THESIS – MN142532

STUDY ON CAPACITY IMPROVEMENT OF A SHIPYARD IN MYANMAR: A CASE STUDY OF "DALLA" SHIPYARD

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THESIS CONFIRMATION SHEET

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Master of Engineering
At
Institut Teknologi Sepuluh Nopember

By
AUNG YE KYAW
NRP: 4114203701

Date: 21 July 2016
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Surabaya, 2 August 2016

Aung Ye Kyaw

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ABSTRACT

Inland Water Transport (IWT) is one of the reliable transport services for the people in Myanmar. Six shipyards are in operation under control of Engineering Department of Inland Water Transport. Among them, Dalla shipyard is the biggest one of the IWT shipyards. This shipyard was established in 1852, Dalla Township, Yangon Region. The shipyard currently accounts for about 50 percent of repair work on ships owned by the Inland Water Transport (IWT). The shipyard is contributing and providing maintenance services of the vessels for the regular runs and security of passengers. The efficiency of the shipyard, which is about 164 years old, is hampered by old equipment, including some from the WWII-era (Word War II).

Now the shipyard needs to be upgraded to improve its current capacity in ship repair. In this study, we proposed two ways which are supporting facilities and re-layout shipyard to increase ship repair. This research obtains two alternative layouts of shipyard. The first alternative layout does not change the existing layout of shipyard but steel plate warehouse are built. The second alternative changes a little the existing layout because machine shop and steel plate warehouse is too far from the slipways. The first and second alternatives renovate zone 5 shop, carpenter shop, pipe and boiler shop and repair slipways. The two alternatives have steel plate warehouse as well as the addition of two material handling equipment mobile crane and forklift.

The second alternative re-locates new machine shop near the slip ways for better material handling and time consuming. The second alternative is the best alternative in terms of economically feasible, good flow of material and perfect of technical term and the most number of ship repairs. Then it can be improved capacity amount 1.43 times and docking time can be reduced from average 33 days to 27 days.

The shipyard should be applied detail above analyzed and changed to a private organization, as the result of the government policy.

Keywords: shipyard, capacity, ship repair, facility and re-layout

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CHAPTER 1
INTRODUCTION

1.1. Background

Myanmar is a geographical entity in that all its physical features-the mountain and hill ranges, the valleys, plains, the deltas, the rivers, streams creeks and lakes all rise within her boundaries and run through within her boundaries. A long line of sea coast of over 1200 miles starting from the Myanmar- Bangladesh bordering the northwest right down to the south and terminating at the most south-easterly tip of the Myanmar-Thailand border is its seafront, with seaports through which Myanmar has had oversea contact since the ancient times.

The region's inland waterways play a vital role in the economic development of remote rural areas and in the welfare of their inhabitants, who are usually among the lowest of low-income groups in the region. In the absence of river and other forms of inland waterway transport, many remote under privileged communities would be inaccessible or too costly to service by other means.

Myanmar is well endowed with natural river resources. The Ayeyarwaddy, the Chindwin, the Thanlwin and the Sittaung rivers are flowing from north to south. The inland waterways transportation in Myanmar has better advantage than other modes of transport in the long term with the reason of least transport cost for heavy and bulky cargos , capability of transporting large amount of cargos in one time from one destination to another, a fuel efficient and environment friendly mode of transportation, no need of huge investment for the infrastructure like other modes of transport and less annual cost for maintenance of river channels, cheapest means of transporting raw materials and finished goods of various industries along the river banks. Inland waterways transportation has been improved rapidly; it is playing an important and essential role of transport due to its natural navigable waterways of rivers.

Government is embarking on a plan to facilitate speedier transport of commodities and people along the Ayeyarwady and Chindwin rivers by building six new inland water ports. Four ports are planned along the Ayeyarwady River at Sin Khan and Mandalay in Mandalay Region, as well as at Pakokku and Magway in Magway Region. Two ports are planned along the Chindwin River in Sagaing Region, at Monywa and Kalewa. The Sin Khan site is intended to facilitate faster transport between China’s Yunnan Province and Myanmar via the Ayeyarwady River. The new port at Mandalay is intended to handle containers trucked in via the Mandalay-Monywa-Tamu and Mandalay-Lashio-Shweli highways, while the Pakokku port is intended to accept goods from upper Myanmar and help to distribute them to the west of the Chindwin River. Monywa and Kalewa ports are intended to facilitate trade with India through Tamu and Kalay. The port planned at Magway is intended to aid the faster flow of goods from Myanmar’s southwest to upper Myanmar and China. Therefore, inland waterways is not only more developed but also more increase inland waterways ships.

Domestic waterborne transport network centering on Yangon Port consists of coastal and delta transport. The inland waterway transport covers the area along the rivers around Yangon and Ayeyarwady Delta. Shipbuilding industry in Myanmar has been developed by three sectors.

The first sector is the semi-government organization represented by Myanma Shipyard, which is engaged in shipbuilding and ship repair, together with other mechanical works on commercial basis.

The second sector is composed of shipyards owned by the government organizations such as IWT (Inland Water Transport), MPA (Myanma Port Authority, DMA (Department of Marine Administration) and so on, where their own ships and fleets are maintained.

The last sector is private shipyards. There are large numbers of shipyards along the Yangon River and the Bago River as well as Seikgyi village near the Twante Canal. There are 31 shipyards in Yangon region. State owned shipyard is 9 and private owned shipyard is 22. The most of state owned shipyard functions are to repair and maintain state owned ships.

Inland Water Transport (IWT) is one of enterprise under Ministry of Transport (MOT). IWT is operating passenger cum cargo transport along the navigable waterways of Delta areas, the Ayeyarwady River, the Chindwin River and rivers in Mon, Kayin and Rakhine states in Myanmar (IWT, 2015). IWT use many vessels to give transport services for the people and cargo.

Engineering department of Inland Water Transport are six shipyards. They are Dalla shipyard, Dagon Seikkan shipyard, Yatanabon shipyard, Chindwin shipyard, Sittwe shipyard, Thanlwin shipyard. These shipyards are giving maintenance services to the vessels regularly.

Dalla Shipyard (state-owned shipyard), the establishment since 1852, locates beside the Yangon River in Dalla Township, Yangon Region. This shipyard is carrying out concerning major ship construction, ship repair and maintenance for Inland water vessels. The functions of shipyard are emergency docking for repair, major overhaul for engines, re-engineering, performing to support full utilization of fleet as planned and annual docking for repair and new constructions for privates and governmental departments. Most constructed ships are barges, tugs, self-propulsion barges and shallow draft vessels (Than, 2009).

1.2. Statement of the Problem

Nowadays, Government's policy changed that the state owned enterprises have to stand with their own budgets and have to get revenue for government. Dalla shipyard docking capacity per year (2015) is 57 vessels. The efficiency of the shipyard, which is about 164 years old, is hampered by old equipment, including some from the WWII-era (Word War II). According to the Inland Water Transport Board Law in 2014, Inland Water Transport (IWT) may have to stand with own budgets and have to seek markets and customers themselves. Therefore, the shipyard needs to be upgraded to improve its current capacity in ship repair.

1.3. Research Question

Based on the background and statement of the problem, the research will solve the following questions.

1. How to identify competitiveness position of Dalla shipyard in ship repair business?
2. How to re-arrange the layout of Dalla shipyard in accordance with the current layout of the shipyard?
3. How to improve facilities and material handling system?

1.4. Research Objectives

In doing this research, there are several goals, as follows:

1. To conduct a survey on the existing situation of the shipyard.
2. To evaluate the factors of production for ship repair in Dalla shipyard today.
3. To get a good productivity after re-arranging the layout.
4. To get a new shipyard layout in accordance with the situation of Dalla shipyard.

1.5. The Scope of Work

The scope of work in this research is as follow:

1. The condition of Dalla shipyard should be known low capacity of ship repair.
2. The shipyard layout is re-arranged based on the current situations of facilities and the material handling system.
3. The new facilities are supported by a mobile crane, a forklift, improved buildings and slipway repair.
4. The feasibility should be known for alternative layout of shipyard.

1.6. Benefits

Based on the background of writing, the research question and the purpose of writing, in this paper the benefit is a material to aid in the selection model of renovation shipyard. With an achievement target is the productivity level to increase circumstances of shipbuilding industry that exists at the moment. After finished the shipyard repair, the capacity improvement is 58 vessels per year (2016). Rationalize of the shipbuilding industry increase the productivity in shipyard and revenue of Inland Water Transport (IWT).

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CHAPTER 2
LITERATURE REVIEW

2.1 Dalla Shipyard

The Irrawaddy Flotilla Company Limited was formed in 1865 to operate transportation services on Irrawaddy River in Myanmar. The larger vessels of the Irrawaddy Flotilla Company are assembled in Dalla shipyard after having been constructed and set up engine in Scotland. Many of the smaller steamers and launches are built entirely in the company's modern shipyard (Dalla shipyard). At that time the shipyard is private owned shipyard and it has complete equipment and facilities.

The Irrawaddy Flotilla Company Limited was nationalized on 1st June 1948 after gaining Independence from the British Colonial Rule. Under the plan to provide new administrative order, "Inland Water Transport Board" was renamed as "Inland Water Transport Corporation" in 1972. It has been changed to the present name of "Inland Water Transport" with effect from 1st April 1989. Now Dalla shipyard is under Inland Water Transport (IWT), Ministry of Transport and communications. Dalla shipyard is located on the southern bank of Yangon River across from downtown Yangon. Dalla shipyard currently accounts for about 50 percent of repair work on ships owned by the Inland Water Transport. The following table 2.1 shows the list of IWT vessels.

