BACHELOR THESIS – ME 141502

DESIGN OF RESTOBARGE GARBAGE AND SANITARY SYSTEMS

RIZQI RAMADHAN PRATAMA
NRP. 4213 101 033

Supervisor
Ir. Hari Prastowo, M.Sc.
Ir. H. Agoes Santoso, M.Sc, M.Phil.

Departement of Marine Engineering
Faculty of Marine Technology
Institut Teknologi Sepuluh Nopember
Surabaya
2017

SKRIPSI – ME 141502

DESAIN TEMPAT PEMBUANGAN SAMPAH DAN SISTEM AIR BERSIH DI RESTOBARGE

RIZQI RAMADHAN PRATAMA
NRP. 4213 101 033

Dosen Pembimbing
Ir. Hari Prastowo, M.Sc.
Ir. H. Agoes Santoso, M.Sc, M.Phil.

Departemen Teknik Sistem Perkapalan
Fakultas Teknologi Kelautan
Institut Teknologi Sepuluh Nopember
Surabaya
2017

APPROVAL FORM

DESIGN OF RESTOBARGE GARBAGE AND SANITARY SYSTEMS

BACHELOR THESIS

Proposed to Fulfill One of the Requirements for Obtaining a Bachelor Engineering Degree
On
Marine Machinery and Systems (MMS) Laboratory
Study Program Bachelor Double Degree of Marine Engineering Department
Faculty of Marine Technology
Institut Teknologi Sepuluh Nopember Surabaya

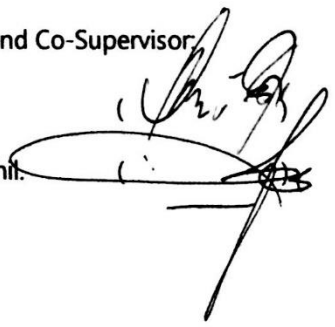
Prepared By:

RIZQI RAMADHAN PRATAMA

NRP. 4213 101 033

Approved by Supervisor and Co-Supervisor:

1. Ir. Hari Prastowo, M.Sc. (
2. Ir. H. Agoes Santoso, M.Sc, M.Phil. (



SURABAYA
July 2017

"This page is intentionally blank"

APPROVAL FORM

DESIGN OF RESTOBARGE GARBAGE AND SANITARY SYSTEMS

BACHELOR THESIS

Proposed to Fulfill One of the Requirements for Obtaining a Bachelor Engineering Degree
On
Marine Machinery and Systems (MMS) Laboratory
Study Program Bachelor Double Degree of Marine Engineering Department
Faculty of Marine Technology
Institut Teknologi Sepuluh Nopember Surabaya

Prepared By:

RIZQI RAMADHAN PRATAMA

NRP. 4213 101 033

Approved by Head of Marine Engineering Department:

Dr. Eng. M. Badrus Zaman, ST. MT.
NIP. 19770802200801 1007

"This page is intentionally blank"

APPROVAL FORM

DESIGN OF RESTOBARGE GARBAGE AND SANITARY SYSTEMS

BACHELOR THESIS

Proposed to Fulfill One of the Requirements for Obtaining a Bachelor Engineering Degree
On
Marine Machinery and Systems (MMS) Laboratory
Study Program Bachelor Double Degree of Marine Engineering Department
Faculty of Marine Technology
Institut Teknologi Sepuluh Nopember Surabaya

Prepared By:

RIZQI RAMADHAN PRATAMA

NRP. 4213 101 033

Approved by Representative Hochschule Wismar in Indonesia :

Dr.-Ing Wolfgang Busse

"This page is intentionally blank"

DECLARATION OF HONOR

I, who signed below hereby confirm that:

This bachelor thesis report has written without any plagiarism act, and confirm consciously that all the data, concepts, design, references, and material in this report own by Marine Machinery and Systems (MMS) in Department of Marine Engineering ITS which are the product of research study and reserve the right to use for further research study and its development.

Name : Rizqi Ramadhan Pratama
NRP : 4213 101 033
Bachelor Thesis Title : Design of *RestoBarge* Garbage and Sanitary Systems
Department : Double Degree Program in Marine Engineering

If there is plagiarism act in the future, I will fully responsible and receive the penalty given by ITS according to the regulation applied.

Surabaya, July 2017

Rizqi Ramadhan Pratama

"This page is intentionally blank"

DESIGN OF RESTOBARGE GARBAGE AND SANITARY SYSTEMS

Name : **Rizqi Ramadhan Pratama**
NRP : **4213101033**
Department : **Double Degree Program of Marine Engineering**
Supervisor 1 : **Ir. Hari Prastowo, M.Sc.**
Supervisor 2 : **Ir. H. Agoes Santoso, M.Sc, M.Phil.**

ABSTRACT

Barge business recently has diminished due to fall of coal industry which mostly delivered by barge. One of the solution is by convert a barge into a floating restaurant. The location of *Restobarge* selected in Gili Trawangan, Lombok because the average height of the waves in the area is just 0.9 meters and the depth of the sea is 6 meters, making it fit for the location of *Restobarge*. The statistic said that Lombok especially in Gili Trawangan is one of the most popular place to visit in Indonesia. Barge that used in converting is Barge SM 28 built by PT. Samudra Marine Indonesia. The purpose of this thesis is to design and calculate the Sanitary and Sewage system, design of Garbage Management, and calculate Material Requirement Planning of those systems. Therefore, it could giving the figure of how much it will the cost to the investor. From the data, sanitary system used Medium Galvanized Steel Pipe Ø 1.5 inch as intake pipe from land and suction pipe to hydrophore. From hydrophore to main object used Rucika VP/AW 1.5 inch. The system used Taiko TMC-32-0.75 centrifugal pump as pump to connect with Hydrophore Pressure Tank model Taiko UH-2.0 -1R. In sewage system, suction pipe system used Rucika PVC VP/AW 3 inch as main pipe, so do with discharge pipe. The sewage pump used model Iron Pump Q 4/300. In Garbage Management, the system use a room that connected to the small boat by a Rucika PVC pipe 12 inch. The Barge don't have a sewage treatment plant because the location of the *Restobarge* is 55 meters from land which more economical by used small boat to discharge into land. Total cost of material which spend to build *RestoBarge* is IDR 78.544.500, cost of drawing is IDR 7.000.000, cost of worker is IDR 27.000.000 with total 9 labor and total workday is 23 days. Total Cost needed to build all systems is IDR 115.244.500 with cost of contingencies is 1%, IDR 1.152.000.

Keyword : *Restobarge*, Material Requirement Planning, Sanitary, Garbage management, Design

DESAIN TEMPAT PEMBUANGAN SAMPAH DAN SISTEM AIR BERSIH DI RESTOBARGE

Nama : Rizqi Ramadhan Pratama
NRP : 4213101033
Departemen :Teknik Sistem Perkapalan Program Double Degree
Dosen Pembimbing 1: Ir. Hari Prastowo, M.Sc.
Dosen Pembimbing 2: Ir. H. Agoes Santoso, M.Sc, M.Phil.

ABSTRAK

Bisnis tongkang dalam beberapa tahun ini telah turun peminatnya karena lesunya industri batu bara yang menggunakan tongkang sebagai alat transportasinya. Salah satu solusi dalam menghadapi hal ini adalah dengan menjadikan tongkang menjadi restoran terapung atau *Restobarge*. Lokasi *Restobarge* direncanakan berada di GIli Trawangan, Lombok karena ketinggian rata-rata ombak hanya 0.9 meter dan kedalaman laut sekitar 6 meter, menjadikan Gili Trawangan sebagai lokasi yang pas untuk *Restobarge*. Data statistik menjelaskan bahwa Gili Trawangan merupakan salah satu destinasi paling popular di Indonesia. Tongkang yang digunakan untuk dijadikan restoran adalah Barge SM 28 buatan by PT. Samudra Marine Indonesia. Tujuan skripsi ini adalah untuk mendesain dan menghitung system air bersih dan air buangan restoran, mendesain system pembuangan sampah, dan menghitung anggaran biaya untuk material yang digunakan. Ini bertujuan agar para investor dapat melihat harga total dalam membangun system yang menunjang kelayakan Restobarge. Berdasarkan data, pipa air bersih menggunakan Medium Galvanized Steel Pipe Ø 1.5 inch carbon steel sebagai tempat masuk sampai ke hydrophore. Dari hydrophore ke object seperti toilet dan dapur menggunakan pipa Rucika VP/AW 1.5 inch. Untuk pompa menggunakan Taiko TMC-32-0.75 centrifugal pump untuk dihubungkan ke Hydrophore Pressure Tank model Taiko UH-2.0 -1R. Pada system pembuangan, dari unit ke sewage tank menggunakan pipa Rucika PVC VP/AW 3 inch sebagai pipa utama, untuk pipa pembuangan dari sewage tank ke darat menggunakan jenis pipa yang sama. Untuk pompa sewage menggunakan model Iron Pump Q 4/300. Pada system pembuangan sampah, disediakan sebuah ruangan dibelakang dapur dan dihubungkan ke perahu kecil dengan menggunakan pipa Rucika PVC 12 inch. *Restobarge* ini tidak mempunyai system pengelolaan air kotor karena lokasinya yang hanya berjarak 55 meter dari pinggir pantai, menjadikanya

lebih ekonomis jika dibuang melalui perahu kecil. Jumlah biaya dari material yang dihabiskan untuk membangun *RestoBarge* adalah IDR 78.544.500, biaya perancangan *Restobarge* adalah IDR 7.000.000, biaya pekerja adalah IDR 27.000.000 dengan total 9 pekerja and dan total pengerjaan selama 23 hari. Total biaya yang dibutuhkan untuk mengerjakan ketiga system tersebut adalah IDR 115.244.500 dengan biaya tak terduga diambil 1%, IDR 1.152.000.

Kata kunci: *Restobarge*, Material Requirement Planning, Sistem sanitari, system pembuangan sampah, Desain

PREFACE

Gratitude belongs only to Almighty God, Allah SWT, who has given his affection to the author for taking the time to complete this bachelor thesis. The author also does not forget to say the great thanks to all those who have contributed to and assisted in the writing of this bachelor thesis. Gratitude is given to:

1. Fahmy Yunarso and Tenny Esianty as the author parent who always inspired and pray to the author. Thank you for your unrequited love so the author can finish this bachelor thesis well. In addition, my brother Reza Satrya Dwitama.
2. Dr. Eng. M. Badrus Zaman, S.T, MT. as Head Department of Marine Engineering FTK-ITS, Surabaya.
3. Prof. Semin, S.T., MT., Ph.D as the Secretary of Marine Engineering Department.
4. Ir. Dwi Priyanta, MSE as Secretary of Double Degree Marine Engineering Program as well as those who have a lot to give aid knowledge preparation of this bachelor thesis.
5. Sutopo Purwono Fitri, S.T., M.Eng., Ph.D as Author's Lecturer Advisor since first semester until now.
6. Ir. Hari Prastowo, M.Sc. as supervisor 1 in this bachelor thesis for the assistance, teaching and guidance, especially in pipping systems and material requirements planning so the author can understand and finish this bachelor thesis well.
7. Ir. H. Agoes Santoso, M.Sc, M.Phil. as supervisor 2 in this bachelor thesis for the assistance, teaching and guidance especially in drawing for sewage, sanitary, and garbage systems so the author can understand and finish this bachelor thesis well.
8. Ninda Rubi Pramestya S.KH who always supporting me. Loving you is important to me. Your love is precious to me.
9. Alfa Muhammad Megawan, Datya Adyata Fiantara, Angya Prambiksono Jericho Tuparev and Adi Osis as friends who always give an optimistic idea.
10. Dimas Yansetyo who give an idea of *Restobarge* system.
11. Kontrakan Ashoy who sometimes bring drought to my life.
12. Barakuda 13 who always caring and accompany when happy or sad.

The author hope this bachelor thesis can help to increase knowledge and information to know the process of making *RestoBarge*, start from choosing the best sanitary and sewage until 3D design of related systems.

Therefore, the author expects criticism and suggestions either in writing or orally so that the author can develop science and make this task perfect.

Surabaya, July 2017

Rizqi Ramadhan Pratama

TABLE OF CONTENTS

LIST OF FIGURE

LIST OF TABLE

"This page is intentionally left blank"

CHAPTER I
INTRODUCTION

I.1. Overview Background

Barges business that transport coal is decreased recently due to economy depressed. Some barges are not operated and the others are scrapped. However, this time barge are not just transported coal or sand but start to spread to another industry like offshore and restaurant. Many ideas of people about utilizations barge when coal business was slow, one of the finest idea is to utilized barge into floating restaurant.

Tourism has become one of the largest income for nation in the last 20 years. In 2012, record number of international tourist (tourist travelling abroad) in 2012 reaching 1 billion people with revenue 1.3 trillion US$ and will increase in the next year. Another data state that 57% tourist are expected to visit destinations in countries whose economies are growth and developed, as well as Indonesia. Therefore, many countries, including Indonesia make tourism as major sector to develop and sector to increase the economy to be better. Indonesia as an archipelago state has a particular magnetism to be world best destination. Nevertheless, until 2013 Indonesia has been visited less than 1% of international tourist, that is 8,6 million international tourists. The number is still far from neighbor country like Malaysia with 25,7 million visits and Thailand with 26,7 million visits. Based on the data, it can be concluded that Indonesia must increase the ability to manage tourism and make an innovative tourism which spread in 33 provinces, include Lombok Island in order to compete with other tourist destination in the world. (UNWTO, 2013)

Figure 1.1 Lombok Island[1]

[1] RIPPARDA NTB, 2013

Lombok is an island in West Nusa Tenggara province. It is roughly 4,514.11km^2 total area. It also become a tourist magnet besides Bali. They also be assigned as National Tourism gateway in MP3EI Koridor V MP3EI (Masterplan Percepatan dan Perluasan Pembangunan Ekonomi Indonesia). There is some popular place that usually be visited in Lombok like Mataram, Rinjani Mountain and Gili Trawangan. In 2015, the number of tourists visiting Gili Trawangan reach 10.000 visitors with tickets sold from Port Bangsal to Gili Trawangan reach the 8200 ticket. Total tourist visits both domestic and international tourists in 2015 reached 503.541 thousand people with an average increase of 15-20 percent (Rasi-Rimanews, 2015). With that statistics, Lombok Island specifically Gili Trawangan is one of the popular place to be visited. The idea to convert barge (*deck cargo barge*) into floating restaurant can be the alternative solution to increase tourist desire.

One of FTK alumnus ever technical analyze cargo barge 250 ft into *RestoBarge* (Restaurant Barge) located in Lombok. Here the author focused in sewage and sanitary systems and 3D modelling in cost of sewage and sanitary systems. Barge, which used as data for analysis is Barge SM 28 built by PT. Samudra Marine Indonesia.

I.2. Problems

1. What is the suitable system & design for sewage in *RestoBarge*?
2. What is the suitable system & design for sanitary in *RestoBarge*?
3. What is the suitable system & design for garbage management in *RestoBarge*?
4. What is the pipping and pump specification for sewage in *RestoBarge*?
5. What is the pipping and pump specification for sanitary in *RestoBarge*?
6. How are the MRP for related system?

I.3. Limitations

1. The author will design sewage system until 3D.
2. The author will design sanitary system until 3D.
3. The author will design garbage system until 3D.

I.4. Objectives

1. To obtain the suitable system & design for sewage in *RestoBarge*.
2. To obtain the suitable system & design for sanitary in *RestoBarge*.
3. To obtain the suitable system & design for garbage in *RestoBarge*.
4. To obtain the MRP in *RestoBarge*.

I.5. Benefit

1. To be used as reference for barge owner to convert barge to a restaurant.

CHAPTER II
LITERATURE REVIEW

II.1 Barge

In this section, the author will explain about barge and the classification of barge by type of load or cargo and *RestoBarge* itself.

II.1.1. Barge Definition

Barge is a long flat-bottomed boat for carrying freight on canals and rivers, either under its own power or towed by another (Oxford Dictionaries, 2016). Barge is type of vessels, which mainly used for the purpose of carrying large load like grain, coals, woods, sands and other materials. However, unlike the other vessels, mostly of barge do not have an engine as main power and do not have propeller as main propulsion. They must be tugged or towed by another vessel like tugboat. Barge usually used in river, lakes or canals but they are extensively used at seaports. A barge is flat-shaped on its bottom. The purpose for this particular shape is to ensure that barge can carrying more load. (Marineinsight, 2016)

Figure 2.1 Barge with Tugboat[2]

In figure 2 the tugboat tugged barge when carrying load. Usually barge sell or rent parallel with tugboat. Rarely can see seller rent or sell barge without tugboat. Because without tugboat, barge cannot move to the desired

[2] Diliff, 2016

destination, like a big box floating in the sea. The only exception, which barge doesn't need tugboat when at berthing and unloading condition.

II.1.2. Barge Classification

Based on load, barge can be classified as four section:

- **Barracks Barge:** A barracks barge is also known as houseboat. Houseboats are a very common site in places like Cambodia, Australia and Canada. As the name suggests, these types of barges are mainly use for residential purposes and look very eye-catching while they float as stationary objects in rivers and lakes. In Indonesia it is not so popular even rare.

Figure 2.2 Barrack Barge[3]

In figure 3 barrack barge still do not have propulsion because it tugged by tugboat.

- **Dry Bulk Cargo Barges:** These types of barges, as their name suggests, are used to haul and ferry dry cargo. When the aspect of dry cargo is considered, it includes food grains, sand, minerals like steel and coal and other dry commodities that can be transferred through the system of barges. In Indonesia itself, it's the most frequently used.

[3] http://render.fineartamerica.com/, 2016

Figure 2.3 Dry Cargo Bulk Barge[4]

In figure 4 dry cargo, bulk barge transport coal and tugged by tugboat. Due to fall off price of coal, this type of barge has started to decreased.

- **Barges Carrying Liquid Cargo**: These types of barges are completely opposite to the dry bulk cargo barges. These barges are very useful in carrying petrochemicals, fertilizers that are used mainly in the liquid state, and other necessary important industrial liquid chemicals.

Figure 2.4 Barge Carrying Liquid Cargo[5]

In figure, 5 liquid are put in the hull of barge.

- **Car-float Barges:** This type of barge was mainly used during the early 20thcentury to ferry rail carts. In simple terms, it can be said that these rail-carts attached to the barges were as portable rail-sets ferried from one location to another. In today's times, car-float barges, still function in some parts of United States of America. In Indonesia itself, this kind of

[4]http://2.bp.blogspot.com/, 2016
https://en.wikipedia.org/wiki/Liquid_cargo_barge[5]

barge usually used in area that not have bridge, or as an emergency if ferries aren't enable to carry load.

Figure 2.5 Car Float Barges[6]

In figure 6 the vehicle are put on upper side of car float barge.

II.1.3. RestoBarge

RestoBarge is a combination of restaurant and barge to be an alternative tourist attraction. It will have located in Gili Trawangan – Gili Meno which is located on the northern island of Lombok, West Nusa Tenggara. 2 of these island is one of the tourist destinations most frequently visited by tourists who visited Lombok. According to Dimas (2016), *Restobarge* will be located approximately 55 meters to the east of the shoreline Gili Trawangan Port, where the average height of the waves in the area is 0.9 meters, with a sea depth is about 6 meters (Forecast.com, 2016). That explains waves in the Gili Trawangan is not too big or dangerous, making it suitable for being used as *RestoBarge* location.

