diagram that used is Bar/Gantt chart. Elements of network diagram that used in this design is Activity On Node (AON).

AON is a element of network that show each activity as a node to and arrows show the predecessor relationship. Predecessor in here means that activity/work that happen before the activity/work in the future or usually called successor. After that Precedence Diagram which is Extension of AON is used in this design. This Precedence Diagram allow current work to overlap another work. This make current work/successor can be started even before the predecessor start. If a work is started earlier without having wait for the predecessor finished, this activity called overlapping activities. Overlapping activities show a condition that might occur in the project where the project need to be completed in shorter condition.

4.6.1. Critical Task and Lag Time

Critical Task is the amount of time where the future successor work can be start with respect of predecessor work. Critical Task basically is the overlap range from one work to another work and usually occur in Finish to Start (FS) relationship where the predecessor work/activity must finish before successor work/activity start. Beside Critical Task, Lag Time also occur in the network diagram.

Lag Time is the range time needed for successor work is delayed with respect of predecessor work, Where there is first activity completes and there is a delay before

second activity starts, this is called Lag Time. Lag time can occur in every works/activity relationship. Critical Task and Lag time is used to modify relationship between works.

In this design, lag time is occur in Pile Cap installation and Borepile installation which is 3 days, casting sloof, beam, column, slab, stairs for library first floor up to third floor which is 3 days and Co-work first floor and second floor casting which is 3 days.

4.6.2. Relationship Type

1. Finish to Start (FS)

Finish to Start (FS) relation is the traditional relationship between work/activities. It means that predecessor activity must be completed in order successor activity to start. In this design, FS relation begin from Land Clearing to Bouw Planck work which is 3 FS, Bouw Planck to Office which is 6 FS and Bouw Planck to Storage which is 10 FS. Bouw Planck to Fence which is 4 FS, Fence to Project Name Board and Construction Sign which is 1 FS, Soil Excavation to Drilling which is 7 FS, Drilling to Pile Cap installation which is 7 FS + 3 Days and Drilling to Bore pile installation which is 7 FS + 3 Days.

Pile Cap installation to Library first floor column which is 54 FS and Bore pile installation to Co-work first floor bar installation which is 50 FS, Library first floor column to library first floor sloof which is 50 FS and Co-work first floor bar to Co-work first to second floor stair which is 50 FS, Library first floor sloof to Library first floor slab which is 66 FS and Co-work first to second stair to Co-work bekisting which is 8 FS. Library first floor slab to library first to second floor stair which is 8 FS and Co-work plumbing to Co-work casting which is 20 FS + 3 Days, Plumbing and Electrical library first floor to bikeisting sloof which is 22 FS, Plumbing and Electrical library first floor to bikeisting column which is 23 FS, Plumbing and Electrical library first floor to bikeisting slab which is 44 FS, Plumbing and Electrical library first floor to bikeisting first to second floor stair which is FS. From bikeisting sloof to Casting sloof which is 9 FS + 3 Days, bikeisting column to casting column which is 3 FS + 3 Days, bikeisting slab to casting slab which is 10 FS + 3 Days and Bikeisting first to second floor stair to casting first to second floor stair which is FS + 3 Days.

Co-working casting to Co-work second floor bar which is 35 FS, Co-work second floor bar to Co-work first to second floor stair which is 50 FS. Co-work first to second

floor stair to Co-work bikisting which is 8 FS. Co-work ring balk to casting which is 20 FS + 3 Days, casting to roof light steel which is 2 FS, roof light steel to galvalume roof which is 50 FS. Light weight brick Co-work to plestering which is 28 FS. Frame and glass Co-work to locks which is 6 FS. Topping Co-work to sanitary which is 2 FS and last Painting Co-work to cleaning which is FS.