Table 2.1 List of IWT Vessels

	Fleet
Powered Crafts	189
Dumb Barges	134
Station Pontoons	30
Total	353

Source: IWT, 2015

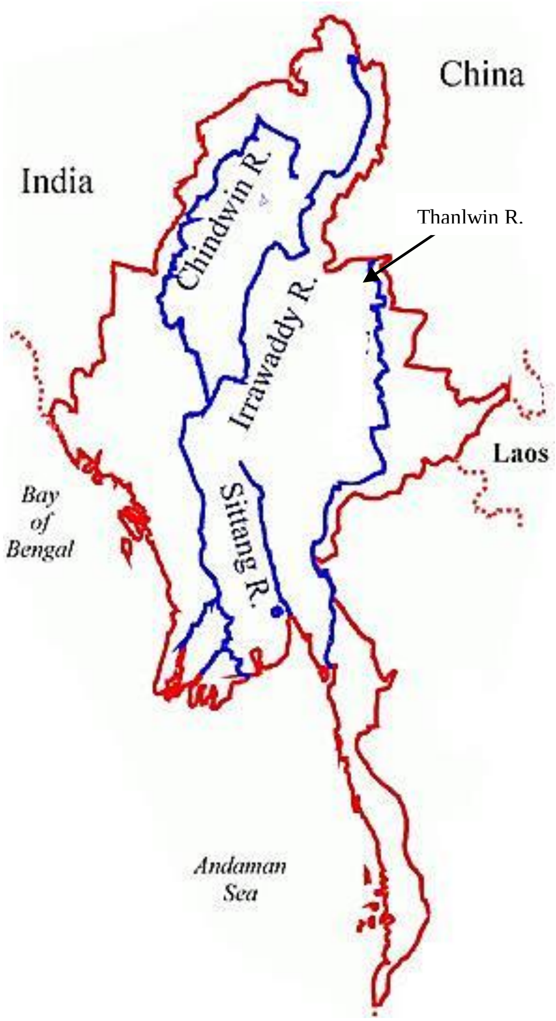

Figure 2.1 Four Rivers for Inland Waterways

2.2 Functions of Shipyard

Dalla shipyard repairs IWT's vessels and build new vessels for private and governmental departments. The functions of shipyard are as following:

1. Annual docking for repair
2. Emergency docking for repair
3. Major overhaul for engines
4. New constructions

1. Annual docking for repair is that the vessels are in dock to repair annually because the lifetime of vessel license is two years permission from Department of Marine Administration (DMA). Annual docking services include carrying out essential steel work repairs, maintaining and servicing engines, overhauling steering gear on vessels, stern tube and propeller, carpenter work and painting the vessel externally and internally.

2. Emergency docking for repair is that problems such as narrow and shallow water channel, grounding and damaging in underwater parts of ships appear to be common, whereas in high season, difficulty in ship handling because of rapid currents, collisions with piers of bridges and consequently, sinking of vessels and barges have to be encountered. Emergency docking services include hull repair, painting the vessel externally and internally, engine maintenance and outside and inside filter work.

3. Major overhaul for engines include engine repair and maintenance, checking propeller and shift alignment.

4. New Constructions is that the shipyard construct new vessel according to the IWT's order. Most constructed ships are barges, tugs, self-propulsion barges and shallow draft vessels.

2.3 Market Opportunity

Dalla shipyard only repairs and maintains Inland Water Transport' vessels. The most common vessel age is more than 30 years old. Therefore, the shipyard gives a big repair service for vessel. Now the government changes its policy for enterprise to make a private company. Yangon International Port handles most of the imports and exports seaborne trade of the country. There are three inland water depots and eighteen international wharves in Yangon port area. The many shipping lines operate from Yangon port to delta region and upper Myanmar from Irrawaddy River. If the shipyard increases incrementally of ship repair for the IWT's vessels and private vessels, its market share will be improved. The number of vessels in Yangon region is 2865 vessels (DMA, 2014). From 2011 to 2015, no of ship repair in Dalla shipyard is varied from 51 to 58 (in average 55 vessels) or 1.9 percent of the total market in Yangon region. The market share with the expected number of ship repair (83 vessels) is 2.9 percent of the total market in Yangon region.

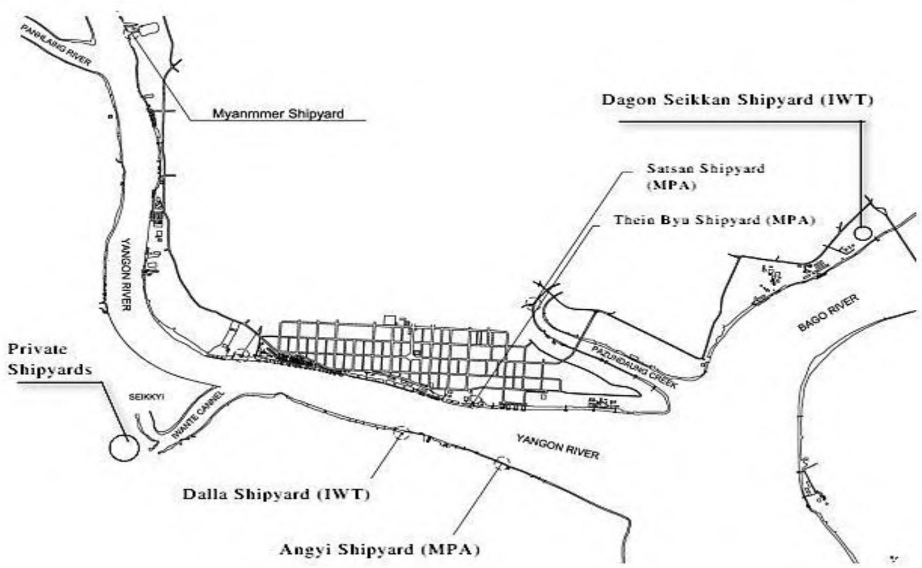

Figure 2.2 Locations of Shipyards in Yangon

2.3.1 Target Order

The target is about the annual capacities of ship repair that ensure the survival of the shipyard is needed to use time series analysis method. Time series analysis method is a pattern of development of ship repair services in the previous time series to obtain the size of the development level of annual repair. From the historical data, we can provide movement patterns or market growth demand, and then the pattern will be predictable market demand in the future. However, we need to consider the forecasting because the future situations face with risks and uncertainties. The following description is about the frequency of ship repair for 6 years in the future.

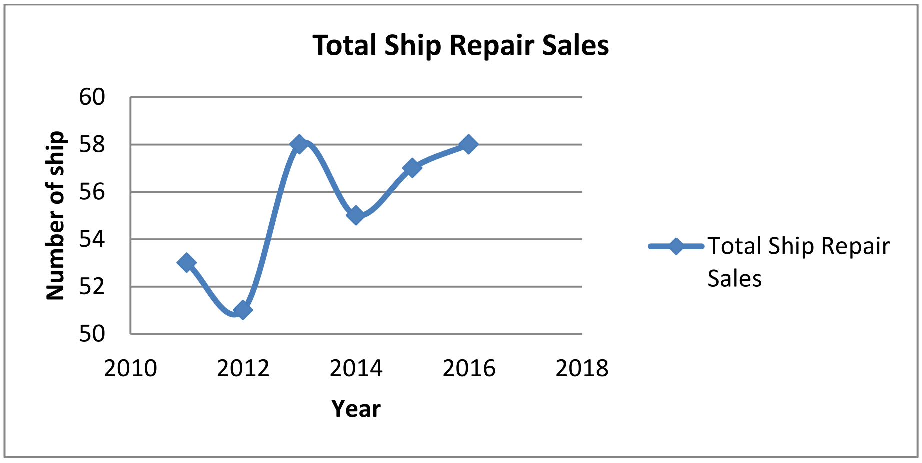

Figure 2.3 Total Ship Repairs 2011-2016

2.4 Layout

2.4.1 Layout of Dalla Shipyard

The total area of Dalla shipyard is 30 acres or 12.146 hectare. The following table 2.2 shows the area of each facility.

Table 2.2 Area of Each Facility

No	Item	Size (m)	Area (m^2)	Established Year	Remark
1	Gate House	17 x 9	153		Good
2	Office	46 x 14	644		Good
3	Medical Center	25 x 10	250	2009	Good
4	Machine Shop	76 x 43	3268		Good
5	Electrical Shop	27 x 14	378		Good
6	Planning Office	16 x 8	128	2010	Good
7	No1 Winch House	15 x 9	135		Good
8	No 2 and 3 Winch House	20 x 13	260		Good
9	Main Store	62 x 39	2418		Good
10	Store 1	74 x 13	962		Good
11	Diesel shop	66 x 15	990		Good
12	Pipe and Boiler shop	50 x 30	1500		Not Good
13	Power Station	40 x 10	400		Good

14	Foundry Shop	45 x 13	585		Not Good
15	Carpenter shop and store	53 x 27	1431		Not Good
16	CNC shop	20 x 10	200	2004	Good
17	Zone 5	76 x 53	4028		Good
18	Zone 3	28 x 15	420		Good
19	No 7 and 12 Winch House	50 x 5	250		Not Good
20	Zone 4	20 x 13	260		Good
21	Outside Filter House	15 x 10	150		Good
22	Water Tank	15 x 10	150		Good
23	Drawing Office	25 x 11	275		Good
24	Bangalow House	20 x 15 x 5	1500		Good
25	Labor House 1	37 x 10	370		Good
26	Labor House 2	50 x 11	550		Good
27	Labor House 3	37 x 10	370		Good
28	Labor House 4	44 x 17	748		Good
29	Oxygen Cylinder Store	7.5 x 6	45		Good
30	Lake	103 x 40	4120		Good
31	Slipway 1	140 x 6.5	910		Good
32	Slipway 2 and 3	100 x 6.5 x 2	1300		Good
33	Slipway 4 (dry dock)	91 x 22	2002		Good
34	Slipway 5 and 6	77 x 14	1078		Not Good
35	Slipway 7 to 12	41 x 58	2378		Good
36	Slipway 13	46 x 81	3726		Good
37	Slipway 14	152 x 6.5	988		Good
38	Labor Canteen	10 x 5	50		Good

39	Transformer House	3 x 3	9		Good
	Total		39379		

Source: Dalla Shipyard

Total used area of shipyard = 39379 m^2

Total area of shipyard = 121406 m^2

Percentage of total used area of shipyard = (39379/121406) x 100%

= 32.4%

Therefore, Percentage of free area of shipyard is 67.6%.

There are several different functions that occur at ship repair and manufacturing facilities. Some facilities employ a few people, while others employ many people, including various subcontractors, electricians, labors, machinists, welders, painters, sandblasters, pipe fitters and a number of administrative and managerial staff. Dock facilities and transportation equipment support the smooth operation of the ship repair. But Dalla shipyard’s facilities and transportation equipment does not support fully the ship repair because most facilities and equipment of Dalla shipyard are long life.

There are two forklifts (10T) in shipyard. One forklift is broken and other get low capacity. Some building needs to repair and maintain. Dalla shipyard store rainwater in the lake because the ground water is salt and water supply from city municipal is not sufficient.

The shipyard has many buildings but some building need to renovate some parts of building. The machine shop is too big because it has many facility and equipment. But the workable machines in machine shop are a little now. Therefore, the second alternative layout builds new machine shop between the pipe and boiler and power station shop for better material handling and time consuming. The size of machine shop in the second alternative is small because workable machine are re-installed in the new machine shop. The pipe and boiler shop in the second alternative layout is re-located for better material handling and time consuming. The size of pipe and boiler shop in the existing layout is too big because it gives piping and boiler repair service. But now the pipe and boiler shop give piping service only. Therefore, the size of the pipe and boiler shop in the second alternative layout is small.

2.4.2 Facilities of Dalla Shipyard

The following table 2.3 shows the production and material handling equipment of Dalla shipyard.