[6] http://image.shutterstock.com/

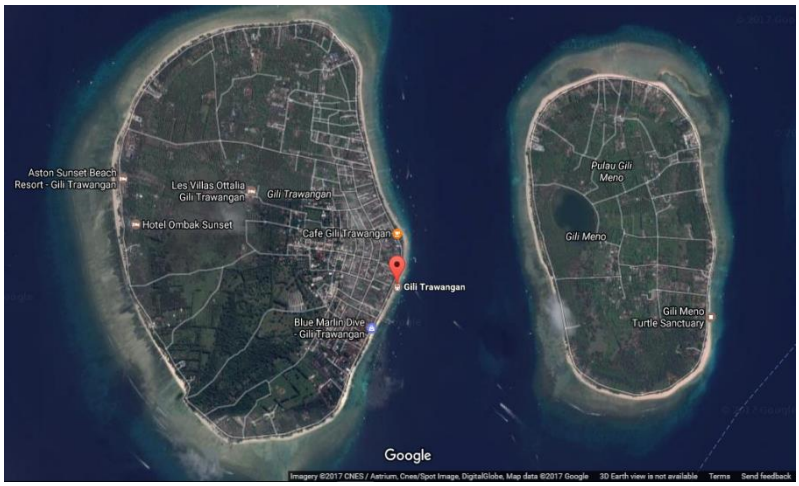


Figure 2.6 Gili Trawangan & Gili Meno Islands[7]

In figure 7 Gili Trawangan & Gili Meno Islands from sky view.

The restaurant is a place or building that is organized commercially which provide good service to all guests either food or beverages (Marsum, 1994). Restaurant according Ministry of Tourism No.KN.73/PVV105/MPPT-85 on Business Regulation of Restaurant is "A business that provides food and beverage services which are managed commercially". While Ministry of Health No. 304/Menkes/Per/89 about requirements of restaurant is "The restaurant is a kind of food service businesses located in most or all of the permanent building and equipped with equipment and supplies for the manufacture, storage and sale of food and drinks to the public at the place of business". Generally, the restaurant is a place to visit to find various kinds of food and beverages. Restaurants usually serve as a unique appeal, either through a menu of cuisine, entertainment and physical appearance of the building.

Based on Government Regulation No. 24, 1979, Restaurant is a business sector that is included in the field of tourism, and supervisors handed over to the Province Government Stage I. However, to achieve the procedures for arrangement and enhancement of the restaurant business, the government issued a decree of the Minister of Tourism, Post and Telecommunications No: KM 73/PW 105/MPPT-85 on Regulatory Affairs of Restaurant. Based on the decree indicates that the guidance and supervision of the restaurant is done by the Governor, while the procedure of supervision established by Governor as District Head Stage I. So to make a Restaurant should have a location permits and business permits, each set by the Governor as District Head Stage I. Meanwhile,

[7]Google Map, 2017

according to the SK Directorate General of Tourism No. 15/U/II/ 88 on the Implementation of the Provisions and Classification Restaurant indicate that licensing in the business of this restaurant can be generally divided into two types:

1. Izin Sementara Usaha Restoran
   Izin Sementara Usaha Restoran is a temporary permit, which is valid until 3 years and granted by the Director-General to establish a restaurant.
2. Izin Tetap Usaha Restoran
   Izin Tetap Usaha Restoran is a fixed license granted by the Director-General to establish the restaurant.

Guidance and supervision of the construction and operation of the restaurant conducted by the Director-General or his representative, as well as the transfer of ownership restaurants or change the name or location also must be reported in writing. Every restaurant must have permission from the Local Government in accordance with the regulations and legislation accepted, and to get a permit, each restaurant must have a certificate of hygienic from the Department of Health.

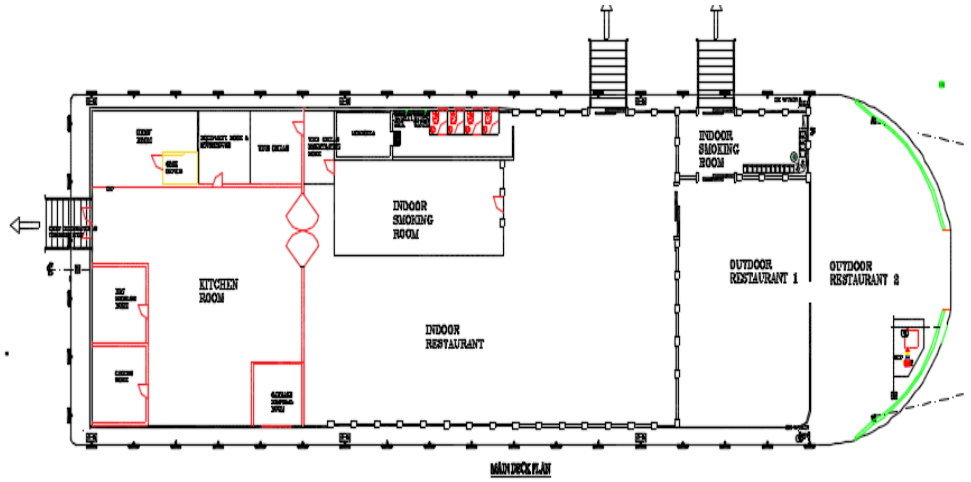


Figure 2.7 *RestoBarge* Plan[8]

In figure 8 is the design overview of *RestoBarge*.

Principal dimensions Deck Cargo Barge SM 28 before converting:

1. **Ship Name** : Barge SM 28
   - Flag : Indonesia

[8]Dimas Yansetyo, 2016

- Shipyard : PT. Samudera Marine Indonesia
- Port Registry : Jakarta
- *Gross Tonnage* : 1921 (2465 after converting) Ton
- Built : 2012
- Classification : Biro Klasifikasi Indonesia

2. **Principal Dimensions**

- *Length of overall* (LOA) : 76.25 m
- *Breadth moulded* : 21.345 m
- *Depth moulded* : 4.88 m
- *Draft* : 3.576 m
- *Min depth* : 1.237 m
- *Max. deck loading* : 7 ton/m^2
- Payload : 4000 ton
- Displacement : 5627 ton

II.2. Sewage and Sanitary

In this section, the author will explain about Sewage, Garbage Management Plan and Sanitary include pipping, treatment, and regulation.

II.2.1. Sewage

Marine environmental pollution is the common problem on ship nowadays. Discarding sewage produced onboard on a ship is one of the few tasks on a ship, which should be taken utmost care of if one wants to same him and his shipping company from heavy fine. The sewage generated on the ship cannot be stored on the ship for a very long time and it for a reason it has to be discharged into the sea. Though sewage can be discharged into the sea, it cannot discharge it directly overboard as there are some regulations regarding discharging of sewage that needs to be followed (marineinsight.com, 2016). Sewage on sea is generally the waste produced from toilets, urinals and toilets scuppers. The rules say that the sewage can be discharged into the seawater only after it is treated and the distance of the ship is 3 nautical miles from the nearest land (*Marpol Annex IV).* In *RestoBarge*, sewage start from scupper, toilets, wastafel, and galley.

In *RestoBarge,* sewage tank is below the kitchen besides the dimensions is 97 m^3 and draining time is 3 hours. In sewage tank there is a small half compartment to separate water and dirt. For sewage disposal systems, pipes shall conform to the standards of the most recent edition of the Uniform Plumbing Code published by IAPMO. Materials approved are acrylonitrilebutadienestyrene (ABS) and polyvinyl chloride (PVC) plastic pipe. Pipe diameter shall be three or four inches (Guidelines for Septic System Design for Commercial Buildings). After

know about the pipe standardization, next step is calculating pipe size to get pump specification.

The calculation procedures of sewage systems are:

a) Determine sewage tank by view previous thesis.
b) Determine the flow velocity and dewatering time.
c) Determine which size of pipe will prefer to the sewage systems.
d) Determine pipe manufacturers in terms of economics.
e) Determine the diameter outside in pipe manufactures catalog to get inside diameter and thickness.
f) Determine the Reynold Number(Rn) of suction pump by equation:
   Rn = (v x D) / n (2.1)
   v = velocity of water
   D = inside diameter
   n = viscosity
g) After get the answer from equation (2.1) the next step is to get mayor loses (hf) by equation:
   $hf = f \times L/D \times v^2/2g$ (2.2)
   f = friction of pipe
   L = suction pipe length
   D = inside diameter
   v = velocity of water
h) Determine the route of sewage pipe from main deck to tank, from tank to discharge, and pump location in AutoCAD.
i) Determine the accessories by drawing sewage pipe in AutoCAD to get minor losses(hl) by equation:
   $hl = k \times v^2/2g$ (2.3)
   k = accessories constant
   v = velocity of water
j) Next, formula to calculate discharge of pump is similar with equation (2.1), (2.2), and (2.3).
k) After get the solution from point i, determine Total Head by equation:
   HT = Hp + Hv + Hs + Hl (2.4)
   Hp = Head difference of Pressure
   Hv = Head difference of Velocity
   Hs = Head static
   Hl = Minor losses

l) After calculating equation (2.4), the next step is select specification of pump by open pump manufacturer catalog. Determine the pump unit by head and capacity from previous equation.

m) Determine the pipe, which pass to the compartment to be changed from PVC with Galvanized pipe and welded to the compartment. Next, PVC will be connected with Galvanized by flange.

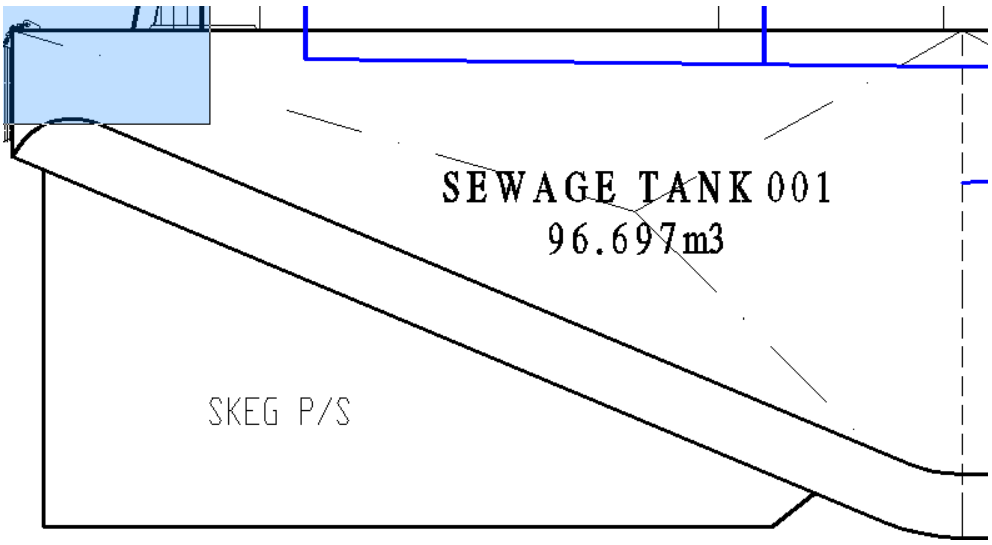


Figure 2.8 Sewage Tank in Restobarge[9]

II.2.2. Garbage Management Plan

Garbage means all kinds of victual, domestic and operational waste excluding fresh fish and parts thereof, generated during the normal operation of the ship and liable to be disposed of continuously or periodically except those substances, which are defined or listed in other Annexes to the present Convention (*MARPOL Annex V*). According to *Marpol Annex V,* shipboard generated garbage is classified into several categories:

- Plastics.
- Floating Dunnage, Lining or packing material.
- Ground-down paper products.
- Paper products.
- Food Waste.
- Incinerator Ash.

In *RestoBarge*, garbage contains every object who have been wasted except dirty water from galley. The garbage is discharge into shore by small ship, because according to *Marpol Annex IV* the sewage can be discharged into the

[9]Dimas YA, 2016

seawater only after it is treated and the distance of the ship is three nautical miles from the nearest land. Design of garbage management plan in *Restobarge* is by using the back room behind galley; also make a pipping system made by PVC pipe from garbage room to small ship, which transferred garbage into shore.

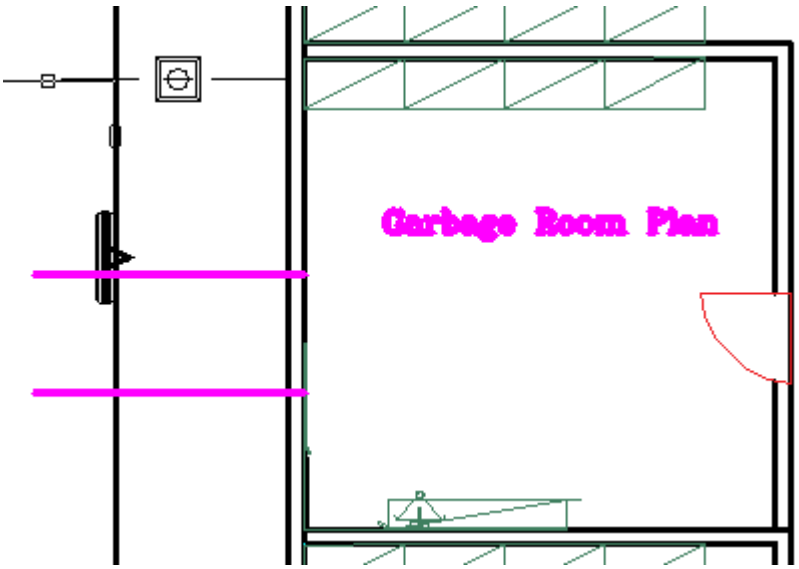


Figure 2.9 Garbage Disposal Plan[10]
(Source: Dimas YA)

In figure 11 is a reference how to select the desired garbage disposal plan.

II.2.3. Sanitary

Sanitary systems or fresh water systems are fresh water distributes systems in ships, which used to fulfill the requirement in ships like drinking, cooking, bathing, laundry etc. In *RestoBarge* itself, sanitary system consists of galley, ablutions, wastafel, toilets. Material that used in pipping system is PVC and Galvanized. PVC is acceptable in sanitary system, but if through the compartment shall use flange to connect PVC to PVC. To meet the water needs, the author used Hydrophore Tank to flow water into discharge alike toilets, galley and wastafel. Hydrophore is a pressurized tank to maintain the pressure of the water supplied to galley, ablutions. wastafel and toilets. It used to keep constant pressure of water. It will replace the used of regular pump in *RestoBarge*.

[10]Dimas YA, 2016

Capacity of fresh water tank in *RestoBarge* is 1415.804 ton. It consists of 3 fresh water tank. To input the fresh water, the author used water from land and delivered by small ship. There is two fresh water intake pipe in *RestoBarge* to move the fresh water into fresh water tank. Then there is a suction pipe made by Galvanized to fulfill the fresh water needs. Before choosing fresh water pump and hydrophore systems, the next step is calculate and determine pipe size to get pump specification.

The calculation procedures of sanitary systems are:

a) Determine the capacity of the pipe by equation:
   Q = water needs per day / working hour (2.5)
b) Determine the flow of water between 3-5 m/s.
c) Determine standard of pipping calculation by equation:
   $d = ((4 \times Q) / (v \times \pi)^{0.5}$ (2.6)
d) After get the result, compare the result with the pipe manufacturer's catalogue.
e) Since in suction side pipe is made by Galvanized to maintain strength, so find catalogue for galvanized pipe.
f) Determine the diameter outside in pipe manufactures catalog to get inside diameter and thickness.
g) Because of difference of diameter, the actual flow can be found by equation:
   $v = Q/(\pi/4 \times((d/1000)^2 \times 3600))$ (2.7)
   Q = Capacity of pipe
h) After get actual flow, continued to discharge pipe. Since discharge pipe is made by PVC, find catalogue for PVC pipe.
i) Diameter outside can be find with the same way as point f.
j) The actual flow of discharge pipe can be found by equation (2.7)
k) Determine Reynolds Number(Rn) by equation (2.1)
l) Calculate the length of suction pipe from tank to suction hole.
m) After get the answer from equation (2.1) the next step is to get mayor loses (hf) by equation (2.2)
n) Determine the accessories by drawing sanitary pipe in AutoCAD to get minor losses(hl) by equation (2.3)
o) The formula to calculate discharge of pump is similar with equation (2.1), (2.2), and (2.3). The different is to calculate the length of discharge pipe, we calculate PVC pipe from discharge of pump until Hydrophore tank, but PVC pipe unlimited from Hydrophore tank to object above main deck like galley and toilets.
p) After get the solution from point o, determine Total Head by equation (2.4)

q) After calculating equation (2.4), the next step is select specification of pump by open pump manufacturer catalog. Determine the pump unit by head and capacity from previous equation.
r) Determine the capacity of Hydrophore tank by equation:
   $Vh = Vo + (D \times Pm) / (t \times (Pm-Po))$ (2.8)
   Vo = Remaining FW in tank planning (2% V)
   Pm = Maximum pressure inside tank, planned 5.5 kg/m²
   Po = Minimum pressure inside tank, planned 3 kg/m²
s) After get the result, determine the desired tank by choose the specific data in catalogue of Hydrophore.
t) After get the result, find Hydrophore tank by specified capacity of fresh water per day divided operational hours.

II.3. MRP (Material Requirements Planning)

Preparation of Budget Plan / *Rencana Anggaran Biaya* (RAB) in a project is an activity that must be done before the project starts. However, before going to Budget Plan step, the next stage must do Bill of Quantity first (BQ). Bill of Quantity is a document who prepared by quantity surveyor that provides project specific measured quantities of the item of work. Quantities usually measured by number, length, area, volume, weight, or time (designingbuildings, 2016). In *RestoBarge*, Bill of Quantity used to determine the amount of work, type of material and how much material is needed.

Budget plan (RAB) is the calculation of the amount of costs required for materials and wages and other costs relating to the implementation of the building or project (Bachtiar Ibrahim, 2007). While according to Sugeng Djojowirono (1984) Budget plan is the estimated cost required for any work in a construction project that will be acquired in total costs necessary to complete a project. Budget plan is the number costs required both wages and materials in a project work. The list is providing volume, unit price, and total price of various types of materials and labor wages are needed for the implementation of the project. In *RestoBarge,* budget plan used for planning amount of costs involved in, like cost material for pipping, labor, licensing and permissions, treatments for sewage and sanitary, and unexpected costs.