For library, after casting sloof, column, slab and first to second floor stair is completed, it proceed into library second floor column work to library second floor sloof which is 50 FS, Library second floor sloof to Library second floor slab which is 66 FS, Library second floor slab to library second to third floor stair which is 8 FS, Plumbing and Electrical library second floor to bikeisting beam which is 22 FS, Plumbing and Electrical library first floor to bikeisting column which is 23 FS, Plumbing and Electrical library first floor to bikeisting slab which is 44 FS, Plumbing and Electrical library first floor to bikeisting first to second floor stair which is FS. From bikeisting beam to Casting beam which is 9 FS + 3 Days, bikeisting column to casting column which is 3 FS + 3 Days, bikeisting slab to casting slab which is 10 FS + 3 Days and Bikeisting second to third floor stair to casting second to third floor stair which is FS + 3 Days.

After casting sloof, column, slab and second to third floor stair is completed, it proceed into library third floor column work to library third floor sloof which is 50 FS, Library third floor sloof to Library third floor slab which is 66 FS, Plumbing and Electrical library third floor to bikeisting beam which is 35 FS, Plumbing and Electrical library first floor to bikeisting column which is 19 FS, Plumbing and Electrical library first floor to bikeisting slab which is 60 FS, Plumbing and Electrical library third floor to ring balk which is FS. From bikeisting beam to Casting beam which is 12 FS + 3 Days, bikeisting column to casting column which is 7 FS + 3 Days, bikeisting slab to casting slab which is 53 FS + 3 Days and ring balk to roof light steel is 2 FS. Roof light steel to galvalume roof installation which is 68 FS. Light brick library installation to plestering which is 28 FS, frame and glass library to locks which is 8 FS, topping to sanitary which is 4 FS and last painting to cleaning which is FS.

2. Start to Start (SS)

Start to Start (SS) relation usually in the beginning of predecessor and successor without considering the end of the predecessor or the successor. In this design, SS relation begin from start to land clearing which is 19 SS.

For library, from library column, sloof and slab in first floor to library first floor confinement bar which is SS. From library first to second floor stair to plumbing and electrical in first floor which is SS. For library column, sloof and slab in second floor to library second floor confinement bar which is SS, from library second floor confinement bar and library stair from second to third floor to plumbing and electrical in second floor which is SS. For library column, sloof and slab in third floor to library second third confinement bar which is SS, from library third floor confinement bar and library third floor slab to plumbing and electrical in third floor which is SS. From galvalume roof installation to roof drainage which is 4 SS, roof drainage to light brick installation which is 84 SS. From plastering to frame and glass library installation which is 15 SS. From locks to flooring which is 25 SS, flooring to topping which is 20 SS. From sanitary to interior installation which is SS and last from interior installation to painting which is 3 SS.

For Co-working, from Co-work bikeesting to electrical which is SS, electrical to plumbing which is SS. Co-work second floor bikeesting to electrical which is SS, electrical to plumbing which is SS, electrical to plumbing which is SS, plumbing to ring balk which is 7 SS. From galvalume roof to roof drainage which is 2 SS, roof drainage to light brick installation which is 84 SS. Plastering to frame and glass installation which is 10 SS. Locks to flooring which is 20 SS, flooring to topping which is 15 SS. Sanitary to interior which is SS and last from interior to painting which is 3 SS.

3. Finish to Finish (FF)

Finish to Finish (FF) relation mean that one work/activity can only be completed when other work/activity is done. Successor activity can only be done if the predecessor activity is done. This relation make two works can be run in parrarel, but the successor can be completely done if the predecessor activity is 100% completed. In this design, there is no FF relation happen.

4.7 Bar Chart and S Curve

Gantt or bar chart is one of the methods for scheduling work in project. Bar chart represent various works/activity with respect of the duration of completion. This chart is created in graphical way with x-axis represent the duration of completion and y-axis represent the work/activity. The length of the bar shows the duration required by works/activity to completed. This bar chart also need the work/activity relationship and work duration analysis before.