Table 2.3 Machine Equipment

Name of Item	Number	Capacity	Year	Workable	Not Workable
Forklift	2	10 Ton	1995	1	1
Mobile Crane	1	25 Ton	1995	1	
Mobile Crane	2	12 Ton	1995	1	1
Truck Car	1	3 Ton	1995	1	
Jetty Crane	1	15 Ton		1	
Jetty Crane	1	10 Ton			1
Jetty	2			2	
Transformer	1	600 KW		1	
Generator	2	395 HP		2	
Lathe Machine L- 10 m	1		1956	1	
Lathe Center Type 23’ x 7”	3		1950	1	2
Lathe Center Type (Cone Pulley Drive)	1		1950	1	
Vertical Drilling Machine (Bench Type)	1		1950	1	
Slotting Machine	1		1950	1	
Boring Machine	1		1950	1	
Milling Machine	1		1950		1
Hydraulic Jack Ton	2	100 Ton	1995	2	
Hydraulic Jack Ton	2	50 Ton	1995	2	
Welding Machine ESAB	30		1998	25	5
Welding Machine TOE	20		2004	19	1
Wood Shaper Machine	1		2009	1	
Hand Grinder Machine 3"	8		2010	6	

Air Compressor	3	2 HP	2011	3	
CNC Lathe Machine	1		2004	1	
CNC Milling Machine	1		2004	1	
Winch Motor	7			7	
Sand Blasting Machine	1		2013	1	
Blower 12” Japan	1		2013	1	
Plate Rolling Machine	1		1996	1	
Hydraulic Shearing Machine (3 m x 6 mm)	1		1996		1
Sheet Metal Bending Machine	1		1996	1	
Volvo	1	90 KVA	2000	1	
Dorman	1	90 KVA	1990	1	
Black Stone	1	300 KVA	1960	1	
Black Stone	1	300 KVA	1965	1	
HINO Engine for compressor	1		2000	1	
2’’ Water Pump with petrol engine	3		1998	3	
4” Water Pump with diesel engine	2		2000	2	
Ferry boat (30’L x 10’ W)	1		1999	1	

Source: Dalla Shipyard

The above table shows that many of existing equipment are not working properly (not workable), and some others are too old but they are still workable. The number of existing material handling equipment in the shipyard is sufficient but the capacity of material handling is not sufficient. Therefore, the first and the second alternative layouts are additional of a new mobile crane (30 Ton) and a new forklift (10 Ton).

2.5 Organization Structure of Shipyard

Shipbuilding industry is known as a very complex business-production system. Therefore, the organizational structures of shipyards are very wide and deep, and it is very hard to manage such complex systems. Dalla shipyard is one of shipyard under engineering department of Inland Water Transport (IWT). The following figure shows the organization structure.

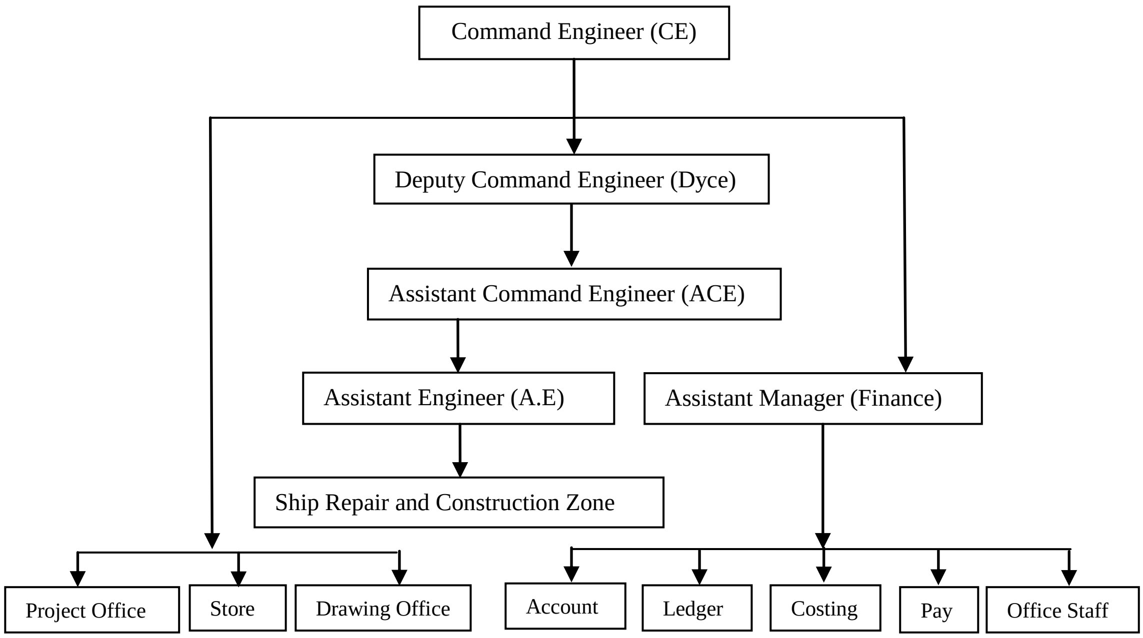

Figure 2.4 Organization Chart of Dalla Shipyard

Dalla shipyard organization allows setting 1320 persons but actually appointed is 312. Therefore, vacancy is 1008 persons. The shipyard cannot appoint new employees for vacancy because of government policy.

2.6 Aspects of Social Relationship and Partnership

Social aspects of Dalla shipyard were judged by including natural environment, employee and education. Shipyard plants trees around the river bank for the process of green environment. Shipyard provides the welfare and convenience for employees.

They are healthcare and medicine supply, facilities supply for employee, financial loans for employees who need suddenly and give holiday allowance. The government assists shipyard to pay loan with small rate of interest. Shipyard provides the opportunity and the chance for students to conduct field work, research or study for educational institutions that have programs shipbuilding techniques.

2.7 Cooperation

Dalla shipyard cooperates with JICA in Japan to increase human resources, technology, standardization and quality control. The shipyard cooperates with India Inland Transport to build new vessels for Kelantan Project. The shipyard cooperates with other shipyard in region and government department.

2.8 Productivity of Ship Repair of Dalla Shipyard

The following table 2.4 shows the number of vessels that are repaired by Dalla Shipyard. This data is from 2011 to 2015.

Table 2.4 Total Ship Repair

No	Month	Year					Total
		2011	2012	2013	2014	2015	
1	January	4	3	5	8	4	24
2	February	4	4	7	3	3	21
3	March	0	2	3	4	6	15
4	April	3	3	1	4	6	17
5	May	6	6	6	4	3	25
6	June	3	6	8	4	7	28
7	July	7	2	2	3	4	18
8	August	7	8	7	4	5	31
9	September	3	3	5	6	3	20
10	October	3	3	5	4	5	20

11	November	7	9	7	6	5	34
12	December	6	2	2	5	6	21
Total		53	51	58	55	57	274

Source: Dalla Shipyard

The following table 2.5 shows the size of vessels that are repaired by Dalla shipyard.

Table 2.5 Total Ships (DWT)

DWT	Year					Total
	2011	2012	2013	2014	2015	
< 100	9	14	11	7	7	48
100-200	15	12	14	16	16	73
200-300	17	17	19	19	18	90
300-400	8	3	8	8	8	35
400-500	4	5	6	5	8	28
Total	53	51	58	55	57	274

The following figure 2.5 shows more details the size of vessels and number of vessels.

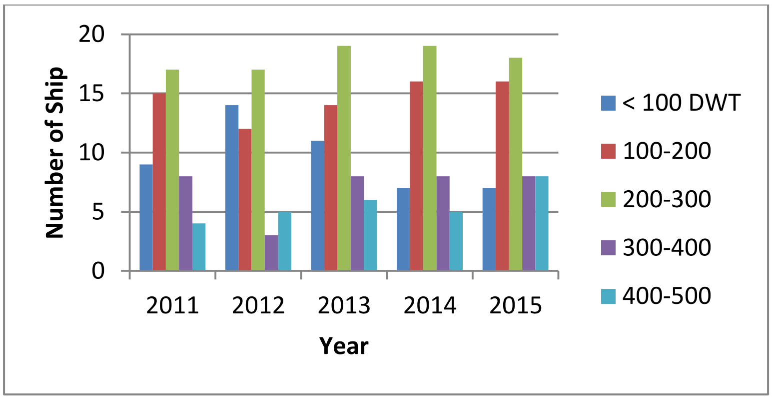

Figure 2.5 Graph of Ship Repair DWT (2011-2015)

According to the previous data of ship repair from the shipyard (2011 – 2015) can be presented base on the total number of vessels in the repair.

- < 100 DWT total is 17.5%
- 100-200 DWT total is 26.5%

- 200-300 DWT total is 33%
- 300-400 DWT total is 13%
- 400-500 DWT total is 10%

From the market of Dalla shipyard data, ship with DWT tonnage < 300 is 77 percentage of overall. Therefore, Dalla shipyard repairs less than 300 DWT every year.

2.9 Shipyard

Shipbuilding is an industry that produces products (ships, offshore structures, floating plants, etc. Ships and floating structures are important engineering structures that serve a wide variety of objectives, e.g. transporting cargo and passengers, exploration/production/storage of oil/gas/minerals, coastal protection and surveillance, and military defense, etc. the product is built to order and customized to the specific requirements of the purchaser (Storch,1995).

Shipbuilding is the construction of ships, and a shipyard is the place where ships are built .Shipbuilding is a construction industry which uses a wide variety of manufactured components in addition to basic construction materials. The process therefore has many of the characteristics of both construction and manufacturing. Shipbuilding requires many workers having various skills (or trades), working within an established organizational structure at a specific location in which necessary facilities are available. The goal of a privately owned shipbuilding company is to earn a profit by building ships (Storch, 1995).

2.9.1. Types of shipyard

According to activities, shipyard can be classified (Soeharto and Soejitno, 1996):

1. Shipyard specialize new buildings; this shipyard specially build ships – new vessel, the new ship construction period is relatively long.

2. Shipyard specialize ship repair, this shipyard specially do ship repair - either annual or special repair.

3. Shipyard for new ship and ship repair, this shipyard has dual activity. They are new buildings and reparations.

2.9.2. Shipbuilding Process

The entire shipbuilding process is likely to vary somewhat, depending on the customer involved, but it generally involves a number of specific stages. These may be summarized as (Storch, 1995):

1. *Development of owner's requirements*

An owner has identified the need for a new ship and defined operational requirements.

2. *Preliminary/concept design*

This stage can be done internally by the owner's staff, by a design agent hired by the owner, or by the staffs of one or more shipyards. The aim is to develop a design that will meet the requirements while taking advantage of the building experience and capability of particular shipyard to minimize construction time and cost.

3. *Contract design*

Based on the general description of the ship to be built, as determined by the end product of the preliminary design stage, more detailed information is required to permit bids and/or contracts to be prepared. This information, called the contract design.