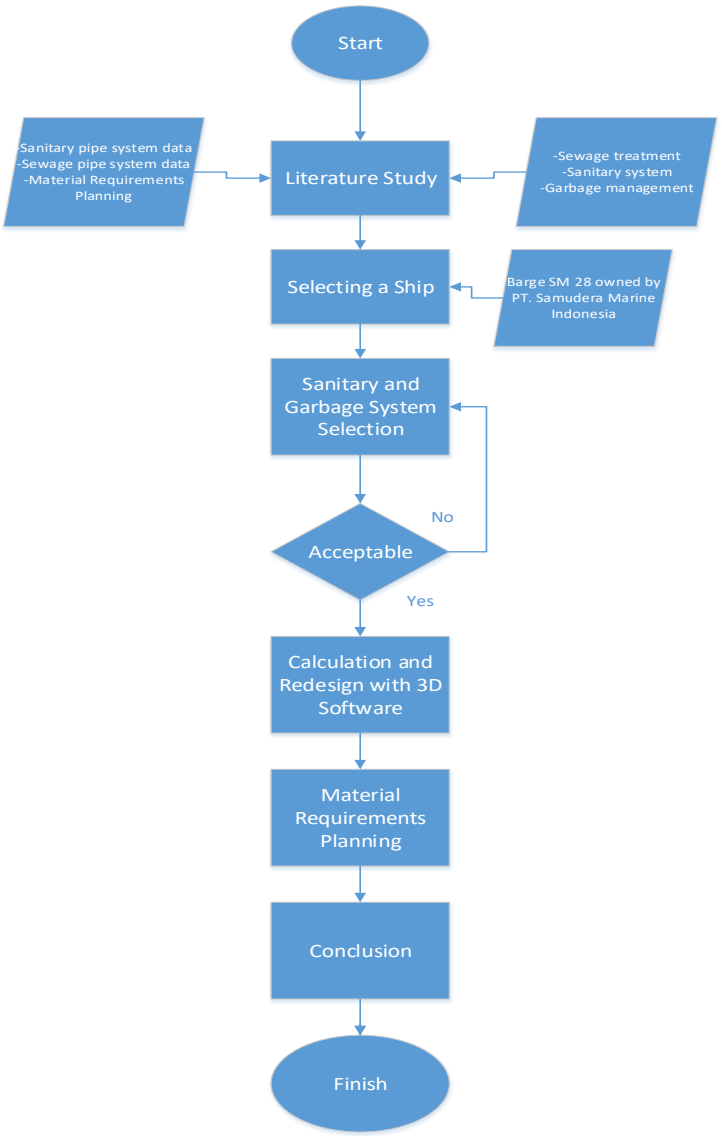
Material requirements planning (MRP) systems is a prominent approach to manage the material flow and components on the factory floor. MRP technique is used to explode bills of material, to calculate net material requirements and for production planning. The master production schedule and bill of materials indicates the materials to be dem anded, order scheduling, cycle time production and supplier lead times then these all factors jointly

determine when orders should be placed. (Dinesh E. D, 2014). In *RestoBarge,* MRP used to calculate amount of material in piping and the cost itself.

CHAPTER III
METHODOLOGY

III.1. Methodology Flow Chart

Methodology flow chart is the steps that will be taken to complete the thesis. Starting from stating the problem, literature study, collecting data, analyze the data, and making some conclusions. Here is the detail of the methodology flow chart:



III.2. Methodology Flow Chart Description

1. Problem Identification: In this section the author determined the method of writing Bachelor Thesis. The purpose of this thesis is to know the suitable system of sanitary, sewage and garbage in *RestoBarge* also pipping system in sanitary and sewage. The benefit of this thesis is to be used as reference for barge owner or entrepreneur to convert barge to a restaurant.

2. Literature Study: In this section the author read some literature from some EBook and previous thesis to know the standard specifications in Sanitary and Sewage. Author also read some literature to know about how to make a Material Requirements Planning. After read some literature it expected all are qualified to applicable regulation.

3. Selecting A Ship: The author used SM 28 Barge owned by PT. Samudera Marine Indonesia as data. The barge itself is still used currently.

4. Sanitary and Garbage system selection: In this section the author chooses the best and suitable system from literature study especially in Restaurant Regulation. In sanitary system to get the most economical, the author chooses Galvanized in sanitary pump suction to maintain strength of pipe, because it located inside tank. On discharge side until equipment resembling to toilet and galley, PVC pipe is the best choice because is less maintenance and cheap to get. But when meet to the compartment or different deck Galvanized is a must for pipping systems. Also the author gets an idea from MARPOL, IAPMO and PERDA Lombok Barat to get the best result. The goal is to get the most economical systems.

5. Calculation and Redesign: In this section the author get fresh water tank data on previous thesis to know about tank capacity. After that the author calculate diameter of pipe by pipe manufacturer catalogue. Afterward the author design the key plan of fresh water pipe to know about total length and minor losses of fresh water pipe. Next the author can get the pump specification because head and capacity is already known. After that the next step is calculating tank capacity and pump of Hydrophore to replace the used of pump. In calculating of sewage system, the working formula is slightly different with fresh water systems but overall is similar. After the author calculate, the author designed 3D systems in sanitary, sewage, and garbage with AutoCAD 3D Plant software. The final

calculation and design can be the final result to be a data to Material Requirements Planning. Material Requirements Planning limited to Sanitary, sewage and garbage include pipe connection, pump and Hydrophore.

6. Material Requirements Planning: In this section the author determined type of material, how much material is needed and cost in making of sanitary and sewage and garbage systems. MRP required pipe material, pipe connection, pipe length, type of pump, and Hydrophore. Also garbage systems component is included. The goal is to be a reference to entrepreneur and barge owner.

7. Conclusion: In this section is done after all analysis is done. Conclusion contain sanitary and sewage fix systems, garbage fix systems, and MRP final.

"This page is intentionally left blank"

CHAPTER IV
DATA ANALYSIS

IV. 1. Background

Barge business has been decreased lately due to the decrease of interest in coal. There are few alternatives in the utilization of barges. Rather than become wrecks, one of the alternatives that can be tried is to change the barge into a restaurant. Lombok has become one of the most popular destinations among tourists in besides Bali. There are 3 islands to be "excellent" in the north of Lombok that is, Gili Trawangan island, Gili Meno island, and Gili Air island. Of the three islands, Gili Trawangan is the most popular island and can be the location of *RestoBarge*. *Restobarge* will be located approximately 55 meters to the east of the shoreline Gili Trawangan Port, where the average height of the waves in the area is 0.9 meters, with a sea depth is about 6 meters (Forecast.com, 2016).

IV. 2. Sewage System Calculation

In *RestoBarge*, sewage system is an important part because the restaurant can occupy 1000 person every day. Therefore, the system should work well to sustain the needs of the *RestoBarge*. According to *MARPOL 73/78 ANNEX IV: "PREVENTION OF POLLUTION BY SEWAGE FROM SHIPS"* state that ship above 400 GT should have Prevention of Pollution by Sewage. *MARPOL* also said that the sewage could be discharged into the seawater only after it is treated and the distance of the ship is 3 nautical miles from the nearest land. In *RestoBarge,* the sewage system won't use sewage treatment because it's not efficient besides, *RestoBarge* is 55 meters from land. Therefore, it's better to used boat with sewage tank to discharge to land.

In *RestoBarge*, there are 3 source water drain hole that become the beginning of sewage that is Galley, Ablution, and Toilet. Each connected by a single pipe toward sewage tank. There is a sewage tank capacity of 97 m^3. It located bellow galley in the rearmost.

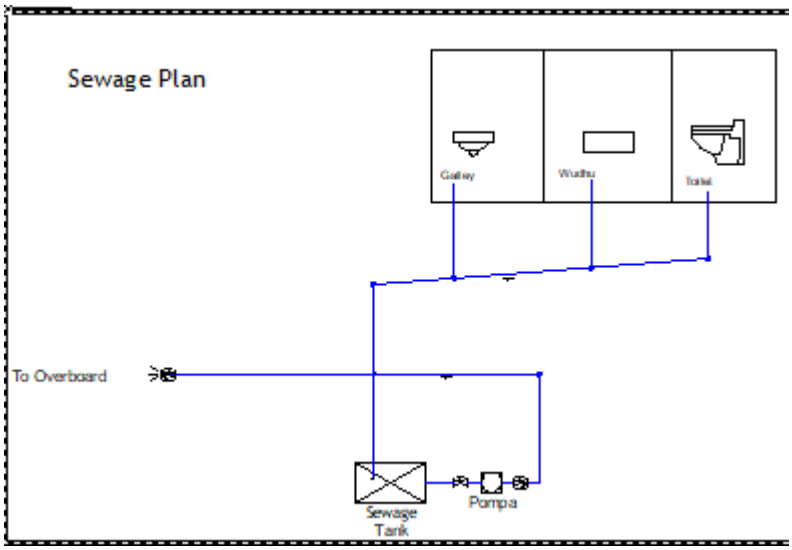


Figure 4.1 Sewage Plan in *RestoBarge*

To calculate the sewage systems, we must know about pipe size standard first. According to sewage section in paragraph 2, sewage systems, pipes shall follow to the standards of the latest of the Uniform Plumbing Code published by IAPMO. Materials approved are acrylonitrilebutadienestyrene (ABS) and polyvinyl chloride (PVC) plastic pipe. Pipe diameter shall be three or four inches (Guidelines for Septic System Design for Commercial Buildings). The author chooses the lowest standard that is 3 inches to be standard calculation of sewage system in *RestoBarge*.

After know the standard of pipping selection, the next step is go into sewage system calculation. First to do is resembling in sewage analysis in chapter 2, the step is open previous thesis to know about sewage tank volume. According to Dimas, the volume is 97 m^3. After that is moving to velocity of fluid. In chapter 2 sewage analysis, the step is to determined velocity of fluid and draining time which aim to know about capacity (Q) of pump.

The formula is $Q = V/t$

Which V is 97 m^3 and t is 3 hours. So the capacity is 32.333 m^3/h.

After know the capacity, the next step is determining suction and discharge diameter of sewage pipe. As explain in previous paragraph, data used 3 inches as standard. But it must compare and change with in pipe manufacturer. The author used PVC Rucika pipe based on JIS standard.

KELAS VP / AW (Pipa bertekanan, dengan tekanan maksimal : 10 kg/cm^2)

Diameter		Tebal Dinding (mm)	Panjang (m)	Sistem Penyambungan
inch	mm			
1/2	22	2,70	4	SP
3/4	26	2,70	4	SP
1	32	3,10	4	SP
1-1/4	42	3,10	4	SP
1-1/2	48	3,60	4	SP
2	60	4,10	4	SP
2-1/2	76	4,10	4	SP
3	89	5,50	4	SP
4	114	6,60	4	SP
5	140	7,00	4	SP
6	165	8,90	4	SP
8	216	10,30	4	SP
10	267	12,70	4	SP
12	318	15,10	4	SP

Table 4.1 Pipe Selection

To know the right diameters, the standards pipe must similar with outside diameter of pipe in catalogue. After get the desire result, it also automatically gets the thickness and inside diameter with formula Outside diameter minus thickness times two.

The result is:

Diameter inside (d)= 78 mm 0.078 m
Thickness = 55 mm 0.0055 m
Diameter outside = 89 mm 0.089 m
Nominal pipe size = 3

After getting the pipe actual dimension, the next step is continued to head suction calculation. Because there is no head different between velocity and pressure, then it can write as zero (0). Head due to different of height can be write as 1 meter because there is a height difference between suction and pump. To calculate mayor losses, first to do is by calculate Reynolds number (Rn) in equation (2.1). After get the Rn, the next step is calculating coefficient of friction (f) to get mayor losses (hf). To calculate hf it can be seen in (2.2).

Before calculating hf, we should draw sewage pipe in AutoCAD to know length and minor losses like strainer and non-return valve.

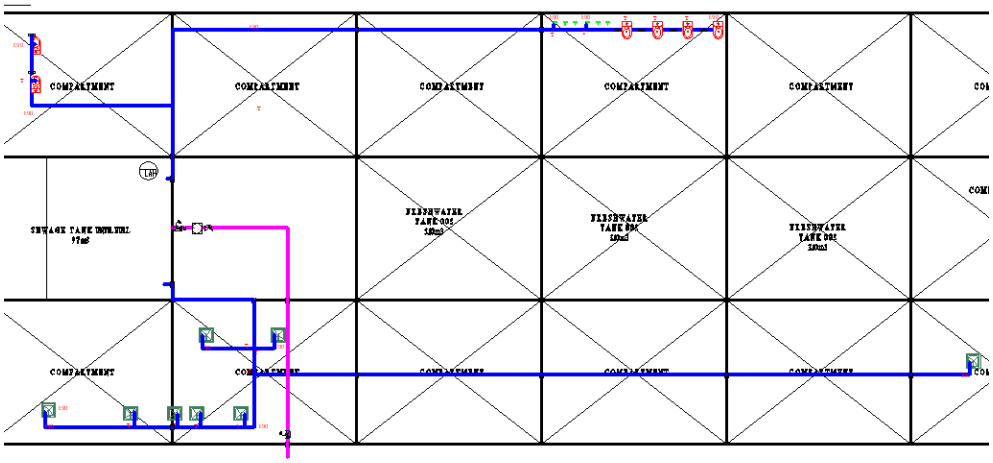


Figure 4.2 Sewage systems Key Plan

Sewage pipe actually starts from unit from main deck to sewage tank and from sewage tank to discharge pipe. But in the calculation, we don't use data from main deck to sewage tank because it's not related with pump calculation. In making of sewage pipe from main deck to sewage tank, we must pay attention to slope of the pipe. According to the International Plumbing Code, sewage pipes should be run with a uniform slope at the following minimum pitches:

Table 4.2 Sewage Pipe Standart

Pipe Diameter	Minimum Slope
2 ½" or smaller	¼" per foot
3" to 6"	1/8" per foot
8" or larger	1/16" per foot

According to data above, it can be choosing 1/8" per foot because the sewage pipe is 3 inches or 76.2 mm. After that, the next step is determining the placement of pipe and jointing. We need to decrease the used of jointing like Elbow 90° and T-Joint to minimize clogged in system. From main deck to sewage tank, there is total 18 T-Joint and 16 Elbow 90°. But in calculation we only used from sewage tank to the discharge pipe. Total length of sewage pipe is 118 meters.

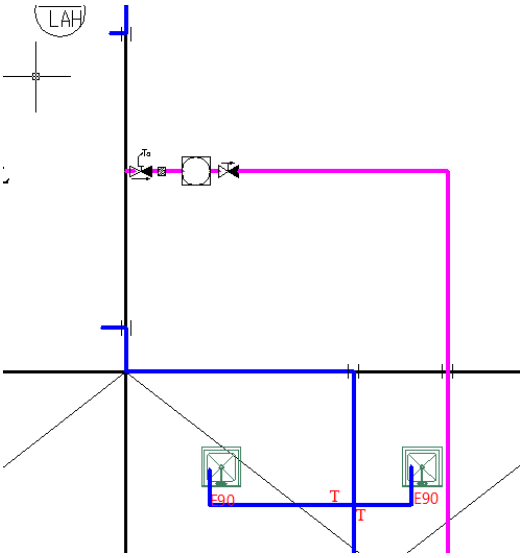


Figure 4.3 Sewage discharge system

In the picture above, it can be seen that ther
e are 2 minor loses or accessories in suction side, strainer and Screw Down Non-Return Valve(SDNRV). After determining the location of strainer and SDNRV, the next step is back to equation (2.2). L in equation (2.2) is the length of suction pipe which we draw in AutoCAD. The result of hf is zero (0) because the loses is very small. After that, the next step is calculating minor loses by equation (2.3). To calculate minor loses there are accessories (k) which draw in AutoCAD previously.

Table 4.3 Accessories minor loses

Accessories	Quantity (n)	K	n x k
Strainer	1	1.5	1.5
SDNRV	1	1.23	1.23
		Total	2.73

So the result of equation (2.3) is 0.01 m.

After calculating minor loses in suction side, the next step is moved to discharge side. In discharge side, the calculation is similar with suction side. The different is in head different of height, where in suction side is 1 meter, in discharge side is 4 meters because the discharge pipe located above main deck, so the height is 4 meters. The next different is in (2.2) formula. In discharge side, the length of pipe is 18 meters according to previous design. So the hf is 0.01 meter, slightly different than suction side. Another different is in Constanta in minor losses, when in discharge side is only 1 SDNRV. Next, the formula is same with equation (2.1), (2.2), and (2.3). After getting the answer in equation (2.1), (2.2), and (2.3), the next step is moving to Total Head (HT). The formula can be

seen in equation (2.4). According to the formula, the answer of HT is 5.04 meters. After get the HT, the next step is opening manufacturer pump catalogue to find the suitable pump in sewage systems, the author chooses:

Table 4.4 Pump Specification

Model	Iron Pump Q 4/300 50 Hz
Capacity	40 m^3/h
Head	10 m
RPM	1000 rpm

After get the pump specification, the next step is determining the pipe which cut through the compartment. If there are any, the solution is by welded between pipe and add some flange in the pipe.

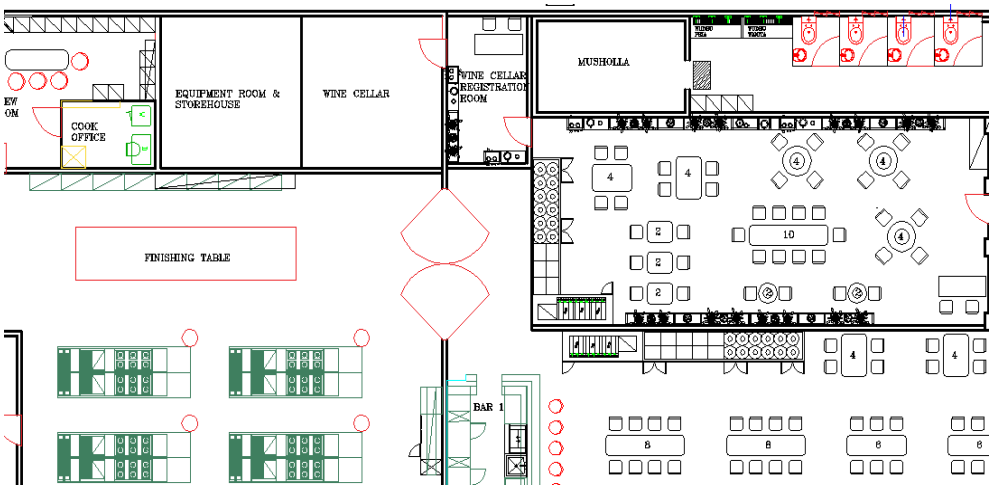


Figure 4.4 Galley, Ablution and Toilet in RestoBarge main deck

IV. 3. Sanitary System Calculation

Sanitary system in *RestoBarge* are fresh water distribute systems in ships which used to fulfill the requirement like cooking and bathing. Fresh water in *Restobarge* flow into 3 parts, Galley, Toilet, and Ablution. Fresh water come from fresh water tank located bellow the deck. To determine the water needs the author must have calculated from displacement until number of pax.

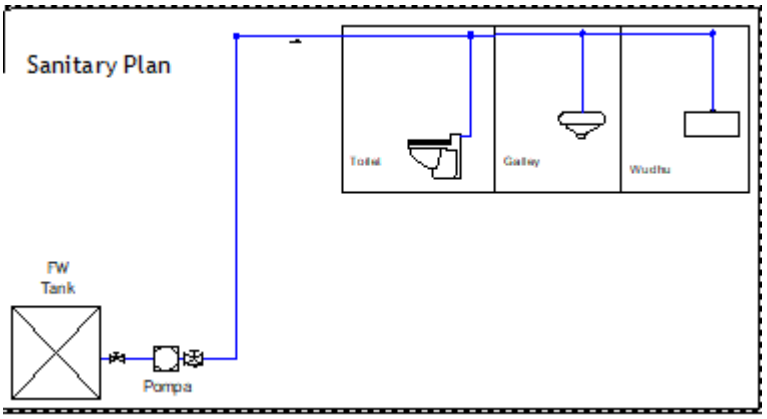


Figure 4.5 Sanitary Plan in RestoBarge

To get the capacity of fresh water, the author must know Displacement, LWT, Modified Superstructure, and Outfitting first.