S-curve is a graph that represent data of a project, such as cost or human resource with the respect of duration. S-curve also represent the growth of the project where in the beginning stages the progress usually slow, and when the time being and progress of works is complete one by one, the growth accelerates rapidly that created a s-like slope in the middle and in the upper part, the works is usually stable and finished one by one until the cleaning of the project. In this design, the bar chart and S-curve is created in Microsoft Project.

Figure 15. S Curve for Cost per Week

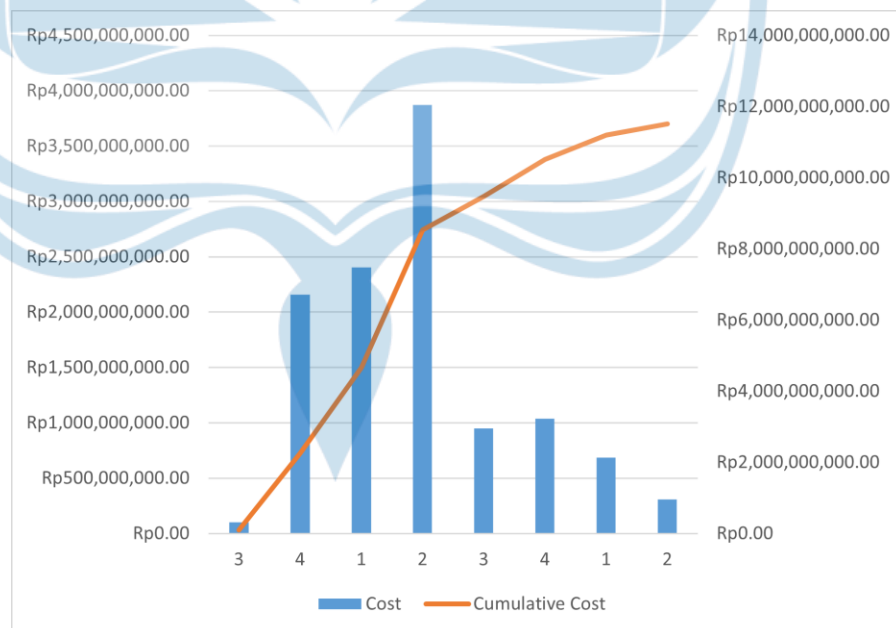
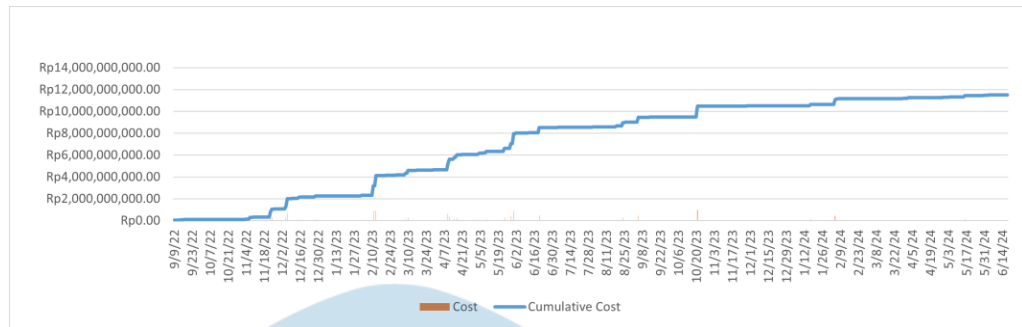


Figure 16. S Curve for Cost per Quarter



4.8 Conclusion

In this design, based on AHSP Magelang and AHSP Yogyakarta, The library structure total cost is Rp15,309,475,581.17. With that data we got building price is Rp3,839,848.40/m². For the duration of the project, it takes 649 days to finish.

4.9 Suggestion

In making this chapter, authors have some suggestion for future reference to the reader:

1. Long duration of work occurs because the calculation only using manpower for the work, not including machinery power.
2. Work unit price analysis (AHSP) mostly used from AHSP Magelang, AHSP Yogyakarta just an addition.
3. There is difference between factor that happen in the field and the calculation
4. Time factor that does not sufficient.

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