4. *Bidding/contracting*

Following completion of the contract design stage, a specific shipyard is chosen to build the vessel. Unless an owner has involved a shipyard in the preliminary and/or contract design stage and thus is negotiating a contract based on a mutually agreeable design, competitive bidding based on the contract design and specifications is common practice.

5. *Detail design and planning*

This stage must answer the questions of "what, where, how, when, and by whom." Determining what parts, assemblies, and systems are to be built and what components are to be purchased is primarily detail design.

6. *Construction*

This stage can be considered to occur in four manufacturing levels. The first is parts manufacturing, using raw materials (such as steel plate and sections, pipe, sheet metal, and cable) to manufacture individual parts. The next manufacturing level involves the joining of parts and/or components to form subassemblies or units. These small collections of joined parts are then combined in the third manufacturing level to form hull blocks. Erection, the final manufacturing level, involves the landing and joining of blocks at the building site.

2.10 Types of Dry Dock

A basic understanding of how a dock is designed and built provides insight into how and why the dock's operational limitations have been derived (Heger, 2005). There are several basic types of dry docks:

1. Basin or Graving docks
2. Floating Dry Docks
3. Marine Railways
4. Vertical Lifts
5. Marine Travel Lifts

2.10.1. Basin or Graving docks

Basin or graving docks are large, fixed basins built into the ground at water's edge, separated from the water by a dock gate. Basin docks are capable of docking all sizes of vessels, with capacities of over 200,000 tons. Its basic structure consists of a floor, sidewalls, head (front) wall and a dock gate. Alters (steps) may be incorporated into the side walls for structural stability.

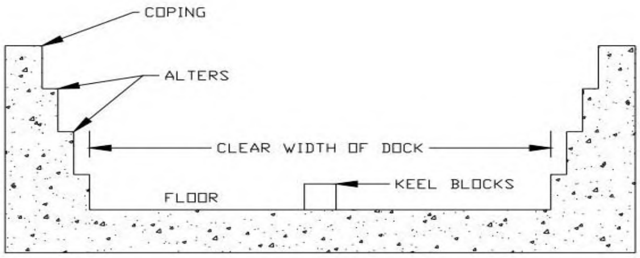

Figure 2.6 Cross Section of Basin Dock Body (Heger, 2005)

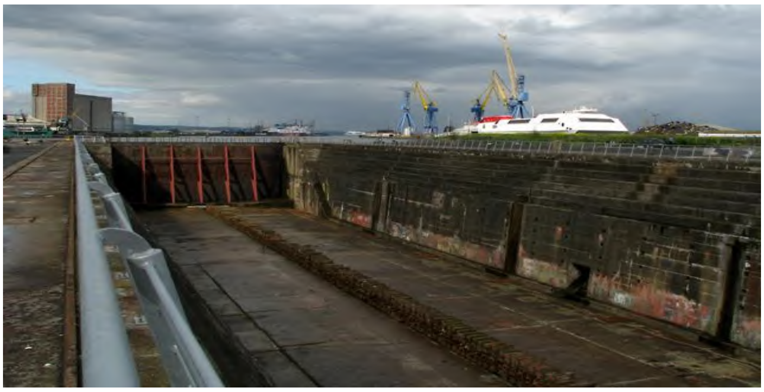

Figure 2.7 Graving Dock (Heger, 2005)

2.10.2 Floating Dry Dock

Floating dry docks are structures with sufficient dimensions, strength, displacement and stability to lift a vessel from the water using buoyancy . Floating docks range in lift capacities from a few hundred tons to over 100,000 tons. In general the most economical range for floating docks is about 1,000 to 100,000 tons.

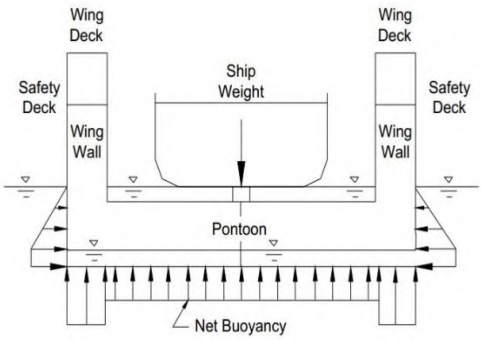

Figure 2.8 Floating Dry Dock Components (Heger, 2005)

2.10.3. Marine Railways

A marine railway is a mechanical means of hoisting a ship out of the water along an inclined plane. Lift capacities range from 100 to 6,000 tons. The cradle, which rolls on rollers or wheels, is lowered into the water along an inclined track until sufficient water over the cradle is achieved. The ship is floated over the cradle and tied to the uprights. The cradle is hauled up the track and the vessel grounds onto the blocks. After complete grounding on the keel blocks, the side blocks are brought to bear and the hauling continues until the cradle is full up. The formulas of slipways length are as following:

$$\mathbf{L = 2l + S(d + h) + b} \text{.....................................} \quad \textbf{(2.1)}$$

Where,

L = length of slipways in meter

l = length of vessel between perpendicular in meter

S = horizontal distance for unit rise of slipways inclination

d = draft of vessel at forecastle bulk head in meter

h = high from rail level to top of block in meter

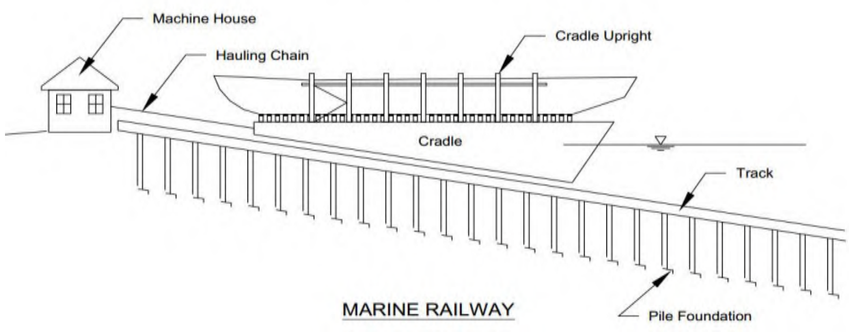

Figure 2.9 Longitudinal Marine Railways (Heger, 2005)

Figure 2.10 Transverse Slipways (IWT, 2015)

2.10.4. Vertical Lifts

A vertical lift is a mechanical means of hoisting a ship out of the water vertically. The dock consists of platform, hoisting mechanism and hoist support pier. The platform is lowered into the water until sufficient water over the blocks is achieved. The ship is floated over the platform and centered. The platform is raised, grounding the vessel on the blocks. As the vessel is raised, all motors are synchronized to insure they each haul at the same rate no matter what the load on each of them is. This insures that no unit gets overloaded.

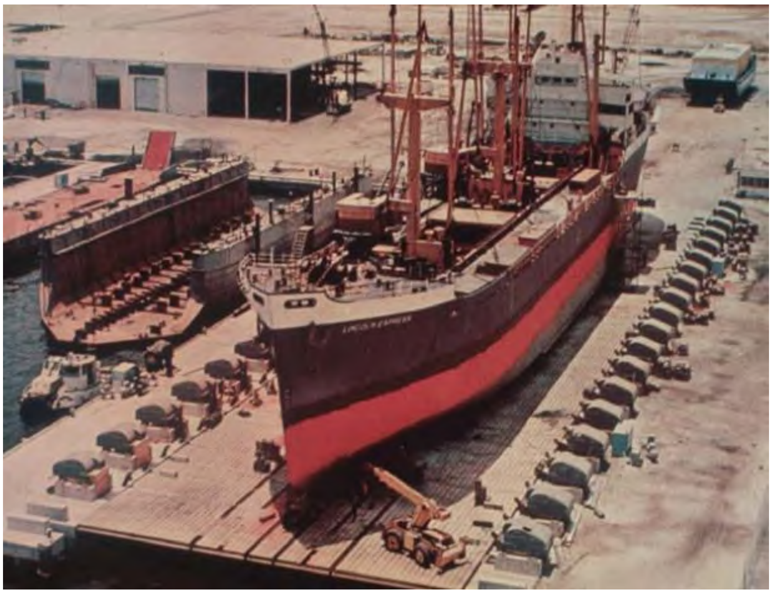

Figure 2.11 Vertical Lifts (Heger, 2005)

2.10.5 Marine Travel Lifts

A marine travel lift is a vertical lift on wheels. Instead of a structurally rigid platform to support the vessel, nylon straps are usually used. The slings are lowered into the water until sufficient water over the slings is achieved. The ship is floated over the slings and centered. The slings are raised to lift the vessel. Once the ship is at yard's elevation, the travel lift can be moved under its own power to place the ship on fixed blocks in a storage berth.

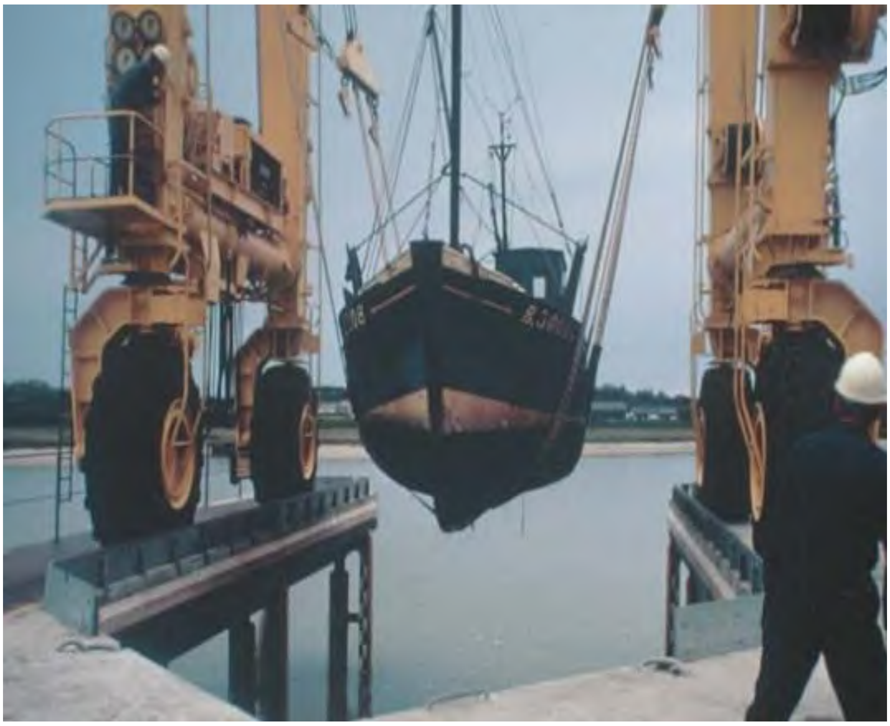

Figure 2.12 Marine Travel Lifts (Heger, 2005)

2.11 Shipyard Facility

In general, shipyards have specialized workshops and spaces such as mechanical, electrical, steel sandblasting, docking, painting, and others. Electrical works, mechanical works, steel renewal, pipe work, and routine docking works such as washing, grit blasting, coating, sea chest cleaning, propeller dismantling, polishing, controlling on tail shaft and stern tube seals can be listed as the main facilities during a docking period (Celik, 2009). A shipyard generally contains several specific facilities laid out to facilitate the flow of material and assemblies.