Displacement = (L x B x T x Cb)
Displacement = 76.25 x 21.345 x 3.576 x 0.85
Displacement = **4947.12** ton/m^3

LWT = **1627** ton (previous thesis data)

Modified Superstructure = (Roof + Starboard & Portside + Back & Front + Divider Between Room)
Modified Superstructure = **261.13** ton

Outfitting + Pax + Garbage + Sewage = (145 + 52.5 + 9.3 + 1.4 + 193.394)
Total = **2289.74** ton

Compartment volume = 1241.576 ton

So, to get capacity of fresh water is Displacement – (LWT + Mod. Superstructure + Outfitting +Compartment Volume) = **1415.804 ton**

After getting volume of fresh water tank, the author moves to calculate water needs per day.

Table 4.5 Fresh water needs per day

SEKTOR	NILAI	SATUAN
SEKOLAH	10	LITER/MURID/HARI
RUMAH SAKIT	200	LITER/BED/HARI
PUSKESMAS	2000	LITER/UNIT/HARI
MASJID	3000	LITER/UNIT/HARI
KANTOR	10	LITER/PEGAWAI/HARI
PASAR	12000	LITER/HEKTAR/HARI
HOTEL	150	LITER/BED/HARI
RUMAH MAKAN	100	LITER/TEMPAT DUDUK/HARI
KOMPLEK MILITER	60	LITER/ORANG/HARI
KAWASAN INDUSTRI	0.2-0.8	LITER/DETIK/HEKTAR
KAWASAN WISATA	0.1-0.3	LITER/DETIK/HEKTAR

Source : KRITERIA PERENCANAAN DITJEN CIPTA KARYA DINAS PU

Number of Pax = 250
Water Needs = 100 liter/seats/day
Desired Pax = 1000/day

Water needs = 250 x 100 L
= 25000 L
= 25 m^3
= **25 ton/day**

Fresh Water Tank = 1415.804 ton
= 1415.804 ton / 25 ton/day
= 56 days
= **57 days**

So the water needs are 25 tons/day. After that, the next step is moved to calculating capacity of pipe. In *RestoBarge*, the calculation can be seen in equation (2.5), which water needs per day is 25 m^3 and working hour is 8 hours. So the capacity of pipe is 3.125 m^3/hr or 0.00087 m^3/s. After that the next step is determining flow of water between 3-5 m/s. The author takes the smallest, 3 m/s. After getting the flow of pipe, the next step is move to calculate standard pipping size in equation (2.6). The result is 23.5 mm. After get the result, the next step is

by comparing the result with the pipe manufacturers catalogue. We used Medium Galvanized Steel Pipe Ø 1.5 inch with JIS standard as suction pipe, because steel pipe is more durable inside fresh water tank than PVC.

JIS Japan Sizes G 3452
Carbon Steel Pipes for Ordinary Piping

Dimensions and Weights (Black and Galvanized)

Nominal Pipe Size	Outside diameter	Approx. Wall Thickness	Approximate Weight						Number of Threads
			Plain End			Treads and Coupling			
in	mm	mm	lbs/ft	kg/m	kg/ft	lbs/ft	kg/m	kg/ft	per Inch
* 1/8	10,5	2,0	0,282	0,419	0,128	0,284	0,423	0,129	28,00
* 1/4	13,8	2,3	0,438	0,652	0,199	0,443	0,659	0,201	19,00
3/8	17,3	2,3	0,572	0,851	0,259	0,579	0,862	0,263	19,00
1/2	21,7	2,8	0,880	1,31	0,399	0,887	1,32	0,402	14,00
3/4	27,2	2,8	1,14	1,69	0,515	1,15	1,71	0,521	14,00
1	34,0	3,2	1,63	2,43	0,741	1,67	2,48	0,756	11,00
1 1/4	42,7	3,5	2,27	3,38	1,03	2,33	3,47	1,06	11,00
1 1/2	48,6	3,5	2,61	3,89	1,19	2,68	3,99	1,22	11,00
2	60,5	3,8	3,57	5,31	1,62	3,69	5,49	1,67	11,00

Table 4.6 Pipe Selection

To know the right diameters, the standards pipe must similar with outside diameter of pipe in catalogue. After get the desire result, we also automatically get the thickness and inside diameter with formula Outside diameter minus thickness times two. The result is:

Diameter inside (d)= 27.6 mm 0.0276 m
Thickness = 32 mm 0.0032 m
Diameter outside = 34 mm 0.034 m
Nominal pipe size = 1

So the outside diameter of suction pipe made by steel is 34 mm or can used 1.5 inch. This also applies with fresh water intake pipe from shore, since the material is same. Because the diameter is difference from earlier, the author can calculate actual flow by equation (2.7). The result of equation (2.7) is 1.45 m/s, or slower because the diameter is bigger than earlier. After get the actual flow, the next step is continuing to discharge pipe. Discharge pipe made by Galvanized. The line is from discharge until Hydrophore tank. But in fresh water pipe from Hydrophore to unit in main deck, it used PVC pipe, because it can reduce cost. To find the right diameters, the method is same with to find suction pipe. The author used the same diameter as suction pipe and same velocity because the diameter is identical.

Diameter inside (d)	= 27.6 mm	0.0276 m
Thickness	= 32 mm	0.0032 m
Diameter outside	= 34 mm	0.034 m
Nominal pipe size	= 1	

In addition, the actual flow by equation (2.7) result 1.45 m/s.

After get the actual flow, the next step is continuing to calculating head for suction pump. Because there is no head different between velocity and pressure, then it can write as zero (0). Head due to different of height can be write as 1 meter because there is a height difference between suction pipe and fresh water pump. The next step is continuing to find Reynold's number (Rn). To find Rn in sanitary system is same as when we calculate Rn from sewage system before, by use equation (2.1). The result is 36423.03. After getting Rn, the next step is continued to find mayor loses (hf). Before calculating hf, the author must find friction coefficient by formula 0.02+0.0005/d. The result is 0.038116 m. Next, the author must find length of pipe by draw in AutoCAD before.

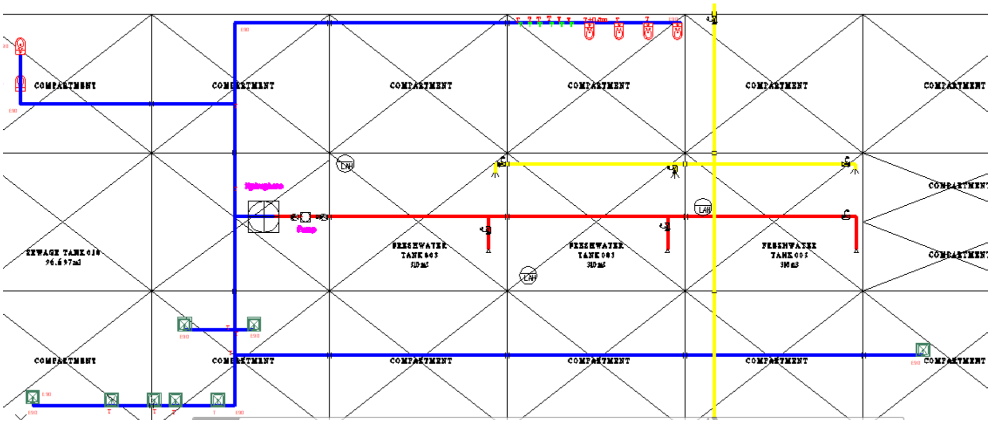


Figure 4.6 Sanitary systems

In the picture above, the suction pipe mark with red line when discharge pipe from Hydrophore to unit in main deck mark with blue line and the fresh water intake pipe from land mark with yellow line. Since fresh water intake pipe is same material, length and dimension with suction pipe and the pump is from land, it can be generalized if the mayor losses is almost same with suction pump and not going to calculated. When the discharge pipe from Hydrophore is calculated next. After drawing pipping suction plan, the next step is to placing the minor losses like strainer and non-return valve.

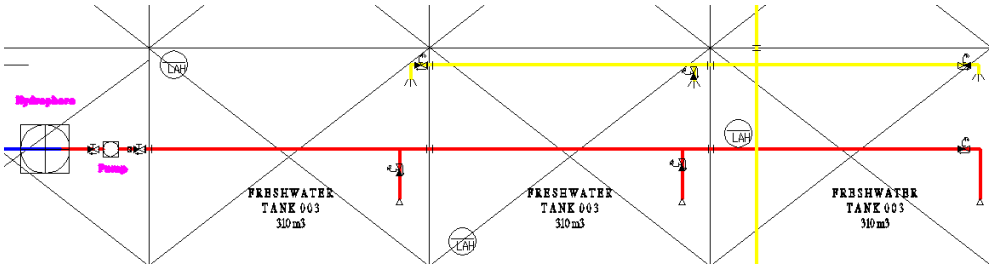


Figure 4.7 Sanitary suction pipe Key Plan

Total length of suction pipe is 33 meters according to AutoCAD drawing. So, after we calculate the equation (2.2), the mayor losses(hf) is 4.9 meters. Hf is 4.9 meters because the suction pipe is long that makes losses is bigger than the shorter pipe. The next step is calculating minor loses by equation (2.3). To calculate minor loses there are accessories (k) that have been drawn in AutoCAD.

Table 4.7 accessories in minor loses

Accessories	Quantity (n)	K	n x k
Strainer	1	1.5	1.5
T-Joint	2	2.9	5.8
Elbow 90	1	0.75	0.75
SDNRV	4	1.23	4.92
		Total	12.97

So the result of equation (2.3) is 1.39 m.

After calculating minor loses in suction side, next is moved to discharge side. In discharge side, the calculation is similar with suction side. The different is in (2.2) formula. In discharge side, the length of pipe is 2 meters because the discharge pipe is tipped in Hydrophore. So the hf is 0.3 meter, much different than suction side. Another different is in Constanta in minor losses, when in discharge side is only 1 SDNRV. Next, the formula is same with equation (2.1), (2.2), and (2.3). After getting the answer in equation (2.1), (2.2), and (2.3), the next step is moving to Total Head (HT). The formula can be seen in equation (2.4). According to the formula, the answer of HT is 8.77 meters. Because the capacity and head is obtained, the next step is opening manufacturer pump catalogue to find the suitable pump in sanitary systems, the author chooses:

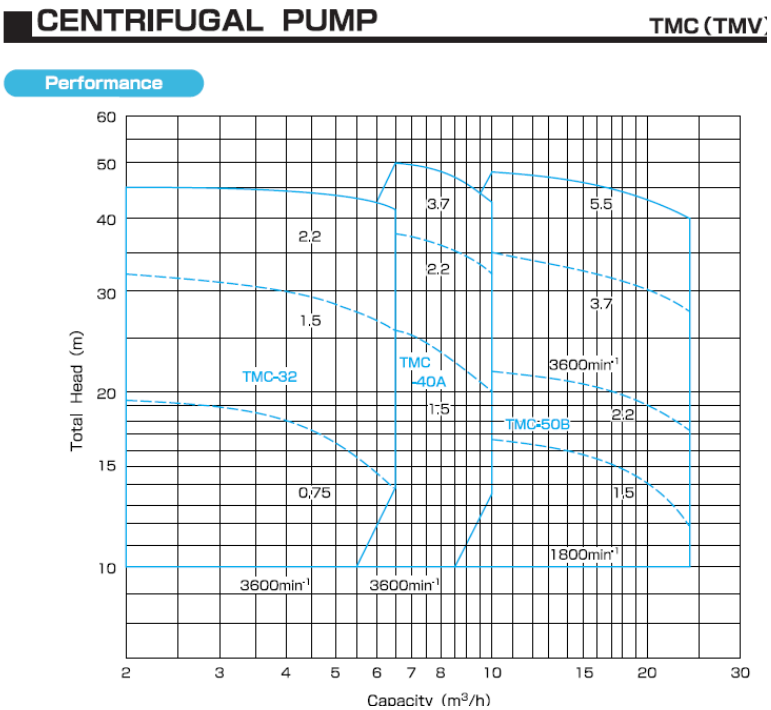


Figure 4.8 Selection of Sanitary Pump

Table 4.8 Pump Specification sanitary

Model	TMC-32-0.75
Capacity	5.5 m³/h
Head	10 m
RPM	3600
Power	0.75 kW

After get the pump specification, the next step is find the Hydrophore Specification. Hydrophore is a tank contain pressured air made by compressor which to maintain the pressure to unit in main deck, as replacement of pump. To calculate Hydrophore Tank, it used equation (2.8). The formula is Vh = 0.5 + (3.125 x 5.5) / (8 x (5.5-3). So Vh =1.6458 m³ or 1600 L. After get Vh, the next step is determining the desired Hydrophore tank by choose the specific data in catalogue of Hydrophore.

Model No.	Bore		Tank Volume (L)	Dimension (mm)																
	Suc.	Dis.		A	B	C	D	E	F	G	H	K	L	M	N	P	Q	R	S	T
UH-0,5-1R	※	50	500	1198	805	450	350	600	795	625	680	680	495	520	595	260	–	700	400	700
UH-0,5-2R	※	50	500	1198	880	450	350	600	795	625	589	589	495	520	595	560	340	700	400	700
UH-1,0-1R	※	50	1000	1967	1570	450	350	650	1620	650	720	720	520	520	620	240	–	700	400	700
UH-1,0-2R	※	50	1000	1967	1570	450	350	650	1620	650	624	624	520	520	620	580	360	700	400	700
UH-1,5-1R	※	50	1500	1956	1530	450	350	700	1520	750	820	820	620	650	715	240	–	800	500	800
UH-1,5-2R	※	50	1500	1956	1530	450	350	700	1520	750	710	710	620	650	715	630	410	800	500	800
UH-2,0-1R	※	50	2000	2170	1700	450	350	750	1690	800	980	980	670	700	785	280	–	900	600	900
UH-2,0-2R	※	50	2000	2170	1700	450	350	750	1690	800	830	830	670	700	785	734	480	900	600	900

Table 4.9 Hydrophore tank selection

Hydrophore which will use in *Restobarge* is **Taiko UH-2.0 – 1R**

After get the desired Hydrophore Tank, the next step is by formula Q of fresh water per day divided operational hours.

The result is 8 m³/h and head is 20 meters, because total height in Restobarge is 5 meters, which in diagram below the smallest is 20 meters.

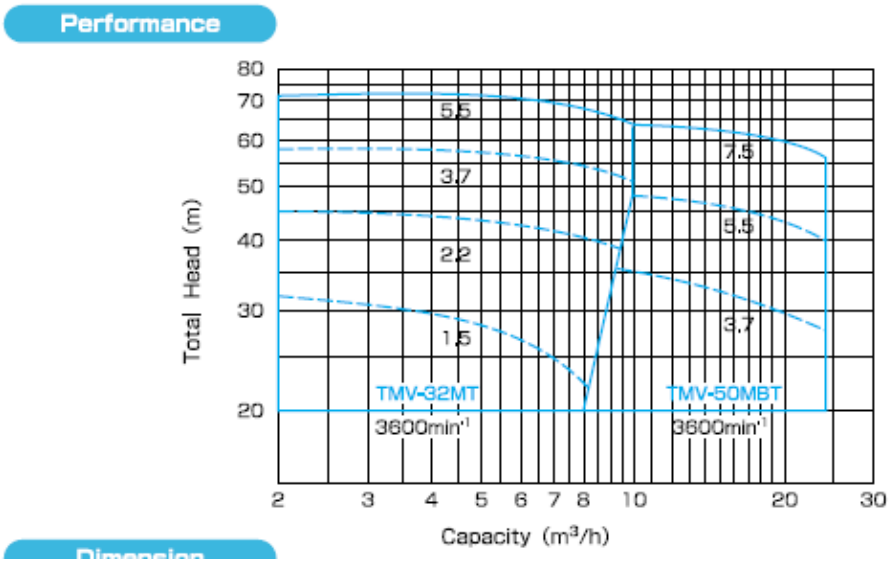


Figure 4.9 Hydrophore pump selection

Hydrophore pump which will use in *Restobarge* is **Taiko TMV-32 MT 1.5 Bar.**

IV. 4. Garbage Management Plan

Garbage Management Plan in *Restobarge* used a room behind galley. It connected to discharge by a 12-inch Rucika PVC pipe 4 meter to throw the garbage into small ship.

IV. 5. Material Requirement Planning

After get the suitable equipment from calculation and design in IV.2 – IV.4, the next step is by doing Material Requirement Planning. It contained data material, amount, and price. Material Requirement Planning is an important to do because it contained a number of costs which the most important data to investor. The lower of price is the better aspects for investor. In making of Material Requirement Planning, cheaper cost and adequate material is a first choice by author.

For the pricing, the information mostly from PT. Metal Abadi Utama in pipping and small part, PT. Sandai Indah jaya in pump and Hydrophore and some from website Alibaba. The price possibility is different now because the fluctuated from market. In the table below, there are Sanitary Systems, Sewage Systems, and garbage Management Sytems.

Table 4.10 Sanitary Sytems

No	Qty	Object	Length (mm)	Material	Price (Rp)
Intake From Land					
1	1	Main Pipe	43.464	Medium Galvanized Steel Pipe sch 40 Ø 1.5 inch	3.926.020
2	5	Screw Down NRV		Steel Screw Down NRV	1.000.000
3	1	T-Joint		T Straight S 40 SL	30.000
4	2	Elbow 90°		Elbow 90° Seamless SS304L sch 40	136.000
5	7	Flange		Carbon Steel PN 10 RF STD 1.5 inch	420.000
Suction Pipe					
6	1	Main Pipe	32.000	Medium Galvanized Steel Pipe sch 40 Ø 1.5 inch	2.426.666
7	1	Screw Down NRV		Steel Screw Down NRV	200.000
8	1	Strainer		Metal	400.000
9	2	T-Joint		T Straight S 40 SL	100.000

Table 4.10 Sanitary Sytems (continuous)					
10	1	Elbow 90°		Elbow 90° Seamless SS304L	68.000
11	1	Level Alarm Indicator		Stainless Steel Breaking Water Level Sensor Horizontal Float Switch	136.000
12	1	Pressure Switch		Coelbo Switchmatic 2 electronic pressure switch	780.000
13	3	Flange		Carbon Steel PN 10 RF STD 1.5 inch	180.000
14	1	Centrifugal Pump		Ebara 12m3/h head 30 m	5.900.000
Discharge Pipe					
15	1	Main Pipe	82.000	Rucika VP/AW Ø 1.5 inch	1.845.000
16	20	Connection Pipe Between Compartement	20.000	Medium Galvanized Steel Pipe sch 40 Ø 1.5 inch	1.820.000
17	6	Closet Wasser		Kloset Wasser WS 88 TS	900.000
18	6	Water Closet		Toto CW660NJ/ SW660J	12.960.000
19	8	Water Tap (Kitchen)		AER Kitchen Faucet Table Mounted [ROV 03B]	1.600.000
20	6	Water Tap		AER Brass Basin Faucet WOV 03B	1.200.000
21	10	Elbow 90°		PVC Elbow D Rucika 1.5 inch	28.000
22	18	T-Joint		PVC Tee D Rucika 1.5 inch	75.600
23	30	Flange		PVC Flange	90.000
24	1	Hydrophore Pressure Tank		Taiko UH-2.0 - 1R 8m3/h-head 20m	14.700.000
Total:					
Rp. 48.449.000					

Table 4.11 Sewage Systems

No	Qty	Object	Length (mm)	Material	Price (Rp)
Suction Pipe					
1	1	Main Pipe	118.00	Rucika PVC VP/AW Ø 3 inch	10.068.350
2	1	Level Alarm Indicator		Stainless Steel Breaking Water Level Sensor Horizontal Float Switch	136.000
3	14	T-Joint		Rucika PVC Tee (D) 3 inch	242.200
4	15	Elbow 90°		Rucika PVC Elbow 90 ° (D) 3 inch	
5	1	Connection Pipe Between Compartment	20.000	Medium Galvanized Steel Pipe sch 40 Ø 3 inch	3.400.000
6	20	Flange		Carbon Steel PN 10 RF STD 3 inch	115.000
Discharge Pipe					
7	1	Main Pipe	16.000	Rucika PVC VP/AW Ø 3 inch	1.365.200
8	2	Screw Down NRV		Non Return Valve Plastic	40.000
9	1	Elbow 90°		Rucika PVC Elbow 90 ° (D) 3 inch	35.000
10	1	Pressure Switch		Coelbo Switchmatic 2 electronic pressure switch	780.000
11	3	Flange		Carbon Steel PN 10 RF STD 3 inch	115.000
12	1	Connection Pipe Between Compartment	6.000	Medium Galvanized Steel Pipe sch 40 Ø 3 inch	1.020.000
13	1	Pump		Ebara 60m3/h head 15m	9.370.000
Total:					

	Rp. 26.854.416

Garbage Management : PVC pipe Rucika 12 inch, IDR 3.241.300

Total Cost of Material : IDR 78.544.500,

Cost of Drawing : IDR 7.000.000,

Cost of Worker : -IDR 200.000, for foreman (7 hour/day)
-IDR 250.000, for supervisor
-IDR 180.000, for welder (7 hour/day)
-IDR 120.000, for piping worker (7 hour/day)
-IDR 90.000, for worker (7 hour/day),
IDR 180.000 for 2 Workers
-IDR 140.000, for installator (7 hour/day),
IDR 360.000 for 2 Workers

Project Scheduling

WBS	Task Name	Duration
1	**Event**	**1**
1.1	Contract signing for workers	1
2	**Drawing and Cost Estimating**	**6**
2.1	Calculation of sanitary and sewage systems	2
2.2	Garbage management fixation system	1
2.3	Drawing of sanitary system	1
2.4	Drawing of sewage system	1
2.5	Cost estimating	1
In this point, equipment determined and booked (Est 2 days)		
3	**Installation**	**16**
3.1	Delivery for each equipment	5
3.2	Fresh Water pipping system arrangement and Units	7
3.3	Sewage pipping arrangement	2
3.4	Garbage management arrangement	1
3.5	Final Checking and test	1
	Total	**23 days**

Total cost for worker : IDR 27.000.000,
Cost of Contingencies : 0.5 – 5% from total cost. Taken 1%.
: IDR 1.153.000,

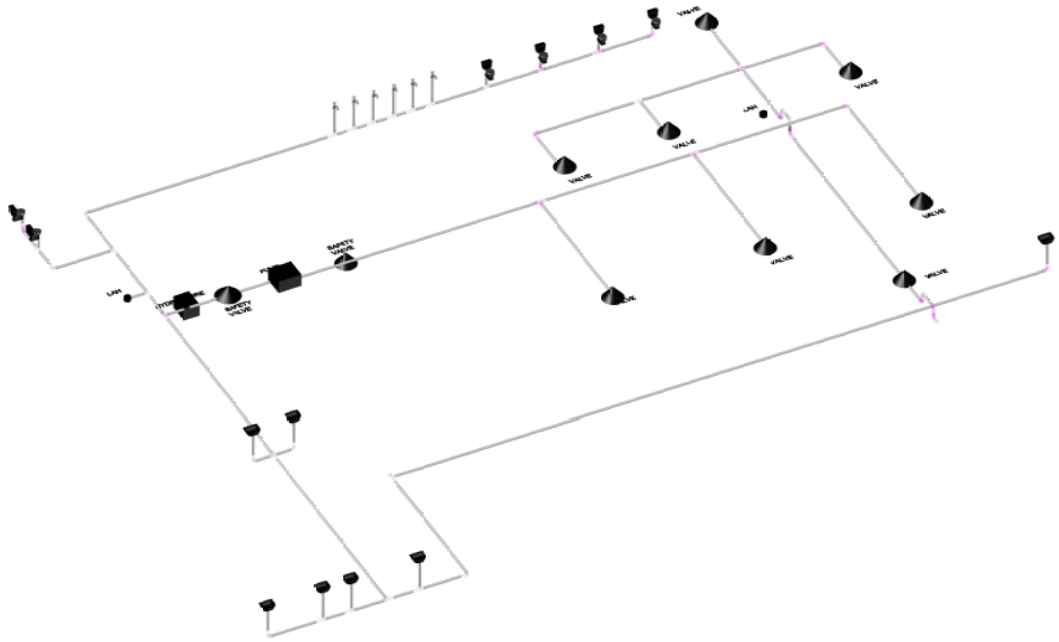
Total cost needed to build Sanitary and Garbage Management :
IDR 115.244.500,

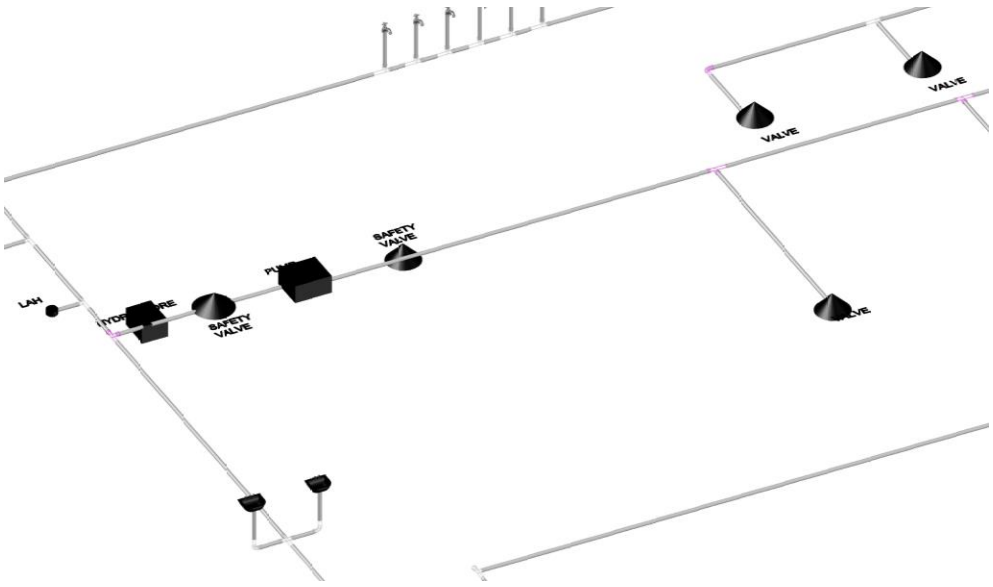
The result is affected by market price. In the field, usually there is a slightly different with calculation.

Cost of worker can be seen in some source from internet. It refers to cost for Surabaya city.

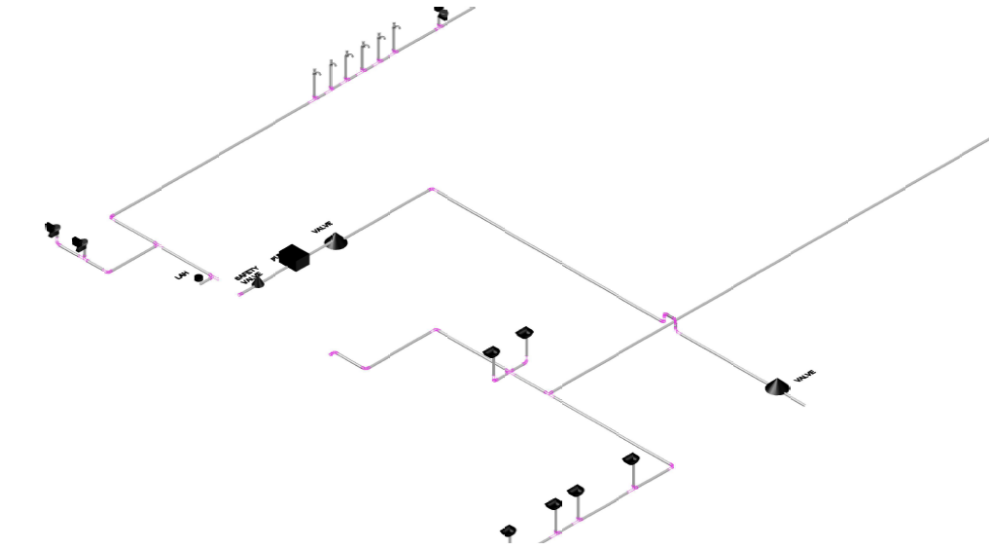
IV. 6. 3D Drawing

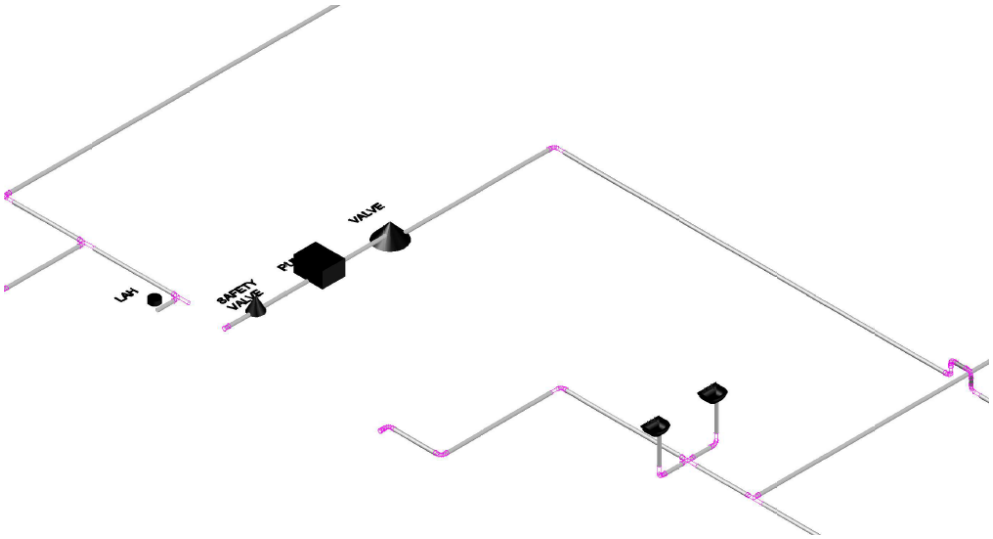
Sanitary systems



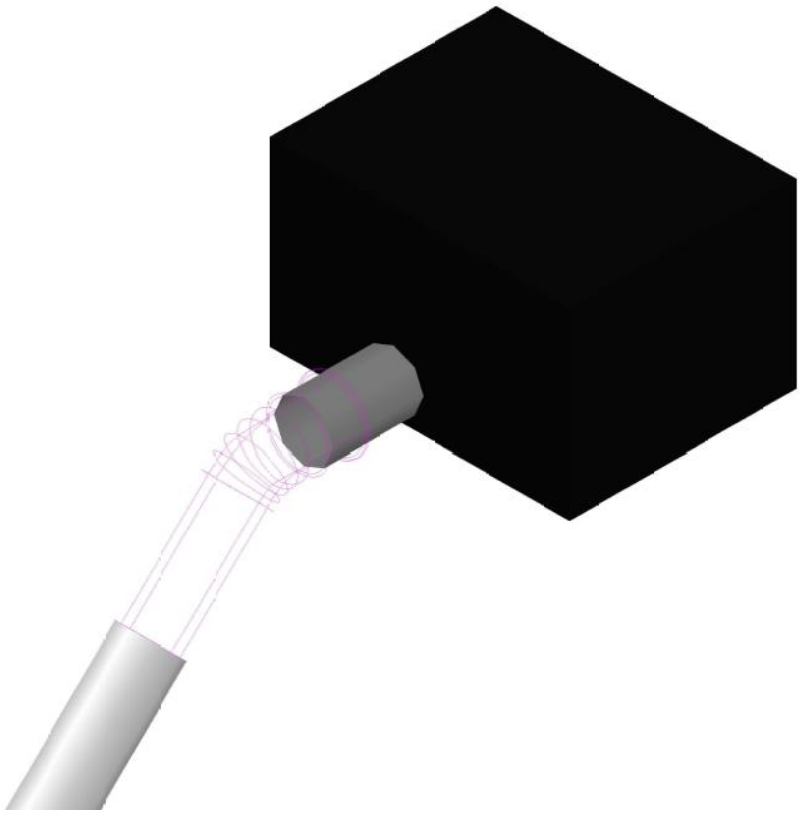


Sewage Systems





Garbage Systems



CHAPTER V
CONCLUSION AND RECOMMENDATION

V. 1. Conclusion

RestoBarge is a barge which convert to a restaurant. The capacity of pax are 1000 guest per day. It's all sustained with outstanding sanitary and sewage system which can make life of *RestoBarge* is more stable and comfort. There are some conclusions that can be taken as explanation below:

1. The model of main intake from land and suction pipe in sanitary system is Medium Galvanized Steel Pipe sch 40 Ø 1.5 inch. For discharge pipe to unit the model is Rucika VP/AW Ø 42mm. The model of Hydrophore Pressure Tank is Taiko UH-2.0 - 1R 8m3/h-head 20m. The cost to build this sanitary system is IDR 48.449.000

2. The model of main suction pipe and discharge pipe is Rucika PVC VP/AW Ø 3 inch. The pump of sewage system is Ebara 60m3/h head 15m. the cost to build the sewage system is
   IDR 26.854.416.

3. Total cost to build of garbage management is IDR 3.21.300.

4. Total cost of material of three system is IDR 78.544.500. The cost of drawing is IDR 7.000.000. The cost of labor, which consist of supervisor, welder, piping officer and worker, is IDR 27.000.000, which can finished in 23 days.

5. Total cost needed to build sanitary and garbage management is IDR 115.244.500.

V. 2. Recommendation

According to the conclusion, there are some recommendations that can be use as consideration for the next research:

1. This thesis is still not faultless because there is some mistake in calculation of piping and cost.

2. The electricity of *Restobarge* and ventilated systems is recommended to do in the next research.

3. The strategy to do in delivery of sewage to land and garbage to land is considered to do in next research.

4. In cost analysis, better if adding some detail for working of labour and material specification.

REFERENCES

Akbar, D. Y. (2016). TECHNICAL AND ECONOMIC ANALYSIS OF 250 FT DECK CARGO BARGE CONVERSION INTO RESTOBARGE FOR GILI TRAWANGAN-GILI MENO SEA, LOMBOK. *TECHNICAL AND ECONOMIC ANALYSIS OF 250 FT DECK CARGO BARGE CONVERSION INTO RESTOBARGE FOR GILI TRAWANGAN-GILI MENO SEA, LOMBOK*, 5-6.

Atmodjo, H. M. (2007). *Restoran dan Segala Permasalahanya.* Andi.

Code, U. P. (n.d.). *GUIDELINES FOR SEPTIC SYSTEM DESIGN.* California: IAPMO.

D, D. E. (2014). Material Requirement Planning for Automobile. *International Journal of Innovative Research in Science, Engineering and Technology*, 1
.

Germanischer Lloyd. (2015). *Germanischer Lloyd Class.* Germanischer Llyod.

Ibrahim, B. (2007). *Rencana Dan Estimate Real Of Cost.* Bumi Aksara.

MARPOL ANNEX IV. (2003). *Regulation For Prevention Of Pollution By Sewage Form.*

MI News Network. (2016, July 20). *Type Of Ships*. Retrieved from Marine Insight: http://www.marineinsight.com/types-of-ships/different-types-of-barges-used-in-the-shipping-world/

Press, Oxford University. (2017). *Oxford Dictionaries*. Retrieved from Oxford Living Dictionary: https://en.oxforddictionaries.com/definition/barge

Rasi, F. (2015, December 23). *rimanews*. Retrieved from rimanews: http://rimanews.com/nasional/peristiwa/read/20151224/252331/Wisatawan-Serbu-Gili-Trawangan-Semua-Hotel-Sudah-Full-Booking-

Taiko. (2015). Hydrophore Tank Unit. *Taiko*, 1-3.

UNWTO. (2013). Tourism Highlights. *e-unwto.org*, 2-3.

Utama, P. A. (2014). *Daftar harga pipa*. Retrieved July 17, 2017, from http://abadimetalutama.com/produk-pipa-pvc-rucika/

Wavin. (2015). *Rucika Brosur*. Retrieved July 17, 2017, from http://www.wavin.co.id/uploads/Brosur-Rucika-Update-November-2015.pdf

ATTACHMENT 1
CALCULATION OF SANITARY SYSTEMS

Perhitungan Untuk Memilih Pompa Air Tawar.

PIPA

kapasitas pipa yaitu: 3.125 m3/hr atau 0.0009 m3/s

Sedangkan aliran air direncanakan antara 3-5 m/s, diambil yaitu:

3 m/s atau 10800 m/hr

d = ((4 x Q)/(v x ∏)^0.5

d= 0.02351 m atau 23.5 mm

Untuk pipa hisap (suction):

Diameter pipa: 23.5 mm = 0.0235 m

Kemudian dipilih spesifikasi pipa Spindo ERW sch 40 berdasarkan standar JIS:

diameter inside (d) = 27.6 mm = 0.0276 m

thickness = 3.2 mm = 0.0032 m

diameter outside = 34.0 mm = 0.034 m

Nominal pipe size = 1

Jadi kecepatan aliran yang sebenarnya terjadi yaitu (karena diameter berubah):

v = 1.45 m/s

Untuk pipa discharge:

Diameter pipa: 23.5 mm = 0.0235 m

Kemudian dipilih spesifikasi pipa Spindo ERW sch 40 berdasarkan standar JIS:

diameter inside (d) = 27.6 mm = 0.0276 m

thickness = 3.2 mm = 0.0032 m

diameter outside = 34.0 mm = 0.034 m

Nominal pipe size = VP 25

Jadi kecepatan aliran yang sebenarnya terjadi yaitu (karena diameter berubah):

v = 1.45 m/s

Perhitungan Head pada sisi Suction Pompa Air Tawar.

- Head karena perbedaan kecepatan = 0 (Ø sama)
- Head karena perbedaan tekanan = 0 (Ø sama)
- Head karena perbedaan ketinggian = 1 m
- Head karena losses =

Mayor losses (karena gesekan)

Reynold's number (Rn) :

viscosity n = 1.1 cst pada 50°C = 0.0000011 m^2/s

Rn = (v x d) / n

Rn = 36423.03 (aliran turbulen)

untuk mencari koefisien gesek dengan menggunakan rumus = 0,02+0,0005/d

jadi gesekan sepanjang pipa (f) 0.038116 m

mayor losses (hf) = f x L/D x $v^2/2g$

panjang pipa suction adalah 33 m panjang

Jadi mayor losses (hf) = 4.90 m

Minor losses (karena aksesoris)

Aksesoris	Jumlah (n)	k	n x k
Strainer	1	1.5	1.5
T-Joint	2	2.9	5.8
Elbow 90	1	0.75	0.75
SDNRV	4	1.23	4.92
		jumlah	12.97

Jadi minor losses (hl) = k x v2/2g

= 1.39 m

Perhitungan Head pada sisi Discharge Pompa Air Tawar.