There is no typical shipyard layout, partly because many shipyards were initially constructed in the nineteenth or early twentieth century. These yards have grown according to the availability of land and waterfront as well as in response to production requirements (Storch, 1995).Typical important features are listed below:

a. a location on land for erecting a ship, along with an associated means for getting the ship to the water, such as a graving dock, launching ways, or a floating dry dock piers for storing ships afloat to permit work to continue following launching
b. shops for performing various kinds of work, such as
    - steel marking, cutting, and forming shop
    - steel assembly shop
    - surface preparation and coating shop
    - pipe shop
    - sheet metal shop
    - machine shop
    - electrical shop
c. storage, marshaling, and outdoor (blue sky) work areas
d. offices and personnel support buildings (cafeteria, sick bay, etc.)

2.12. Organization.

Shipyard workers are organized within departments or sections that are responsible for some aspect of the operation of the company**.** Although each company is likely to have some variation in its organization, the usual subdivision is into six functions. They are

1. Administration
2. Production
3. Engineering
4. Purchasing
5. Quality Assurance
6. Project management

Besides, the complexity of the activity organization in a shipyard which implements Group Technology requires a reliable and efficient Quality Control System in order to reduce rework. Assembling various blocks often produced in separate locations with different production processes is tributary of a high level of accuracy and coordination.

2.12.1 Management Approach

Management Approach is only one system management to ship repair and maintenance has been by function (Storch, 1995). This was because the work definition, design, estimating, purchasing, planning, and testing were all done by systems, the same system that were the exclusive responsibility of specific trade skill function. The pipefitter did pipe system, the shipbuilder built hull structure, electricians ran wire and hooked up electrical equipment, machinists worked on machinery, and the sheet metal workers did ventilation.

This approach can be effective for smaller shipyard, simple jobs involving only a few systems. It can be any collection of tasks, grouped logically tor efficient performance. As with product-oriented new construction, sequencing is done in terms of problem areas and stages within a problem area. One component might even be part of different zones at various stages of the work. The zone concept allows task grouping, source allocation, and interdependency decisions to be made earlier and from a project perspective of the single waterfront foreman (Ilela, 2010).

2.13 Productivity

Productivity implies a mental attitude that always has a view of the quality of life today should be better than yesterday and tomorrow better than today (Rafiy, 2015). Quantitatively productivity is the ratio between the output and the input that is used per unit time (hour, day, month, and year).

This formulation applies to the company, industry, economic, fishermen and others. Generally productivity formulated as the concept that describes the relationship between the results of the form of goods or services with the production resources (material, labor, machine and equipment, money, method) (Arif, 2014).

Productivity is commonly defined as a ratio between the output volume and the volume of inputs. Specifically means the ability to produce something that includes increased efficiency and speed to produce a product that is the result of a combination of effectiveness, efficiency and economies. Productivity variable is the ratio between the output to the input or resource productivity has two (2) dimensions; 1. Effectiveness is the achievement of such targets; quality, quantity and time, 2. Efficiency comparing inputs are actually used or how the work is done or executed (Rafiy, 2015). In the shipbuilding industry, productivity refers to the volume of workers, cranes, building docks or berths, shipbuilding techniques, etc. There are a number of methods to calculate both input and output.

$$\textbf{Productivity} = \textbf{Output / Input} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textbf{(2.2)}$$

Capacity of the slipways can be determined according to the formula,

$$\mathbf{K} = (\mathbf{F1.F2.h.C.n})/\mathbf{H} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textbf{(2.3)}$$

Where,

F1 = Coefficient of dock space using

F2 = coefficient of time using

h = shipyard day taken 300 days

C = high lift slipways (TLC)

n = number of side slipways

H = docking day average one vessel

(Japan international cooperation agency maritime technology and safety bureau)

The number of ship repaired obtained by the formula (Talib in Ikhsan, 2015),

$$\textbf{Number of ship repaired} = \frac{\mathbf{300}\ \boldsymbol{Days}}{\textbf{Time of ship repaired}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textbf{(2.4)}$$

2.14. Type of Layout

Most shipyards are well established and were originally sited in a suitable location for building small ships with methods which have now been superseded. With the growth in ship sizes and the introduction of new building methods it has been recognized that a revised shipyard layout will be advantageous. Advantages to be gained, apart from the ability to construct larger vessels, are primarily, a uniform work load, a shorter ship build cycle, and economies in construction practices (Storch, 1995).

Layout is defined as the arrangement of facilities aimed to achieve the operational objectives of an enterprise at minimum costs and with maximum efficiency. A poor layout can reveal highly detrimental to productivity and consequently to profitability (Chabane, 2004). Symptoms that are peculiar to a poor plant arrangement can be summarized into:

1. great travel distances in the flow of materials
2. bottlenecks in the shipment of resources
3. excessive handling of materials
4. poor information circulation
5. inefficient communication system
6. low rate of machine and labor utilization

The causes that may lie behind such deficiencies may reside in:

1. insufficient infrastructures
2. inefficient location arrangement of the various departments
3. poor handling equipment
4. inadequate fabrication processes and technology
5. inefficient planning system

An ideal layout for a modern shipyard is based on a production flow basis, with the yard extending back from the river or shore at which the berths or building dock are located. There are three type of layout as following;

1. *Process layouts*, also known as *functional layouts*, group similar activities together in departments or work centers according to the process or function they perform.

2. *Product layouts*, better known as *assembly lines*, arrange activities in a line according to the sequence of operations that need to be performed to assemble a particular product. Each product or has its own "line" specifically designed to meet its requirements.

3. *Group Layout*, Layout is based on the same work processes and material flows prepared in accordance with the material flow with automated machine support and material handling as well as more oversight.

2.14.1 L-typed and U-typed Layout

The hull of a ship is constructed such that production is continuous. Many different layouts are possible, but the best layout is that in which the materials travel the shortest possible distance with minimum handling. L-typed or U-typed Layout flow dependent on the physical environment and areas available and could be visualized as shown in Figure 2.8.

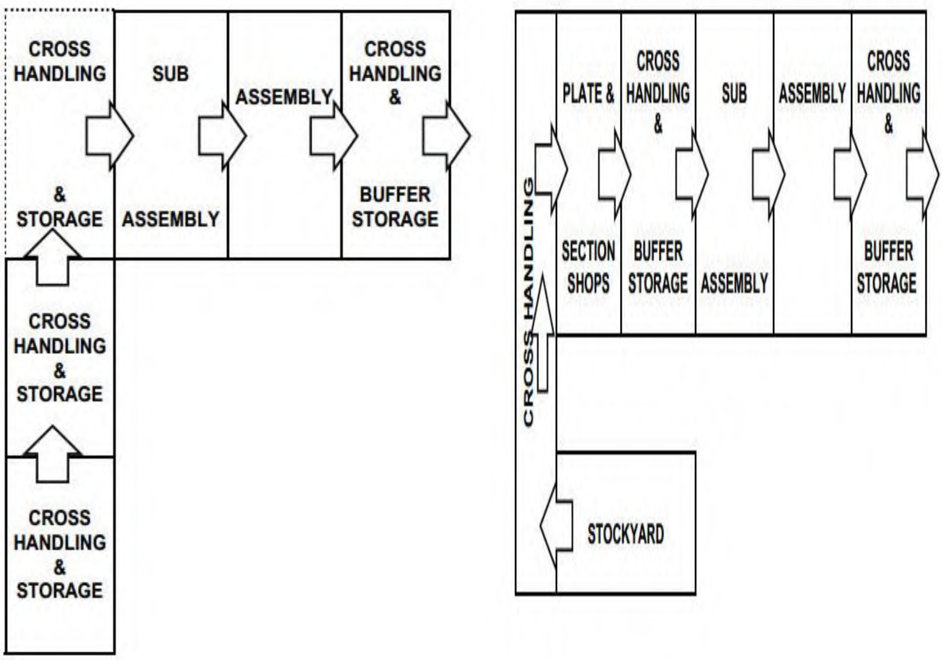

Figure (2.13) L-typed and U-typed Layout (Shenoi, 2007)

2.15 Material Handling Equipment

Material handling cannot be avoided in logistics, but can certainly be reduced to minimum levels. The productivity potential of logistics can be exploited by selecting the right type of handling equipment. The selection of material handling equipment cannot be done in isolation, without considering the storage system. Investment in the material handling system will be sheer waste if it is not compatible to the warehouse layout plan. The layout will create obstacles for free movement of equipment and goods, resulting in poor equipment productivity. Recent trends indicate preference for automated system with higher logistics productivity to enhance the effectiveness of human energy in material movement (Sople, 2007).

Materials handling is loading, moving and unloading of materials. To do it safely and economically, different types of tackles, gadgets and equipment are used, when the materials handling is referred to as mechanical handling of materials. Materials handling is used with reference to industrial activity. In any industry, be it big or small, involving manufacturing or construction type work, materials have to be handled as raw materials, intermediate goods or finished products from the point of receipt and storage of raw materials, through production processes and up to finished goods storage and dispatch points (Ray, 2008). Some of the other definitions are:

- Materials handling is the movement and storage of materials at the lowest possible cost through the use of proper methods and equipment.
- Materials handling is the moving of materials or product by any means, including storage, and all movements except processing operations and inspection.
- Materials handling is the art and science of conveying, elevating, positioning, transporting, packaging and storing of materials.

All the functions of materials handling have been referred to which are conveying, elevating, positioning, transporting, packaging and storing. Storage or warehouse is very much a part of materials handling. Materials handling uses different equipment and mechanisms called Materials Handling Equipment.

The essential requirements of a good materials handling system may be summarized as:

i. Efficient and safe movement of materials to the desired place.
ii. Timely movement of the materials when needed.
iii. Supply of materials at the desired rate.
iv. Storing of materials utilizing minimum space.
v. Lowest cost solution to the materials handling activities

These long distance movements of materials are generally termed as transportation of materials through various modes of transport like, road, rail, ship or air. Transportation is generally excluded from the scope of materials handling. However, at each of the sources and destinations, loading and unloading of materials is necessary and these are referred to as materials handling of these locations.

2.16 SWOT Analysis

According to (David, 2015), internal strengths and internal weaknesses are an organization's controllable activities that are performed especially well or poorly. They arise in the management, marketing, finance/ accounting, production/operations, research and development (R&D), and management information systems (MIS) activities of a business. Identifying and evaluating organizational strengths and weaknesses in the functional areas of a business is an essential strategic- management activity. Strengths and weaknesses can be determined by elements of being rather than performance.