- Head karena perbedaan kecepatan = 0 m
- Head karena perbedaan tekanan = 0 m
- Head karena perbedaan ketinggian = 1 m
- Head karena losses =

Mayor losses (karena gesekan)

Reynold's number (Rn) :

viscocity n = 1.1 cst pd 50°C = 0.0000011 m^2/s

Rn = (v x d) / n

Rn = 36423.03 sama dengan sisi suction karena diameter sama.

untuk mencari koefisien gesek dengan menggunakan rumus = 0,02+0,0005/d

jadi gesekan sepanjang pipa (f) 0.038116 m

mayor losses (hf) = f x L/D x $v^2/2g$

panjang pipa discarge adalah 2 m

Jadi mayor losses (hf) = 0.30 m

Minor losses (karena aksesoris)

Aksesoris	Jumlah (n)	k	n x k
SDNRV	1	1.23	1.23
		jumlah	1.23

310.394

Jadi minor losses (hl) = k x v2/2g

= 0.18 m

Sehingga Head Total:

= Hp+Hv+Hs+Hlosses

= **8.77** m

Jadi pompa yang dipilih adalah:

Model : **TMC-32-0.75**

Capacity : **5.5 m3/h**

Head : **10M**

RPM : **3600 rpm**

Power : **0.75 kW**

Perhitungan Kebutuhan Hydrophore

(V) Volume fresh water per day = 25 m^3

(D) Rata-rata konsumsi FW = 25 m^3/8 jam operasional

= 3.125 m^3/jam

Kebutuhan volume tanki hydrophore =

Vh = Vo + (D x Pm) / (t x (Pm-Po)

Vh = Volume tangki hydrophore

Vo = Perencanaan sisa FW dalam tangki, diambil 2% V

= 2% x 25 = 0.5 m^3

Pm = Pressure max didalam tangki, direncanakan = 5.5 kg/m^2

Po = Pressure minimum didalam tangki, direncanakan = 3 kg/m^2

Vh = 0.5 + (3.125 x 5.5) / (8 x (5.5-3)

Vh : **1.6458** m^3

Type hydrophore yang dipilih adalah :

Taiko UH-2.0 - 1R

Capacity : 8 m^3/h

Head : 20 m

TMV-32MT 1.5 bar

JIS Japan Sizes G 3452

Carbon Steel Pipes for Ordinary Piping

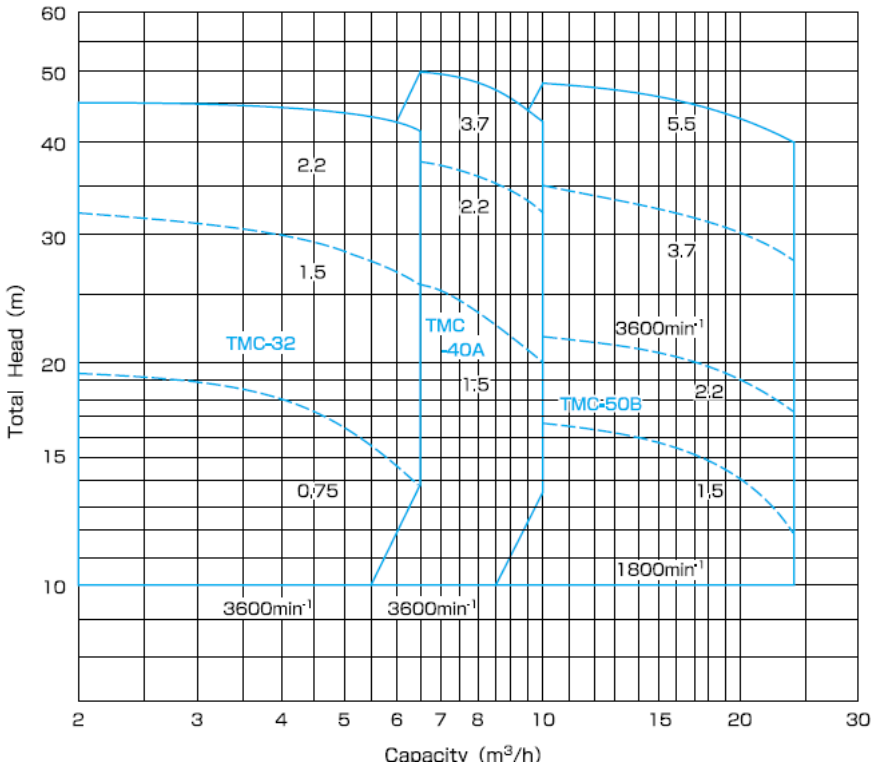
Dimensions and Weights (Black and Galvanized)

Nominal Pipe Size	Outside diameter	Approx. Wall Thickness	Approximate Weight						Number of Threads
			Plain End			Treads and Coupling			
in	mm	mm	lbs/ft	kg/m	kg/ft	lbs/ft	kg/m	kg/ft	per Inch
* 1/8	10,5	2,0	0,282	0,419	0,128	0,284	0,423	0,129	28,00
* 1/4	13,8	2,3	0,438	0,652	0,199	0,443	0,659	0,201	19,00
3/8	17,3	2,3	0,572	0,851	0,259	0,579	0,862	0,263	19,00
1/2	21,7	2,8	0,880	1,31	0,399	0,887	1,32	0,402	14,00
3/4	27,2	2,8	1,14	1,69	0,515	1,15	1,71	0,521	14,00
1	34,0	3,2	1,63	2,43	0,741	1,67	2,48	0,756	11,00
1 1/4	42,7	3,5	2,27	3,38	1,03	2,33	3,47	1,06	11,00
1 1/2	48,6	3,5	2,61	3,89	1,19	2,68	3,99	1,22	11,00
2	60,5	3,8	3,57	5,31	1,62	3,69	5,49	1,67	11,00
2 1/2	76,3	4,2	5,02	7,47	2,28	5,21	7,75	2,36	11,00
3	89,1	4,2	5,91	8,79	2,68	6,15	9,15	2,79	11,00
3 1/2	101,6	4,2	6,79	10,1	3,08	7,12	10,6	3,23	11,00

CENTRIFUGAL PUMP

TMC (TMV)

Performance



PT. ABADI METAL UTAMA
Jl. Raya Sukomanunggal Jaya A6, Satelit Town Square, Surabaya, Jawa Timur
Telp. : (031)7317975; 7325885 (Hunting) Fax. : (031) 7325030, 7326050
E-mail : abadimetalutama@gmail.com
Website : www.abadimetalutama.com

Daftar harga pipa Spindo ERW SCH 40 Hitam

18 April 2017

DIAMETER	PANJANG	HARGA
1/2"	6 METER	**Rp83,619**
3/4"	6 METER	**Rp110,923**
1"	6 METER	**Rp164,394**
1-1/4"	6 METER	**Rp224,691**
1-1/2"	6 METER	**Rp266,785**
2"	6 METER	**Rp356,661**
2-1/2"	6 METER	**Rp567,700**
3"	6 METER	**Rp740,626**
4"	6 METER	**Rp1,053,487**
5"	6 METER	**Rp1,425,507**
6"	6 METER	**Rp1,842,465**
8"	6 METER	**Rp2,818,590**

VP (JIS K6741) Pipe

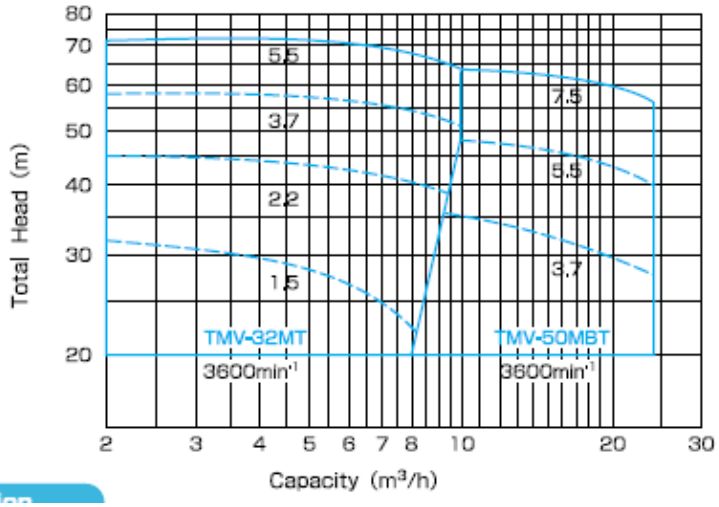
Unit:mm

Nominal Size (mm)	Identification	Outer diameter			Thickness		Approximate Inner diameter	Length	Calculated Weight (kg/m)	HI-VP PIPE
		Basic Dimension (mm)	Max. Min. Tolerance	Average Tolerance	Min. Dimension	Tolerance				
13	VP 13	18	±0.2	±0.2	2.2	±0.6	13	4,000	0.174	●
16	VP 16	22	±0.2	±0.2	2.7	±0.6	16	4,000	0.256	●
20	VP 20	26	±0.2	±0.2	2.7	±0.6	20	4,000	0.310	●
25	VP 25	32	±0.2	±0.2	3.1	±0.8	25	4,000	0.448	●
30	VP 30	38	±0.3	±0.2	3.1	±0.8	31	4,000	0.542	●
40	VP 40	48	±0.3	±0.2	3.6	±0.8	40	4,000	0.791	●
50	VP 50	60	±0.4	±0.2	4.1	±0.8	51	4,000	1.122	●
65	VP 65	76	±0.5	±0.3	4.1	±0.8	67	4,000	1.445	●
75	VP 75	89	±0.5	±0.3	5.5	±0.8	77	4,000	2.202	●
100	VP100	114	±0.6	±0.4	6.6	±1.0	100	4,000	3.409	●
125	VP125	140	±0.8	±0.5	7.0	±1.0	125	4,000	4.464	●
150	VP150	165	±1.0	±0.5	8.9	±1.4	146	4,000	6.701	●
200	VP200	216	±1.3	±0.7	10.3	±1.4	194	4,000	10.129	●
250	VP250	267	±1.6	±0.9	12.7	±1.8	240	4,000	15.481	●
300	VP300	318	±1.9	±1.0	15.1	±2.2	286	4,000	21.962	●

VP-Straight Pipe

HI-VP-Straight Pipe

Performance



Dimension

for suction cover ϕ20 Drain valve for suction cover

※mark is based on the bore size of attached pump.

Model No.	Bore		Tank Volume (L)	Dimension (mm)																
	Suc.	Dis.		A	B	C	D	E	F	G	H	K	L	M	N	P	Q	R	S	T
UH-0.5-1R	※	50	500	1198	805	450	350	600	795	625	680	680	495	520	595	260	–	700	400	700
UH-0.5-2R	※	50	500	1198	880	450	350	600	795	625	589	589	495	520	595	560	340	700	400	700
UH-1.0-1R	※	50	1000	1967	1570	450	350	650	1620	650	720	720	520	520	620	240	–	700	400	700
UH-1.0-2R	※	50	1000	1967	1570	450	350	650	1620	650	624	624	520	520	620	580	360	700	400	700
UH-1.5-1R	※	50	1500	1956	1530	450	350	700	1520	750	820	820	620	650	715	240	–	800	500	800
UH-1.5-2R	※	50	1500	1956	1530	450	350	700	1520	750	710	710	620	650	715	630	410	800	500	800
UH-2.0-1R	※	50	2000	2170	1700	450	350	750	1690	800	960	960	670	700	785	280	–	900	600	900
UH-2.0-2R	※	50	2000	2170	1700	450	350	750	1690	800	830	830	670	700	785	734	480	900	600	900

ATTACHMENT 2
CALCULATION OF SEWAGE SYSTEMS

Perhitungan Untuk Memilih Pompa Sewage.
PIPA

Diambil 3 inch

Volume Tangki Sewage: 97 m3

v = 0.20 m/s

Lama waktu pengurasan = 3 jam atau 180 menit

Q= V/t

= 97 m3 / 3 jam

= 32.33333 m^3/h

Menurut GUIDELINES FOR SEPTIC SYSTEM DESIGN, diameter pipa minimal 3 atau 4 inch

Untuk pipa hisap (suction):

Diameter pipa: 76.2 mm = 0.0762 m

Untuk pipa discharge:

Diameter pipa: 76.2 mm = 0.0762 m

Kemudian dipilih spesifikasi pipa RUCIKA PVC berdasarkan standar JIS:

diameter inside (d) = 78.0 mm = 0.078 m

thickness = 5.5 mm = 0.0055 m

diameter outside = 89.0 mm = 0.089 m

Nominal pipe size = VP 3 inch

v = 0.20 m/s

Perhitungan Head pada sisi Suction Sewage.

- Head karena perbedaan kecepatan = 0 (Ø sama)
- Head karena perbedaan tekanan = 0 (Ø sama)
- Head karena perbedaan ketinggian = 1 m
- Head karena losses =

Mayor losses (karena gesekan)

Reynold's number (Rn) :

viscosity n = 1.1 cst pada 50°C = 0.0000011 m^2/s

Rn = (v x d) / n

Rn = 14181.82 (aliran turbulen)

untuk mencari koefisien gesek dengan menggunakan rumus = 0,02+0,0005/d

jadi gesekan sepanjang pipa (f) 0.02641 m

mayor losses (hf) = f x L/D x $v^2/2g$

panjang pipa suction adalah 1 m panjang

Jadi mayor losses (hf) = 0.00 m

Minor losses (karena aksesoris)

Aksesoris	Jumlah (n)	k	n x k	konstanta
Strainer	1	1.5	1.5	
SDNRV	1	1.23	1.23	
		jumlah	2.73	

Jadi minor losses (hl) = k x v2/2g

= 0.01 m

Perhitungan Head pada sisi Discharge Pompa Air Tawar.

- Head karena perbedaan kecepatan = 0 m
- Head karena perbedaan tekanan = 0 m
- Head karena perbedaan ketinggian = 4 m
- Head karena losses =

Mayor losses (karena gesekan)

Reynold's number (Rn) :

viscocity n = 1.1 cst pd 50°C = 0.0000011 m^2/s

Rn = (v x d) / n

Rn = 14181.82 sama dengan sisi suction karena diameter sama.

untuk mencari koefisien gesek dengan menggunakan rumus = 0,02+0,0005/d

jadi gesekan sepanjang pipa (f) 0.02641 m

mayor losses (hf) = f x L/D x $v^2/2g$

panjang pipa discarge adalah 18 m

Jadi mayor losses (hf) = 0.01 m

Minor losses (karena aksesoris)

Aksesoris	Jumlah (n)	k	n x k
SDNRV	1	1.23	1.23
		jumlah	1.23

Jadi minor losses (hl) = k x v2/2g

= 0.03 m

Sehingga Head Total:

= Hp+Hv+Hs+Hlosses

= 5.04 m

Jadi pompa yang dipilih adalah:

Model : **Iron Pump Q 4/300 50 Hz**

Capacity : **40 m3/h**

Head : **10 m**

RPM : **1000 rpm**

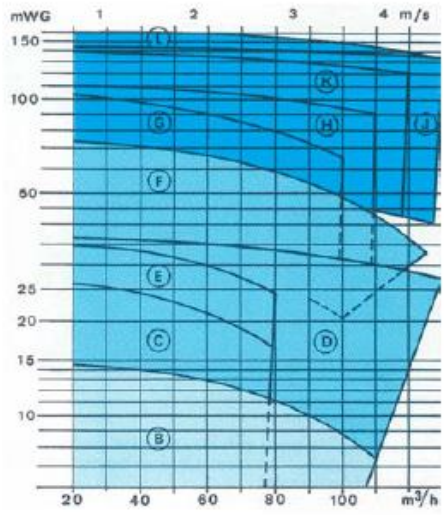
KELAS VP / AW (Pipa bertekanan, dengan tekanan maksimal : 10 kg/cm^2)

Diameter		Tebal Dinding (mm)	Panjang (m)	Sistem Penyambungan
inch	mm			
1/2	22	2,70	4	SP
3/4	26	2,70	4	SP
1	32	3,10	4	SP
1-1/4	42	3,10	4	SP
1-1/2	48	3,60	4	SP
2	60	4,10	4	SP
2-1/2	76	4,10	4	SP
3	89	5,50	4	SP
4	114	6,60	4	SP
5	140	7,00	4	SP
6	165	8,90	4	SP
8	216	10,30	4	SP
10	267	12,70	4	SP
12	318	15,10	4	SP

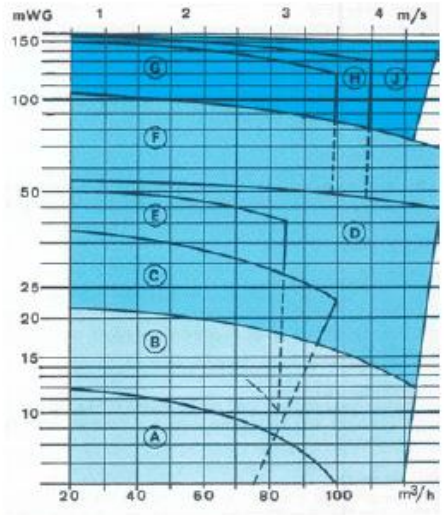
Capacity: 40...100 m^3/h

DN 100 (4" dia) Flange connections

50 Hz power supply



60 Hz power supply



IDENTIFICATION OF PUMP TYPE NO. AND CURVE SHEET NO.