External opportunities and external threats refer to economic, social, cultural, demographic, environmental, political, legal, governmental, technological, and competitive trends and events that could significantly benefit or harm an organization in the future. Opportunities and threats are largely beyond the control of a single organization.

Many companies in many industries face the severe external threat of online sales capturing increasing market share in their industry. A basic tenet of strategic management is that firms need to formulate strategies to take advantage of external opportunities and avoid or reduce the impact of external threats. Novozhilova (2010) present the SWOT-analysis is performed with the purpose to study the business environment, legal terms, weak and strong sides of own enterprise and enterprises-competitors, as well as of complex inter-influencing of the studied factors. Dana (2012) present for organizations to develop, they often must undergo significant change at various points in their development, unfortunately, there still are not enough elements about how to analyze organization, identify critically important priorities. Ma'ruf (2006) describes The SWOT analysis that mostly used in strategy formulation is considered very general.

2.16.1 Internal Factor Evaluation (IFE) Matrix

This strategy-formulation tool summarizes and evaluates the major strengths and weaknesses in the functional areas of a business, and it also provides a basis for identifying and evaluating relationships among those areas. Intuitive judgments are required in developing an IFE Matrix, so the appearance of a scientific approach should not be interpreted to mean this is an all-powerful technique. A thorough understanding of the factors included is more important than the actual numbers (David, 2015). An IEF Matrix can be developed in five steps:

1. Use a total of 20 internal factors, including both strengths and weaknesses. List strengths first and then weaknesses. Be as specific as possible, using percentages, ratios, and comparative numbers.
2. Assign a weight that ranges from 0.0 (not important) to 1.0 (all-important) to each factor. The weight assigned to a given factor indicates the relative importance of the factor to being successful in the firm's industry. Regardless of whether a key factor is an internal strength or weakness, factors considered to have the greatest effect on organizational performance should be assigned the highest weights. the sum of all weights must equal 1.0
3. Assign a 1-to-4 rating to each factor to indicate whether that factor represents a major weakness (rating = 1), a minor weakness (rating = 2) a minor strength (rating = 3), or a major strength (rating = 4). Note that strengths must receive a 3 or 4 rating and weaknesses must receive a 1 or 2 rating. Ratings are thus company-based, whereas the weights in step 2 are industry-based.

4. Multiply each factor's weight by its rating to determine a weighted score for each variable.
5. Sum the weighted scores for each variable to determine the total weighted score for the organization.

Regardless of how many factors are included in an IFE Matrix, the total weighted score can range from a low of 1.0 to a high of 4.0, with the average score being 2.5. Total weighted scores well below 2.5 characterize organizations that are weak internally, whereas scores significantly above 2.5 indicate a strong internal position. Like the EFE Matrix, an IFE Matrix should include 20 key factors. The number of factors has no effect on the range of total weighted scores because the weights always sum to 1.0.

2.16.2 External Factor Evaluation (EFE) Matrix

David (2015) describe an external factor evaluation (EFE) matrix allows strategists to summarize and evaluate economic, social, cultural, demographic, environmental, political, governmental, legal, technological, and competitive information. The EFE Matrix can be developed in five steps:

1. Include a total of 20 factors, including both opportunities and threats that affect the firm and its industry. List the opportunities first and then the threats. Be as specific as possible, using percentages, ratios, and comparative numbers whenever possible.
2. Assign to each factor a weight that ranges from 0.0 (not important) to 1.0 (very important). The weight indicates the relative importance of that factor to being successful in the firm's industry. Opportunities often receive higher weights than threats, but threats can receive high weights if they are especially severe or threatening. The sum of all weights assigned to the factors must equal 1.0.
3. Assign a rating between 1 and 4 to each key external factor to indicate how effectively the firm's current strategies respond to the factor, where 4 = the response is superior, 3 = the Response is above average, 2 = the response is average and 1 = the response is poor. Ratings are based on effectiveness of

the firm's strategies. Ratings are thus company-based, whereas the weights in Step 2 are industry-based. It is important to note that both threats and opportunities can receive a 1, 2, 3, or 4.

4. Multiply each factor's weight by its rating to determine a weighted score.
5. Sum the weighted scores for each variable to determine the total weighted score for the organization.

Regardless of the number of key opportunities and threats included in an EFE Matrix, the highest possible total weighted score for an organization is 4.0 and the lowest possible total weighted score is 1.0. The average total weighted score is 2.5. A total weighted score of 4.0 indicates that an organization is responding in an outstanding way to existing opportunities and threats in its industry.

2.17 Forecasting Method

Chiang (2016) present that firms had less-than-expected forecast performance because they relied on using simple forecasting methods, such as moving average, simple exponential smoothing, and straight-line projection, though more advanced methods, like regression-based forecasting, times series forecasting, and simulation, are known and accessible. Forecasts can be obtained in different ways. They are qualitative, time series method, causal relationship and simulation.

2.17.1 Time Series Method

A time series is a collection of data recorded over a period of time—weekly, monthly, quarterly, or yearly. A time series can be used by management to make current decisions and plans based on long-term forecasting. There are four components to a time series: the trend, the cyclical variation, the seasonal variation, and the irregular variation.

a. Secular Trend

   The long-term trends of sales, employment, stock prices, and other business and economic series follow various patterns. Some move steadily upward, others decline, and still others stay the same over time.

b. Cyclical Variation

The second component of a time series is cyclical variation. A typical business cycle consists of a period of prosperity followed by periods of recession, depression, and then recovery with no fixed duration of the cycle. There are sizable fluctuations unfolding over more than one year in time above and below the secular trend.

c. Seasonal Variation

The third component of a time series is the seasonal component. Many sales, production, and other series fluctuate with the seasons. The unit of time reported is either quarterly or monthly.

d. Irregular Variation

Many analysts prefer to subdivide the irregular variation into episodic and residual variations. Episodic fluctuations are unpredictable, but they can be identified. The initial impact on the economy of a major strike or a war can be identified, but a strike or war cannot be predicted. After the episodic fluctuations have been removed, the remaining variation is called the residual variation. The residual fluctuations, often called chance fluctuations, are unpredictable, and they cannot be identified. Of course, neither episodic nor residual variation can be projected into the future.

For the formula of times series method is as follows:

$$\mathbf{Y = a + bx} \quad \text{.........} \quad \mathbf{(2.5)}$$

Where, Y= value of the variable for a selected value of x

a= estimated value when x is zero

b= slope of the line, the average change in Y for each change of one unit in x.

x= any value of time that is selected

2.18 Net Present Value (NPV)

According to (Chaiwat, 2012) Net Present Value is a central tool in discounted cash flow analysis, and is a standard method for using the time value of money to appraise long-term projects. Used for capital budgeting, and widely throughout economics, finance, and accounting, it measures the excess or shortfall of cash flows, in present value terms, once financing charges are met.

The NPV is calculated using the following formula:

$$\mathbf{P}\ (\mathbf{i}) = \sum_{t=0}^{N} \frac{A_t}{(1+i)^t}$$

Or

$$\mathbf{P}(\mathbf{i}) = \sum_{t=0}^{N} \boldsymbol{A_t} \left({}^{P}\!/_{F}\, , i\%, t \right) \quad \textbf{(2.6)}$$

Where,

P (i) = the present value of all cash flows at an interest rate i%

A_t = cash flow at the end of the period

i = interest rate (Minimum Attractive Rate of Return, MARR) or discount rate

t = the time of the cash flow

N = number of period

If the project is economically feasible, its NPV is greater than zero (NPV > 0).When the NPV is positive; it means that the benefits of the project are greater than its costs. The NPV criterion is limited in that it cannot be used to rank a number of alternative investment projects because the NPV of a project is likely to be positively related to the project's investment cost or scale (Chaiwat, 2012).

2.19 Benefit- Cost Ratio (B/C ratio)

The B/C ratio is designed to avoid the limitation of the NPV method. Thus, a project is evaluated in terms of benefits per one monetary unit of cost. A project would be worth investing in only if it meets the criterion where the B/C ratio is greater than 1(Chaiwat, 2012). The B/C ratio is calculated using the following formula:

Benefit-cost ratio = (benefit)/ (cost)

$$= \frac{\sum_{t=0}^{n} \frac{A_t}{(1+i)^t}}{\sum_{t=0}^{n} \frac{C_t}{(1+i)^t}} \quad \textbf{...} \; \textbf{(2.7)}$$

Where, Ct = present value of cost or cost at time t

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Flow Chart

Methods of research can be seen in the flow chart (outside diagram) in figure 3.1 below:

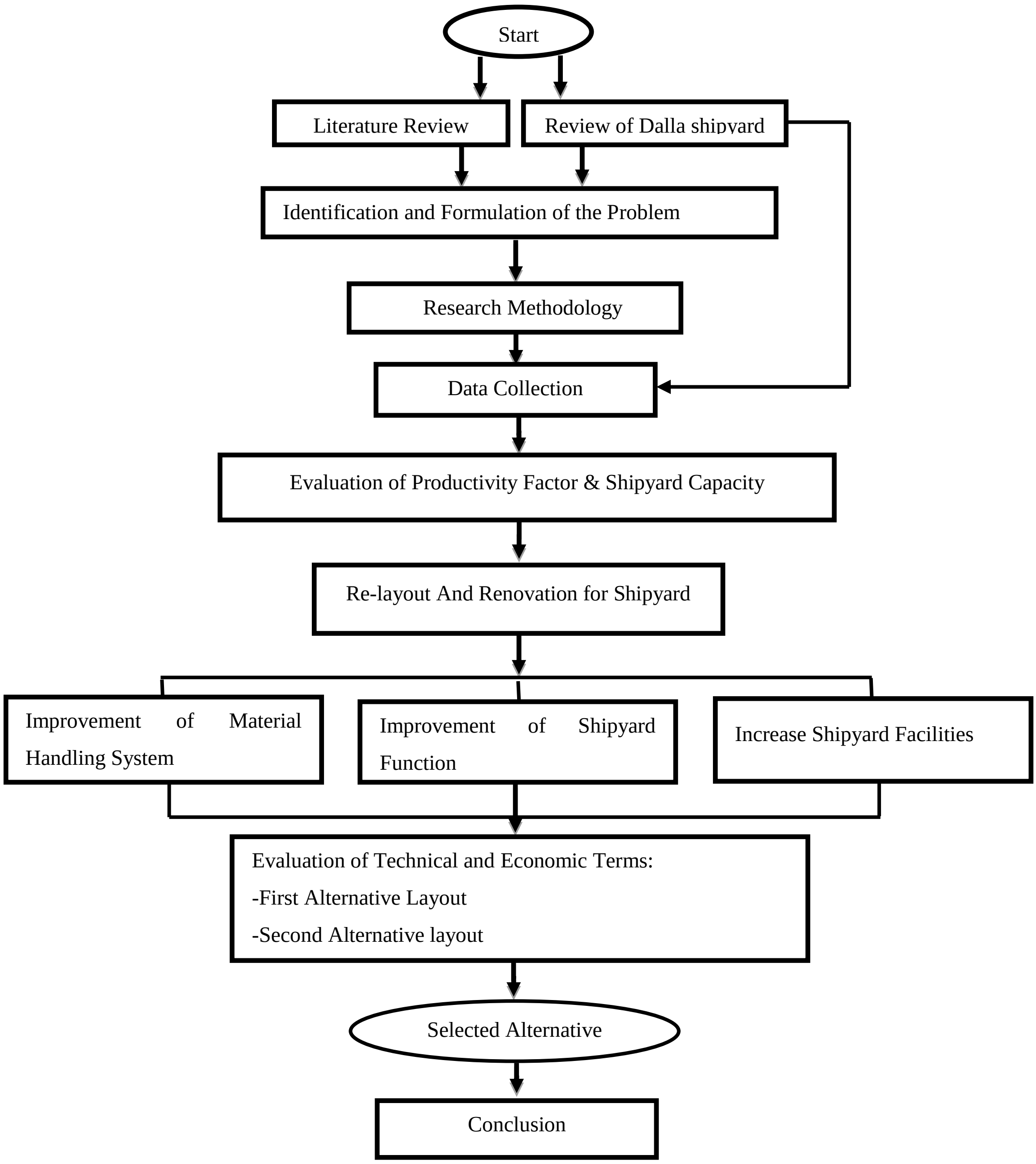

Figure 3.1 Flow Chart of Research Methodology

3.1.1. Identification and Formulation of the Problem

The identification of problem is a discussion that focuses on the development of Dalla shipyard. After the identification, the next choose the method or solve the problem. In this research the shipyard improve facilities, material handling equipment and re-layout. The alternative layout is determined by using DCF and NPV method.

3.1.2. Literature Review

Literature review is intended to obtain research results in accordance with the problems. Theories and references support to understand and determine the method for this research. More details literature reviews explain in chapter 2.

3.1.3 Data Collection

Most of the data usages obtain from observation and interviews with officer of Dalla shipyard and some missing data are from papers and books. Data collections have to support on improving and developing this research. Therefore, all data about collected directly from the shipyard.

3.1.4 Evaluation of Productivity Factor and Shipyard Capacity

This stage calculates the existing situation of productivity and efficiency of shipyard capacity. Calculations show how many ships that perform repairs at the shipyard and how to use the shipyard dock facilities as effectively as possible. After collecting dock facilities at current situation, it shows how much land is being used and how many facilities needed for the shipyard.

3.1.5 Re-layout and Renovation for Shipyard

This stage supports re-layout shipyard based on existing shipyard layout. The re-layout shipyard is good material transportation form warehouse and shop to slipways. The second alternative layout of transportation time is shorter than exiting layout. The shipyard need to renovate for machine shop, zone 5, carpenter shop and pipe and boiler shop.

3.1.6 Improved of Material Handling System, Shipyard Function and Increase Shipyard Facilities

In this stage supports facility for shipyard because the equipment and some machine are very old. After that Shipyard productivity compares than existing condition. A crane and a forklift of material handling systems support for better flow of material. For increasing shipyard facilities, the shipyard supports a new hydraulic shearing machine for cutting. Therefore, the shipyard function is more quickly and effective than existing situation.

3.1.7 Evaluation of Technical and Economic Terms

Technical and economic terms evaluate for fist alternative and second alternative. Technical aspect also involves evaluation of the hardware and the software requirement of the proposed layout. Economic aspect involves cost and benefit associated with project layout.

3.1.8 Selected Alternative

According to technical and economic feasibility calculations, the first alternative and the second alternative are feasible. But productivity of the first alternative is different as the second alternative. After comparing productivity of alternative, better productivity of alternative that is selected alternative.

3.1.9 Conclusion

There are an increase or addition of dock facilities such material handling equipment, warehouse for plate, pipe and boiler shop, machine shops and slipways repair. Based on a feasibility study, the method Discount Cash Flow, Net Present Value and Payback period show that Dalla shipyard project is viable or feasible.

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CHAPTER 4
COMPETITIVENESS POSITION OF DALLA SHIPYAD

4.1 SWOT Analysis Method

SWOT analysis is an effective management technique to evaluate the business environment of an organization both internal and external to analyze the present status and future prospectus of the firm. All organizations have strengths and weaknesses in the functional areas of business. No enterprise is equally strong or weak and opportunity or threat in all areas. The strategy-formulation tool summarizes and evaluates the major strengths or weaknesses and opportunities or threats in the functional areas of a business. Based on Ma'ruf (2006) explains the environment's characteristics of the middle-sized shipyards are the same, the proposed models may be considered as generic models not only for the Indonesian middle-sized shipyards but also for similar shipyards in other countries. Therefore, all Strategic factors obtained from his research are used in this particular variable. The factors and the weight include as the table.

Table 4.1 Strategic Factors in Ship Repair (Ma'ruf, 2006)

Internal Strategic Factors		**External Strategic Factors**	
Factors and Variables	**Weight**	**Factors and Variables**	**Weight**
Factor 1: Price Quotation	**(0.46)**	**Factor 1: Interim Supply**	**(0.63)**
1.Price Level	0.24	1.Price of material	0.22
2.Employee how-know	0.22	2.Quality of material	0.21
		3.Quality of sub-contractor	0.20
Factor 2: Shipyard management	**(0.21)**	**Factor 2: Maritime Policies**	**(0.21)**
3.Company culture	0.11	4.Bank support	0.07
4.Business network	0.10	5.Government support to shipyard	0.07
		6.Government support to shipping	0.07
Factor 3: Product performance	**(0.18)**	**Factor 3: Repair Order**	**(0.16)**
5.Delivery time	0.09	7.Domestic market	0.16
6.Quality of product	0.09		
Factor 4: Yard Location	**(0.15)**		

7.Shipyard location	0.15		
Total	**1.00**		**1.00**

According to table 4.1, the following descriptions are internal factor and external factor of Dalla shipyard.

4.1.1 Internal Factors

1. Price level (Strength)

   Ship repair price is cheaper than other shipyard in this region. The shipyard has machine shop, carpenter shop, pipe and boiler shop, bending machine, etc. Private shipyards and other stat-owned shipyard in this region do not have facilities and machines. Therefore, the shipyard reduces ship repair cost than other.

2. Employee know-how (Weakness)

   Employee know-how price is low. Despite the low labor costs, the shipbuilding sector is not able to compete internationally due to skills, shipbuilding rules and regulations, lacking technology.

3. Company Culture (Weakness)

   The shipyard management culture is not effective because it has many management levels. If private ship wants to be repaired, it needs to get permission from managing director. The shipyard should reduce the management level become effective level for better productivity and command engineer make all decision for ship repair work.

4. Business network (Strength)

   The shipyard is working together to accomplish certain goals with some international organization. Dalla shipyard cooperates with JICA in Japan to increase human resources, technology, standardization and quality control. The shipyard cooperates with India Inland Transport to build new vessels for Kelantan Project.

5. Delivery time (Weakness)

   The shipyard does not finish ship repair in time because facilities and material handling equipment is not full support for ship repair. The IWT' ships are very old and are about 20 years. Therefore, the shipyard gives more repair service for ships.

6. Quality of product (Strength)

   Ship repair quality is good because the shipyard is good reputation. The shipyard is about 164 years and ship repair experience is good. The shipyard currently accounts for about 50 percent of repair work on ships owned by IWT.

7. Shipyard location (Strength)

   The shipyard is located in Dalla Township near Yangon City which is economic city and has import and export harbor from the whole country. In addition, local inland shipping lines transport cargo and goods based on Yangon region. Therefore, Dalla shipyard is located in the most important region and biggest market share region in Myanmar.

4.1.2 External Factors

1. Price of material (Threat)

   Price of material is expansive because all materials are imported from the neighboring countries. Absence of an organized material and spare parts supply and basic materials such as steel plates and machineries are imported from the neighboring countries

2. Quality of material (Opportunity)

   Quality of material is good because basic materials such plates and machineries are imported from the neighboring countries.

3. Quality of sub-contractor (Threat)

   Quality of sub-contractor is low because the shipbuilding sector is not able to compete internationally due to skills, shipbuilding rules and regulations, lacking technology.

4. Bank support (Opportunity)

   Myanma Economic bank supports to the shipyard for loan. If the shipyard needs a loan for buying machine and equipment, Myanma Economic bank supports it. Asian Development Bank (ADB) identifies possible technical assistance and investment initiatives for the transport sector for support.

5. Government support to shipyard (Threat)

   Government support a little to the shipyard. The potential of the market lies in the political reforms, with government trying to attract foreign investments.

6. Government support to shipping (Threat)

   Government support a little to the shipping. Foreign investments in shipping lines for domestic and international will be triggered.

7. Domestic market

   Repair orders get from domestic market because the shipyard serve the IWT' vessels. The shipbuilding industry of Myanmar is still a small scale industry, which focuses on the construction and maintenance of the domestic inland cargo and cruise vessels market. Therefore, there are big domestic markets.

4.2 Internal Factor Evaluation Matrix

Internal Factor Evaluation matrix is a strategic management tool for auditing or evaluating major strengths and weaknesses in functional areas of a business. Internal factor evaluation matrix can be utilized to evaluate how a shipyard is performing in regards to identified internal strengths and weaknesses of a shipyard. Internal factor evaluation matrix can be created using the following five steps:

1. Internal factor

   Conduct internal audit and identify both strengths and weaknesses in shipyard. The number of factors has no effect on the range of total weighted scores because the weights always sum to 1.0.First, list strengths and then weaknesses. It is wise to be as specific and objective as possible.

2. Weight

   Assign a weight that ranges from 0.00 to 1.00 to each factor. The weight assigned to a given factor indicates the relative importance of the factor. Zero means not important. One indicates very important. Regardless of whether a key factor is an internal strength or weakness, factors with the greatest importance in shipyard performance should be assigned the highest weights. After assigning weight to individual factors, make sure the sum of all weights equals 1.00.

3. Rating

   Assign a 1-to-4 rating to each factor to indicate whether that factor represents a major weakness (rating = 1), a minor weakness (rating = 2), a minor strength (rating = 3), or a major strength (rating = 4). Note that strengths must receive a 3 or 4 rating and weaknesses must receive a 1 or 2 rating. Ratings are thus company-based, whereas the weights in step 2 are industry-based.