Index letter	Basic type No.	Impeller No.	Data for continous duty at 50 Hz		Max. allowed power transmission kW				Data for continous duty at 60 Hz		Max. allowed power transmission kW			
			RpM	Curve No.	QV	QVP	QVK	QH	RpM	Curve No.	QV	QVP	QVK	QH
A	Q..4/300	2017							900	03.91	58		58	58
B	Q..4/300	2017	1000	01.91	64		64	64	1200	04.91	77		77	77
C	Q..4/300	3200	1500	51.60	96	96	96	96	1800	52.60	115	115	115	115
D	Q..4/300	2017	1500	05.72	96	96	96	96	1800	07.72	115	115	115	115
E	Q..4/300	3400	1500	02.78	96	96	96	96	1800	03.78	115	115	115	115
F	Q..2-4/300	2950 H+V	1500	19.76	88*	56*		67	1800	01.76	105*	66*		80
G	Q..4/300	3427	3000	31.76	130*	130*	130	130	3600	20.81	130*		130	130
H	Q..4/300	3200	3000	06.81	130*	130*	130	130	3600	07.81	130*		130	130
J	Q..4/300	2017	3000	44.60	130*	130*	130	130	3600	45.60	130*		130	130
K	Q..4/300	3400	3000	09.81	130*	130*	130	130						
L	Q..4/300	2950 H+V	3000	02.91	130*	110*		130						

*Valid for built-in bottom sleeve bearing only

ATTACHMENT 3
ADDITIONAL PLATE FOR *RESTOBARGE*

(Krakatau Steel 2017)

Additional plate				
No	Parts	Plate dimension (mm)	Quantity	Wieght (ton)
1	Roof	6000 x 1500 x 7	178	176.06
2	Starboard & port	6000 x 1500 x 14	44	43.52
3	Back & front	6000 x 1500 x 14	16	15.83
4	Divider between room	6000 x 1500 x 7	52	25.72
		Total	290	261.12
		The price of steel per ton (Rp)	8,300,000.00	
		total price (Rp)	2,167,315,920.00	

ATTACHMENT 4
WATER NEEDS OF RESTAURANT

KEBUTUHAN AIR NON DOMESTIK UNTUK KATEGORI I, II, III, IV

SEKTOR	NILAI	SATUAN
SEKOLAH	10	LITER/MURID/HARI
RUMAH SAKIT	200	LITER/BED/HARI
PUSKESMAS	2000	LITER/UNIT/HARI
MASJID	3000	LITER/UNIT/HARI
KANTOR	10	LITER/PEGAWAI/HARI
PASAR	12000	LITER/HEKTAR/HARI
HOTEL	150	LITER/BED/HARI
RUMAH MAKAN	100	LITER/TEMPAT DUDUK/HARI
KOMPLEK MILITER	60	LITER/ORANG/HARI
KAWASAN INDUSTRI	0.2-0.8	LITER/DETIK/HEKTAR
KAWASAN WISATA	0.1-0.3	LITER/DETIK/HEKTAR

SUMBER: KRITERIA PERENCANAAN DITJEN CIPTA KARYA DINAS PU

OPERASIONAL RESTORAN = 8 JAM
JUMLAH BANGKU = 250
KEBUTUHAN AIR = 100 LITER/TEMPAT DUDUK/HARI
JUMLAH PENGUNJUNG YANG DIINGINKAN = 1000/HARI
RUMAH MAKAN

KEBUTUHAN AIR = 250 x 100 massa jenis air 1 ton/m^3
= 25000 liter
= 25 m^3
= 25 ton/hari

KAPASITAS TANGKI = 1415.804 ton 1415.8
DAYA TAMPUNG TANGKI = 1415.804 ton / 25 ton/hari
= 56.63216 hari
= 57

HARGA AIR PER M3 = Rp 9800
HARGA AIR TOTAL UNTUK 57 HARI OPERASI = Rp 9800 x 1415.804 ton
IDR 13,874,879.20
HARGA AIR UNTUK SEMINGGU OPERASI = IDR 1,902,800.93

ATTACHMENT 5
FRESH WATER TANK VOLUME CALCULATION

1	Displasmen = LxBxTxCb	
	4947.12	
2	LWT = berat baja awal	
	1627	
3	Berat baja modifikasi restoran = Roof + Portside & Starboard + Back & Front + Room Dividers	
	261.13	
4	Outfitings + Pax + Garbage + Sewage	
	401.6102	

TOTAL : 2289.74

Dikurangin 8 tangki = 1415.804
FW Tank = 1415.804 m3

ATTACHMENT 6
BILL OF MATERIAL SANITARY SYSTEM

Line	Qty.	Description	Volume mm	Material	Price Rp
		INTAKE FROM LAND			
1	1	Main Pipe	43464.0	Carbon Steel black Spindo ERW sch 40 Ø 1.5 inch	IDR 1,932,590.54
2	5	Screw Down NRV		Steel Screw Down NRV	IDR 1,000,000.00
3	1	T-Joint		T Straight S 40 SL	IDR 30,000.00
4	2	Elbow 90°		Elbow 90° Seamless SS304L sch 40	IDR 136,000.00
5	7	Flange		Carbon Steel PN 10 RF STD 1.5 inch	IDR 420,000.00
		SUCTION PIPE			
6	1	Main Pipe	32000.0	Carbon Steel black Spindo ERW sch 40 Ø 1.5 mm	IDR 1,422,853.33
7	1	Screw Down NRV		Steel Screw Down NRV	IDR 200,000.00
8	1	Strainer		Metal	IDR 400,000.00
9	2	T-Joint		T Straight S 40 SL	IDR 100,000.00
10	1	Elbow 90°		Elbow 90° Seamless SS304L	IDR 68,000.00
11	1	Level Alarm Indicator		Stainless Steel Breaking Water Level Sensor Horizontal Float Switch	IDR 136,000.00
12	3	Flange		Carbon Steel PN 10 RF STD 1.5 inch	IDR 180,000.00
13	1	Centrifugal Pump		Taiko TMC-32-0.75, 5.5 m3/h - head 10 m	IDR 5,900,000.00
		Discharge Pipe			
14	1	Main Pipe	82000.0	Rucika VP/AW Ø 1.5 inch	IDR 2,402.60
15	20	Connection Pipe Between Compartement	20000.0	Carbon Steel black Spindo ERW sch 40 Ø 1.5 inch	IDR 1,067,140.00
16	10	Elbow 90		PVC Elbow D Rucika 1.5 inch	IDR 28,000.00
17	18	T-Joint		PVC Tee D Rucika 1.5 inch	IDR 75,600.00
18	30	Flange		PVC Flange	IDR 90,000.00
	1	Hydrophore Pressure Tank		Taiko UH-2.0 - 1R 8m3/h-head 20m	IDR 14,700,000.00
				Total :	**IDR 27,888,586.47**

Carbon Steel black Spindo ERW sch 40 Ø 1.5 inch

PT. ABADI METAL UTAMA
Jl. Raya Sukomanunggal Jaya A6, Satelit Town Square, Surabaya, Jawa Timur
Telp. : (031)7317975; 7325885 (Hunting) Fax. : (031) 7325030, 7326050
E-mail : abadimetalutama@gmail.com
Website : www.abadimetalutama.com

Daftar harga pipa Spindo ERW SCH 40 Hitam

18 April 2017

DIAMETER	PANJANG	HARGA
1/2"	6 METER	**Rp83,619**
3/4"	6 METER	**Rp110,923**
1"	6 METER	**Rp164,394**
1-1/4"	6 METER	**Rp224,691**
1-1/2"	6 METER	**Rp266,785**
2"	6 METER	**Rp356,661**
2-1/2"	6 METER	**Rp567,700**
3"	6 METER	**Rp740,626**
4"	6 METER	**Rp1,053,487**
5"	6 METER	**Rp1,425,507**
6"	6 METER	**Rp1,842,465**
8"	6 METER	**Rp2,818,590**

Carbon Steel PN 10 RF STD 1.5 inch

DAFTAR HARGA FLANGES						
Size	T	PN 10 RF STD		T	PN 16 RF STD	
Inchi		PN 10 RF	PN 10 RF B		PN 16 RF	PN 16 RF B
½	14	Rp24,000	Rp26,000	14	Rp24,000	Rp26,000
¾	16	Rp29,000	Rp31,500	16	Rp29,000	Rp31,500
1	16	Rp36,000	Rp39,000	16	Rp36,000	Rp39,000
1¼	16	Rp53,000	Rp58,000	16	Rp53,000	Rp58,000
1½	16	Rp60,000	Rp65,000	16	Rp60,000	Rp65,000
2	18	Rp77,000	Rp87,500	18	Rp77,000	Rp87,500
2½	18	Rp93,000	Rp108,000	18	Rp93,000	Rp108,000
3	20	Rp115,000	Rp138,000	20	Rp115,000	Rp138,000
4	20	Rp128,000	Rp168,000	20	Rp128,000	Rp168,000

Taiko TMC-32-0.75, 5.5 m3/h - head 10 m (equated)

CENTRIFUGAL PUMP :
Merk : EBARA
Type : 50X40 FSHA
Cap. : 12 M3/ Hr
Head : 30 M
Sealling : Mechanical Seal
Power : 2,2 KW/ 3 HP/ 380 V/ 50 HZ/ 3 Phase/ 2 Pole/ 2950 Rpm
Price : Rp 5.900.000,- / Unit C/W Motor, Coupling, Base Plate

PVC Elbow D Rucika 1.5 inch

DAFTAR HARGA ELBOW 90° (D)		
DIAMETER	**ISI / BOX**	**HARGA**
1 1/4"	90	Rp2,100
1 1/2"	60	Rp2,800
2"	100	Rp4,700
2 1/2"	45	Rp7,700
3"	30	Rp11,200
4"	15	Rp22,700
5"	15	Rp55,800
6"	10	Rp66,500
8"	3	Rp146,600
10"	2	Rp292,000
12"	1	Rp441,500

Elbow 90° Seamless SS304L

Harga Elbow ELBOW 90° SEAMLESS SS304L Terbaru :

SIZE	ASTM JIS	ASTM	ASTM
	SCH 10 (Rp)	SCH 20 (Rp)	SCH 40 (Rp)	SCH 80 (Rp)
1/2"	21.000	21.000	22.000	23.000
3/4"	25.000	26.000	26.000	28.000
1"	38.000	38.000	39.000	40.000
1 1/4"	51.000	51.000	52.000	59.000
1 1/2"	64.000	65.000	68.000	77.000
2"	96.000	106.000	110.000	130.000
2 1/2"	150.000	160.000	180.000	245.000
3"	240.000	265.000	290.000	395.000
4"	380.000	410.000	490.000	690.000
5"	680.000	695.000	870.000	1.250.000
6"	950.000	970.000	1.300.000	2.100.000
8"	1.750.000	2.200.000	2.700.000	4.300.000
10"	4.600.000	7.100.000	10.200.000	15.600.000
12"	8.000.000	11.000.000	17.000.000	29.000.000
14"	13.900.000	15.100.000	18.500.000	38.000.000

Taiko UH-2.0 - 1R 8m3/h-head 20m (equated)

84198990

Date	HS Code	Description	Origin Country	Port of Discharge	Unit	Quantity	Value (INR)	Per Unit (INR)
Jul 13 2015	84198990	HYDROPHORE UNIT WITH SELF-PRIMING PUMPS FOR FRESH WATER,TANKACCESS,COMMON FRAME(SKID) MADE OF ALUMINIUM AS PER INVOICE	Poland	Bombay Sea	SET	1	680,581	680,581

PVC Tee D Rucika 1.5 inch

DAFTAR HARGA TEE (D)

DIAMETER	ISI / BOX	HARGA
1 1/4"	55	2,900
1 1/2"	40	4,200
2"	65	6,400
2 1/2"	32	11,600
3" X 1 1/2"	36	11,600
3" X 2"	30	13,200
3" X 2 1/2"	22	14,800
3"	20	17,300
4" X 2"	15	22,100
4" X 3"	12	26,100
4"	8	30,000
5" X 4"	6	53,100
5"	10	50,800
6" X 4"	8	71,800
6"	6	91,700
8" X 4"	4	97,400
8"	2	190,400

PVC Flange

PVC Plastik Pipa Fitting flange/Keran Flange

Harga Fob: US $0.1 Meter/meter | Get Latest Price

Pelabuhan: SHANGHAI PORT OR OTHERS

Jumlah Pesanan Minimum: 1 Meter/meter

Kemampuan Suplai: 100000 Meter/meter per Bulan PVC Plastik Pipa Fitting flange/Keran Flange

Waktu Pengiriman: dikirim dalam 10 hari setelah pembayaran

Ketentuan Pembayaran: L/C,D/A,D/P,T/T,Western Union,MoneyGram

Hubungi Sekarang | Mulai Order

Jaminan Perdagangan

Steel Screw Down NRV

Besi cor ayunan/limbah katup | screw-down tidak kembali katup harga rendah

Harga Fob:	US $ 20-500 / Unit | Get Latest Price
Pelabuhan:	Qingdao, China
Jumlah Pesanan Minimum:	20 Unit/unit besi cor ayunan/limbah katup | screw-down non kembali katup
Kemampuan Suplai:	3000 Unit/unit per Bulan besi cor ayunan/limbah katup | screw-down non kembali katup
Waktu Pengiriman:	dalam waktu 20-30 hari setelah pembayaran
Ketentuan Pembayaran:	L/C,D/A,T/T,Western Union,MoneyGram

Hubungi Sekarang | Mulai Order

Rucika VP/AW Ø 1.5 inch

PT. ABADI METAL UTAMA
Jl. Raya Sukomanunggal Jaya A6, Satelit Town Square, Surabaya, Jawa Timur
Telp. : (031)7317975; 7325885 (Hunting) Fax. : (031) 7325030, 7326050
E-mail : abadimetalutama@gmail.com
Website : www.abadimetalutama.com

Pipa PVC Rucika standard JIS K-6741/K-6742
(Panjang 4 m / batang)

Ukuran		Tipe	
inch	mm	VP(AW)	VU(D)
½	22	Rp38,300	
¾	26	Rp46,000	
1	32	Rp66,900	
1¼	42	Rp90,100	
1½	48	Rp117,200	Rp61,400
2	60	Rp166,500	Rp77,500
2½	76	Rp214,200	Rp122,700
3	89	Rp341,300	Rp179,300
4	114	Rp527,500	Rp269,200
5	140	Rp660,400	Rp405,400
6	165	Rp991,600	Rp582,900
8	216	Rp1,499,700	Rp972,600
10	267	Rp2,285,000	Rp1,440,300
12	318	Rp3,241,300	Rp2,022,300
TrueGlue(400 g)		Rp36,000	
TrueGlue(60 g)		Rp7,500	
TrueGlue(40 g)		Rp5,500	

ATTACHMENT 7
BILL OF MATERIAL SEWAGE SYSTEM

Line	Qty.	Description	Volume mm	Material	Price Rp
		SUCTION PIPE			
1	1	Main Pipe	118000.0	Rucika PVC VP/AW Ø 3 inch	IDR 10,068,350.00
2	1	Level Alarm Indicator		Stainless Steel Breaking Water Level Sensor Horizontal Float Switch	IDR 136,000.00
5	14	T-Joint		Rucika PVC Tee (D) 3 inch	IDR 242,200.00
6	15	Elbow 90°		Rucika PVC Elbow 90 ° (D) 3 inch	IDR 168,000.00
		Connection Pipe Between Compartment	20000.0	Carbon Steel black Spindo ERW sch 40 Ø 3 inch	IDR 2,466,666.67
	20	Flange		Carbon Steel PN 10 RF STD 3 inch	IDR 115,000.00
		DISCHARGE PIPE			
8	1	Main Pipe	16000.0	Rucika PVC VP/AW Ø 3 inch mm	IDR 1,365,200.00
9	2	Screw Down NRV		Non Return Valve Plastic	IDR 40,000.00
13	1	Elbow 90°		Rucika PVC Elbow 90 ° (D) 3 inch	IDR 35,000.00
15	3	Flange		Carbon Steel PN 10 RF STD 3 inch	IDR 115,000.00
		Connection Pipe Between Compartment	6000.0	Carbon Steel black Spindo ERW sch 40 Ø 3 inch	IDR 740,000.00
		Pump		Iron Pump Q 4/300 50 Hz 40m3/hr - 10m	IDR 9,370,000.00
				Total :	**IDR 24,861,416.67**

Rucika PVC VP/AW Ø 3 inch

PT. ABADI METAL UTAMA
Jl. Raya Sukomanunggal Jaya A6, Satelit Town Square, Surabaya, Jawa Timur
Telp. : (031)7317975; 7325885 (Hunting) Fax. : (031) 7325030, 7326050
E-mail : abadimetalutama@gmail.com
Website : www.abadimetalutama.com

Pipa PVC Rucika standard JIS K-6741/K-6742 (Panjang 4 m / batang)			
Ukuran		Tipe	
inch	mm	VP(AW)	VU(D)
½	22	Rp38,300	
¾	26	Rp46,000	
1	32	Rp66,900	
1¼	42	Rp90,100	
1½	48	Rp117,200	Rp61,400
2	60	Rp166,500	Rp77,500
2½	76	Rp214,200	Rp122,700
3	89	Rp341,300	Rp179,300
4	114	Rp527,500	Rp269,200
5	140	Rp660,400	Rp405,400
6	165	Rp991,600	Rp582,900
8	216	Rp1,499,700	Rp972,600
10	267	Rp2,285,000	Rp1,440,300
12	318	Rp3,241,300	Rp2,022,300
TrueGlue(400 g)		Rp36,000	
TrueGlue(60 g)		Rp7,500	
TrueGlue(40 g)		Rp5,500	

Rucika PVC Elbow 90 ° (D) 3 inch

DAFTAR HARGA ELBOW 90° (D)		
DIAMETER	ISI / BOX	HARGA
1 1/4"	90	Rp2,100
1 1/2"	60	Rp2,800
2"	100	Rp4,700
2 1/2"	45	Rp7,700
3"	30	Rp11,200
4"	15	Rp22,700
5"	15	Rp55,800
6"	10	Rp66,500
8"	3	Rp146,600
10"	2	Rp292,000
12"	1	Rp441,500

Non-Return Valve Plastic

Harga terbaik non-return valve plastik pvc pipa katup

Harga Fob:	US $ 0.1-2 / Potongan | Get Latest Price
Pelabuhan:	Ningbo,/Shanghai
Jumlah Pesanan Minimum:	1 Karton/karton
Kemampuan Suplai:	12000 Karton/karton per Hari
Waktu Pengiriman:	2-4 minggu
Ketentuan Pembayaran:	L/C,D/A,D/P,T/T

Hubungi Sekarang | Mulai Order

Jaminan Perdagangan

Carbon Steel black Spindo ERW sch 40 Ø 3 inch

PT. ABADI METAL UTAMA
Jl. Raya Sukomanunggal Jaya A6, Satelit Town Square, Surabaya, Jawa Timur
Telp. : (031)7317975; 7325885 (Hunting) Fax. : (031) 7325030, 7326050
E-mail : abadimetalutama@gmail.com
Website : www.abadimetalutama.com

Daftar harga pipa Spindo ERW SCH 40 Hitam
18 April 2017

DIAMETER	PANJANG	HARGA
1/2"	6 METER	Rp83,619
3/4"	6 METER	Rp110,923
1"	6 METER	Rp164,394
1-1/4"	6 METER	Rp224,691
1-1/2"	6 METER	Rp266,785
2"	6 METER	Rp356,661
2-1/2"	6 METER	Rp567,700
3"	6 METER	Rp740,626
4"	6 METER	Rp1,053,487
5"	6 METER	Rp1,425,507
6"	6 METER	Rp1,842,465
8"	6 METER	Rp2,818,590

Rucika PVC Tee (D) 3 inch

DAFTAR HARGA TEE (D)		
DIAMETER	ISI / BOX	HARGA
1 1/4"	55	2,900
1 1/2"	40	4,200
2"	65	6,400
2 1/2"	32	11,600
3" X 1 1/2"	36	11,600
3" X 2"	30	13,200
3" X 2 1/2"	22	14,800
3"	20	17,300
4" X 2"	15	22,100
4" X 3"	12	26,100
4"	8	30,000
5" X 4"	6	53,100
5"	10	50,800
6" X 4"	8	71,800
6"	6	91,700
8" X 4"	4	97,400
8"	2	190,400

Iron Pump Q 4/300 50 Hz 40m3/hr - 10m (equated)

CENTRIFUGAL PUMP :
Merk : EBARA
Type : 100X80 FSJA
Cap. : 60 M3/ Hr
Head : 15 M
Sealling : Gland Paking
Power : 3,7 KW/ 5 HP/ 380 V/ 3 Phase/ 50 HZ/ 1450 RPM
Price : Rp 9.370.000,-/ Unit C/W Motor, Coupling, Base Plate

Carbon Steel PN 10 RF STD 3 inch

DAFTAR HARGA FLANGES						
Size	T	PN 10 RF STD		T	PN 16 RF STD	
Inchi		PN 10 RF	PN 10 RF B		PN 16 RF	PN 16 RF B
½	14	Rp24,000	Rp26,000	14	Rp24,000	Rp26,000
¾	16	Rp29,000	Rp31,500	16	Rp29,000	Rp31,500
1	16	Rp36,000	Rp39,000	16	Rp36,000	Rp39,000
1¼	16	Rp53,000	Rp58,000	16	Rp53,000	Rp58,000
1½	16	Rp60,000	Rp65,000	16	Rp60,000	Rp65,000
2	18	Rp77,000	Rp87,500	18	Rp77,000	Rp87,500
2½	18	Rp93,000	Rp108,000	18	Rp93,000	Rp108,000
3	20	Rp115,000	Rp138,000	20	Rp115,000	Rp138,000
4	20	Rp128,000	Rp168,000	20	Rp128,000	Rp168,000

ATTACHMENT 8
BILL OF MATERIAL GARBAGE MANAGEMENT SYSTEM

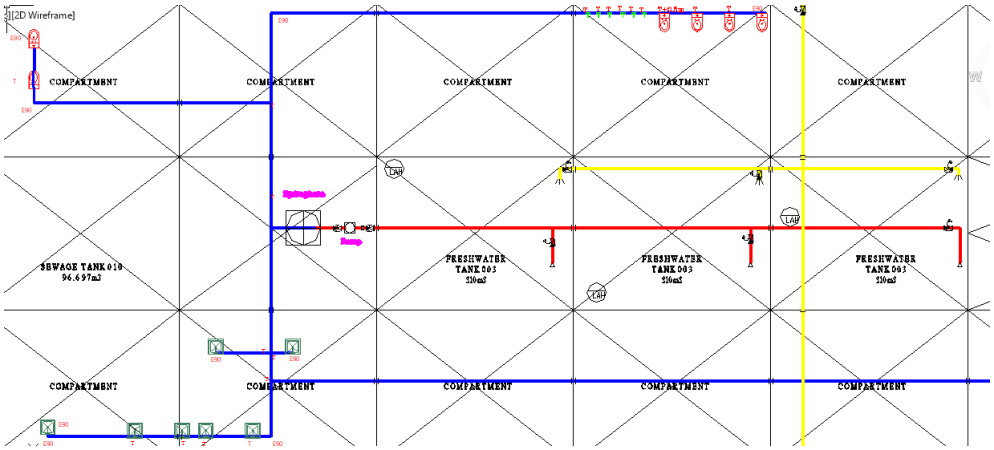
Rucika PVC VP/AW Ø 12 inch

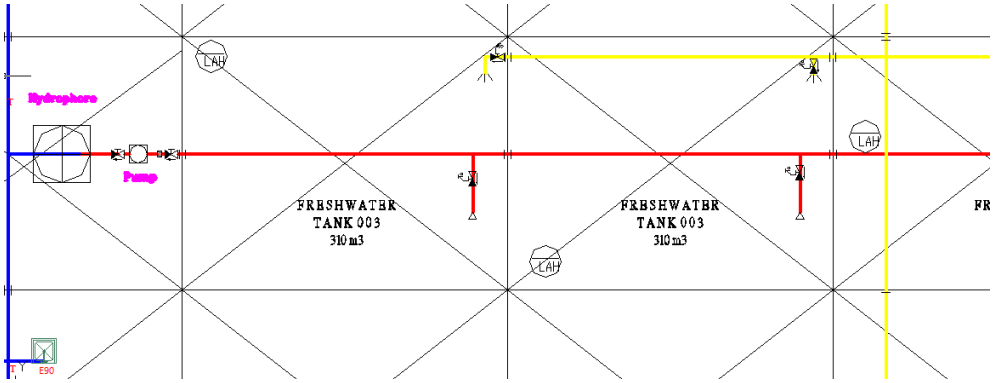
PT. ABADI METAL UTAMA
Jl. Raya Sukomanunggal Jaya A6, Satelit Town Square, Surabaya, Jawa Timur
Telp. : (031)7317975; 7325885 (Hunting) Fax. : (031) 7325030, 7326050
E-mail : abadimetalutama@gmail.com
Website : www.abadimetalutama.com

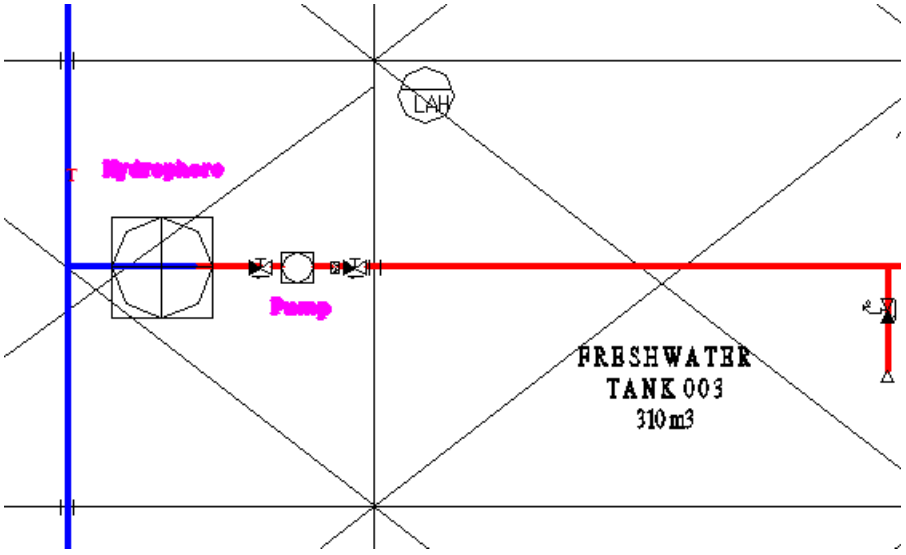
Pipa PVC Rucika standard JIS K-6741/K-6742
(Panjang 4 m / batang)

Ukuran		Tipe	
inch	mm	VP(AW)	VU(D)
½	22	Rp38,300	
¾	26	Rp46,000	
1	32	Rp66,900	
1¼	42	Rp90,100	
1½	48	Rp117,200	Rp61,400
2	60	Rp166,500	Rp77,500
2½	76	Rp214,200	Rp122,700
3	89	Rp341,300	Rp179,300
4	114	Rp527,500	Rp269,200
5	140	Rp660,400	Rp405,400
6	165	Rp991,600	Rp582,900
8	216	Rp1,499,700	Rp972,600
10	267	Rp2,285,000	Rp1,440,300
12	318	Rp3,241,300	Rp2,022,300
TrueGlue(400 g)		Rp36,000	
TrueGlue(60 g)		Rp7,500	
TrueGlue(40 g)		Rp5,500	

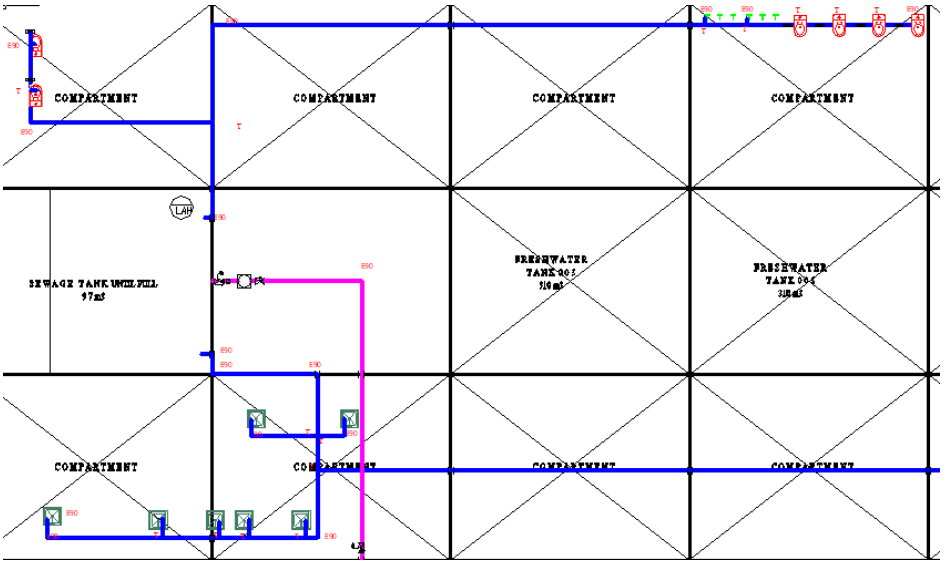
ATTACHMENT 9
DESIGN OF RESTOBARGE SANITARY

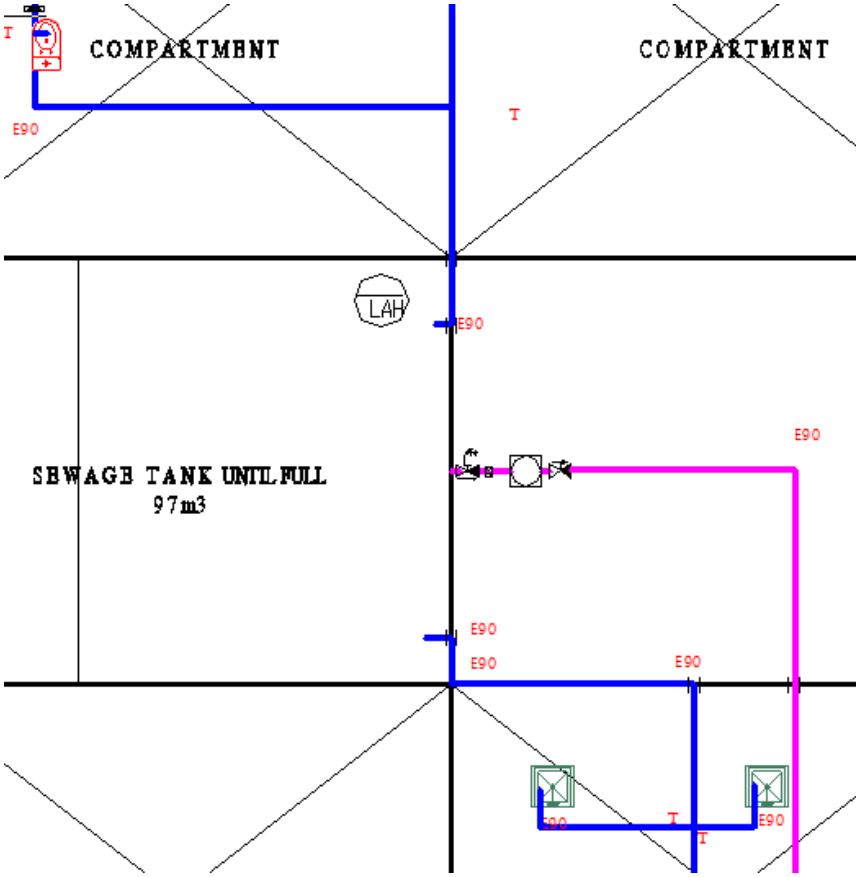

[2D Wireframe]
COMPARTMENT
COMPARTMENT
COMPARTMENT
COMPARTMENT
COMPARTMENT
Hydrophore
Pump
SEWAGE TANK 010
96.697m3
FRESHWATER
TANK 003
310m3
FRESHWATER
TANK 003
310m3
FRESHWATER
TANK 003
310m3
LAH
COMPARTMENT
COMPARTMENT
COMPARTMENT
COMPARTMENT
COMPARTMENT
E90


Hydrophore
Pump
LAH
FRESHWATER
TANK 003
310 m3
FRESHWATER
TANK 003
310 m3
LAH
LAH
E90

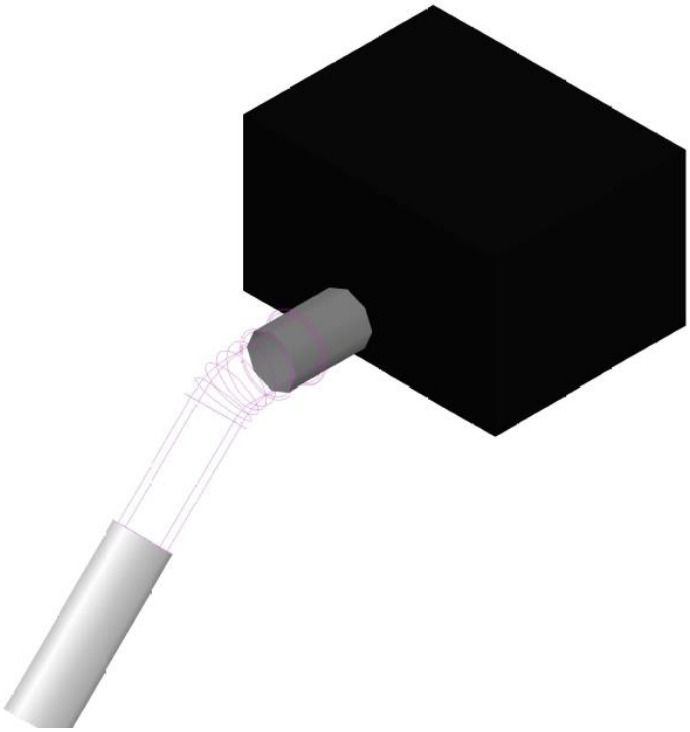

LAH
Hydrophore
Pump
FRESHWATER
TANK 003
310 m3

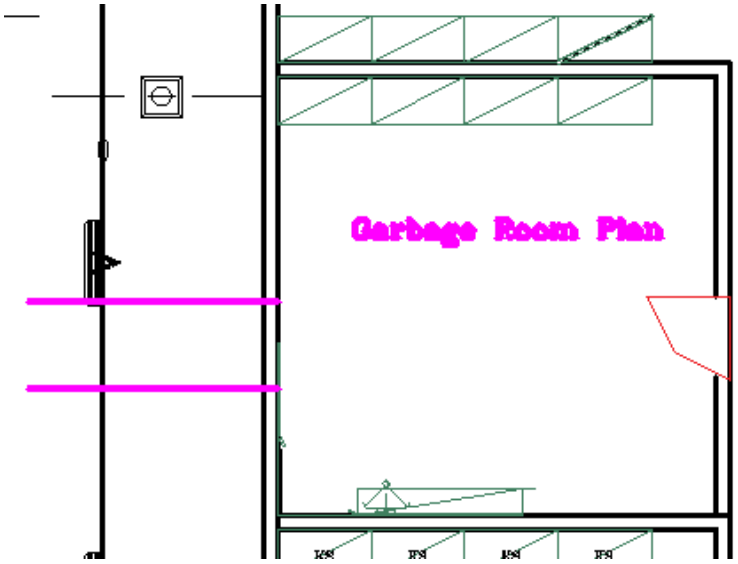
ATTACHMENT 10
DESIGN OF RESTOBARGE SEWAGE


COMPARTMENT
COMPARTMENT
COMPARTMENT
COMPARTMENT
SEWAGE TANK UNTIL FULL
97m3
FRESHWATER
TANK 96%
FRESHWATER
TANK 96%
COMPARTMENT
COMPARTMENT
COMPARTMENT
COMPARTMENT

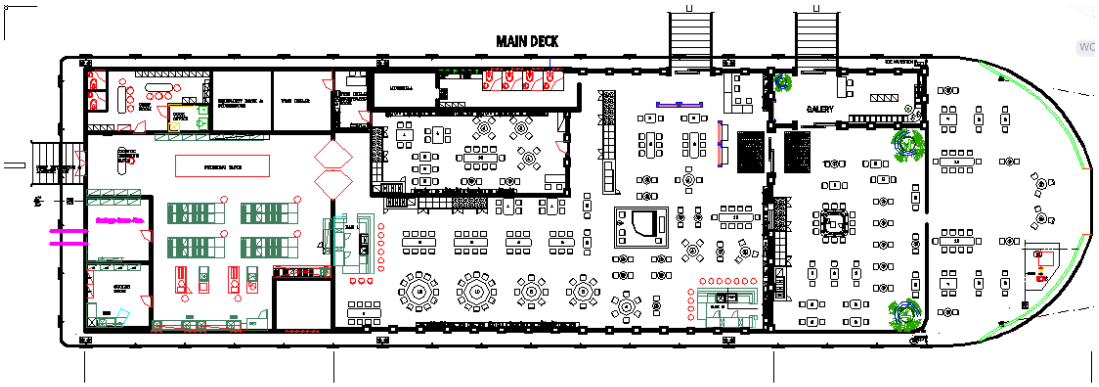

COMPARTMENT
COMPARTMENT
T
E90
T
LAH
E90
E90
SEWAGE TANK UNTIL FULL
97m3
E90
E90
E90
E90
T
T
E90

ATTACHMENT 11
DESIGN OF RESTOBARGE GARBAGE MANAGEMENT




Garbage Room Plan

ATTACHMENT 12
DESIGN OF RESTOBARGE MAIN DECK


MAIN DECK
GALERY

ATTACHMENT 13
LIST OF WORKER WAGES

Upah Jasa Tukang Bangunan Per Hari :

No	Jenis Pekerjaan	Waktu	Upah/ Gaji (Rp)
1	Pekerja	harian	99.000
2	Tukang gali	harian	120.000
3	Kepala tukang batu	harian	140.000
4	Tukang batu	harian	122.000
5	Kepala tukang kayu	harian	140.000
6	Tukang kayu	harian	122.000
7	Kepala tukang besi	harian	140.000
8	Tukang besi	harian	122.000
9	Kepala tukang cat	harian	140.000
10	Tukang cat	harian	122.000
11	Tukang aspal	harian	122.000
12	Mandor / Pengawas	harian	158.000

13	Instalator	harian	140.000
14	Pembantu instalator	harian	122.000
15	Tukang babat rumput	harian	103.000
16	Kepala tukang pasang	harian	122.000
17	Tukang pasang pipa	harian	103.000
18	Operator alat berat	harian	158.000
19	Pembantu operator	harian	122.000
20	Tukang las	harian	122.000

http://boshargabangunan.com/upah-tukang-bangunan/#

BIOGRAPHY

Rizqi Ramadhan is a writer of this thesis. The writer born in Bandung, 19 Februari 1996. The parent's name of writer are Fahmy Yunarso and Tenny Esianty. The writer lives in Raffles Hills Depok. The writer take an elementary school in Fajar Hidayah Bogor (graduated in 2007), Al-Azhar 19 Cibubur Junior High School (graduated in 2010), 48 Senior High School (graduated in 2013, and now in Institut Teknologi Sepuluh Nopember (ITS) Surabaya.

The writer also active in organization. The writer active in BEM Fakultas FTK as Head of Division in BUMF, Dewan Perwakilan Angkatan Himasiskal as Treasurer, and also take in World Merit Indonesia, a non-profit organization.

With a passion, disciplined, and self-motivated, the writer now has finished the Thesis well. I hope this Thesis can be useful for educational world.

So finally, the writer expressed gratitude because this Thesis titled "**Design of *Restobarge* Sewage and Garbage Systems"** has finished very well.