4. Multiply

   Multiply each factor's weight by its rating. This will give a weighted score for each factor.

5. Sum

   Sum the weighted scores for each variable to determine the total weighted score for the organization.

Table (4.2) Internal Factor Evaluation (Ma’ruf, 2006)

Factor and Variables	S / W	Weight	Rating	Weighted Score
1.Price level	S	0.24	3	0.72
2.Employee know-how	W	0.22	2	0.44
3.Company culture	W	0.11	2	0.22
4.Business network	S	0.10	3	0.30
5.Delivery time	W	0.09	2	0.18
6.Quality of product	S	0.09	3	0.27
7.Shipyard location	S	0.15	4	0.60
Total		1.00		2.73

Total weighted score of 2.73 indicates that the business has above 2.5 indicated a strong internal position. (David, 2015)

4.3 External Factor Evaluation Matrix

External factor evaluation matrix method is a strategic-management tool often used for assessment of current shipyard conditions. The external factor evaluation matrix is a good tool to visualize and prioritize the opportunities and threats that a business is facing.

Developing an external factor evaluation matrix is an intuitive process which works conceptually very much the same way like creating the internal factor evaluation matrix. The external factor evaluation matrix process uses the same five steps as the internal factor evaluation matrix.

1. External factor

   The first step is to gather a list of external factors. Divide factors into two groups: opportunities and threats.

2. Weight

   Assign a weight to each factor. The value of each weight should be between 0 and 1. Zero means the factor is not important. One means that the factor is the most influential and critical one. The total value of all weights together should equal 1.

3. Rating

   Assign a rating between 1 and 4 to each key external factor to indicate how effectively the firm's current strategies respond to the factor, where 4 = the response is superior, 3 = the response is above average, 2 = the response is average and 1 = the response is poor.

4. Weight

   Multiply each factor weight with its rating. This will calculate the weighted score for each factor.

5. Sum

   Sum the weighted scores for each variable to determine the total weighted score for the organization.

Table (4.3) External Factor Evaluation (Ma'ruf, 2006)

Factor and Variables	O/ T	Weight	Rating	Weighted Score
1.Price of material	T	0.22	2	0.66
2.Quality of material	O	0.21	2	0.42
3.Quality of sub-contractor	T	0.20	3	0.60
4.Bank support	O	0.07	3	0.21

5.Government support to shipyard	T	0.07	2	0.14
6.Government support to shipping	T	0.07	2	0.14
7.Domestic market	O	0.16	4	0.64
Total		1.00		2.59

Total weighted score of 2.59 indicates that the business has above 2.5 indicated a high response to its external business environment.

The Strengths-Weaknesses-Opportunities-Threats (SWOT) Matrix is an important matching tool that helps managers develops four types of strategies: SO (strengths-opportunities) strategies, WO (weaknesses-opportunities) strategies, ST (strengths-threats) strategies, and WT (weaknesses-threats) strategies.

Table 4.4 SWOT Matrix (David, 2015)

IFE Factor / EFE Factor	**Strengths**	**Weakness**
	1. Location	1. Company culture
	2. Business network	2. Delivery time
	3. Price level	3. Employee know-how
	4. Quality of product	
Opportunities	**SO strategies**	**WO strategies**
1. Domestic market	1. Add facilities (S1,O1,O4)	1. Add material handling equipment and re-layout shipyard (W2, O1)
3. Quality of material		
4. Bank support		
Threats		
1. Quality of sub-contractor		
2. Government support to shipyard		
3. Government support to shipping		
4. Price of material		

As shown in table 4.3, SWOT matrix shows problem of Dalla shipyard, including: add facilities, add material handling equipment and re-layout.

4.4 Forecast

Time series analysis method uses to analyze the future of shipyard increment. Previous data of ship repair for 5 years use to predict the future of ship repair for 5 years. According to data of ship repair from shipyard, the base year is 2011 year. To simplify the calculations, the years are replaced by coded values. That is, we let 2011 be 0, 2012 be 1, and so forth. We use the following equations to find the slope, **b**, and the intercept, **a**, to substitute into the linear trend equation (**Y=a+bx**).

$$\mathbf{a} = \frac{(\sum \boldsymbol{y})(\sum \boldsymbol{x^2}) - (\sum \boldsymbol{x})(\sum \boldsymbol{xy})}{\boldsymbol{n}(\sum \boldsymbol{x^2}) - (\sum \boldsymbol{x})^2}$$

$$\mathbf{b} = \frac{\boldsymbol{n}(\sum \boldsymbol{xy}) - (\sum \boldsymbol{y})(\sum \boldsymbol{x})}{\boldsymbol{n}(\sum \boldsymbol{x^2}) - (\sum \boldsymbol{x})^2}$$

$$\mathbf{Y} = \mathbf{a} + \mathbf{bx}$$

Where, n = Total years from previous data from shipyard

x = number of year (code)

y = actual ship repair

Y = ship repair from shipyard in year(x)

a = the permanent component and demand every year

b = the quantity of demand in the first year

Year	Year of code (x)	y	x^2	xy
2011	0	53	0	0
2012	1	51	1	51
2013	2	58	4	116
2014	3	55	9	165
2015	4	57	16	228
Total	10	274	30	560

$$\mathbf{a} = \frac{(\mathbf{274})(\mathbf{30}) - (\mathbf{10})(\mathbf{560})}{(\mathbf{5})(\mathbf{30}) - (\mathbf{10})^{\mathbf{2}}}$$

$$\mathbf{a} = \frac{\mathbf{8220 - 5600}}{\mathbf{150 - 100}}$$

$$\mathbf{a = 52.4}$$

$$\mathbf{b} = \frac{(\mathbf{5})(\mathbf{560}) - (\mathbf{10})(\mathbf{274})}{(\mathbf{5})(\mathbf{30}) - (\mathbf{10})^{\mathbf{2}}}$$

$$\mathbf{b} = \frac{\mathbf{2800 - 2740}}{\mathbf{150 - 100}}$$

$$\mathbf{b = 1.2}$$

$$\mathbf{Y = 51.4 + 1.2(5)}$$

$$\mathbf{Y = 58.4}$$

According to the calculation, shipyard can be repaired 58 vessels for 2016. Base on those five years ship repair data, we estimated ship repair of shipyard for 2020. The calculations and data are same. The year 2017 is coded 6, 2018 is coded 7, 2019 is coded 8 and 2020 is coded 9. Therefore, the following table shows the forecast for future 5 years.

Table 4.5 Forecast for Future 5 Years

Year	Total vessels
2016	58
2017	59
2018	61
2019	62
2020	63

The ship repair in the year becomes to be improved by the current status of data. The results of predictable pattern show market demand or market growth in the future.

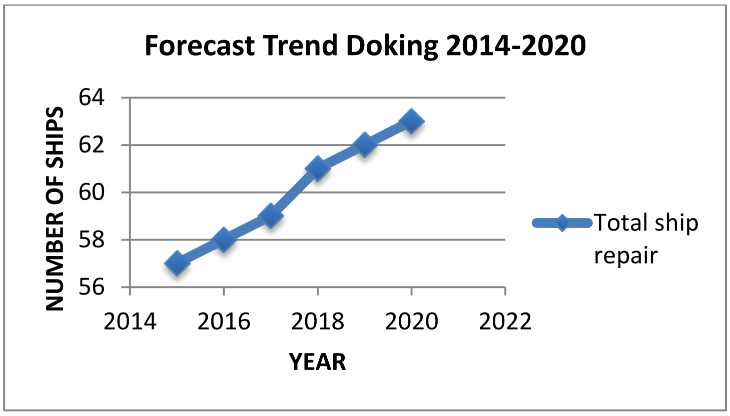

Figure 4.1 Total Ship Repair Forecast Trend

From the results of analysis using time series method, we can compare the number of ship repair in Dalla shipyard before and after analysis. The number of ship repair was increased to get the target market. But it is necessary to know the possibilities causes or problems experienced in the shipyard.

4.5 Estimation of Shipyard Capacity

There are (14) slipways in Dalla shipyard. The following table shows the number of slipways and its capacity.

Table 4.6 Number of Slipway and Its Capacity

No	Slipway Number	Capacity (Ton)	Establish Year	Remark
1	1	274	1908	Good
2	2	205	1898	Broken
3	3	205	1898	Good
4	Dry Dock	1400	2001	Good
5	5 and 6	125	1892	Broken
6	7 to 12	468	1900	Good
7	13	125	1963	Good
8	14	274	1920	Good

Source: Dalla Shipyard

The number of slipway no (2), (5) and (6) use airbag for docking and launching. The number of slipway (7) to (12) use continuous because winch machine is only one. The following table is shown shipyard repair capacity for previous five years.

Table 4.7 Ship Repair List Detail for Previous Five Years

Year	Slipway 1	Slipway 3	Dry Dock	Slipway 7-12	Slipway 13	Slipway 14	Total
2011	10	6	4	8	15	10	53
2012	9	8	5	9	12	8	51
2013	10	8	6	8	15	11	58
2014	8	7	5	8	16	11	55
2015	8	7	8	8	16	10	57

Source: Dalla Shipyard

According to table 4.5 and 4.6, to estimate shipyard affectivity based on each slipway. For average capacity of no 1 slipway are 9 vessels per year and average of DWT are 140 T. The docking day for average one vessel is 33 days. The production capacity of slipway calculated theoretically.

For Slipway1 $K = F1.F2.T.\frac{C}{H}$

$= 0.8\times0.8\times300(274)/33$

$= 1594.18$ DWT

$= 1594.18$ DWT/ 140

$= 11$ vessels

For Slipway 3, Average capacity = 7 vessels

Average DWT = 50 DWT

$K = F1.F2.T.C/H$

$= 0.8\times0.8\times300(205)/43$

$=915.3$

$=915.3/50$

$=18$ vessels

For Slipway 4 (Dry Dock) = 6 vessels

For Slipway 7 to 12, Average capacity = 8 vessels

Average DWT = 200 DWT

$$K = F1.F2.T.C/H$$

$$=0.8\times0.8\times300(462)/38$$

$$=2334.3157$$

$$=2334.3157/200$$

=12 vessels

For Slipway 13, Average capacity = 15 vessels

Average DWT = 120 DWT

$$K = F1.F2.T.C/H$$

$$=0.8\times0.8\times300(125)/20$$

$$=1200$$

$$=1200/120$$

=10 vessels

For slipway no 14, Average capacity = 10 vessels

Average DWT = 140 DWT

$$K = F1.F2.T.C/H$$

$$=0.8\times0.8\times300(274)/30$$

$$=1754/140$$

=13 vessels

Therefore according to theoretically, total capacity for existing layout is 70 vessels. The numbers of existing vessels are sufficient to repair for forecasting number of vessels. The layout of Dalla shipyard shows in Figure 4.2.

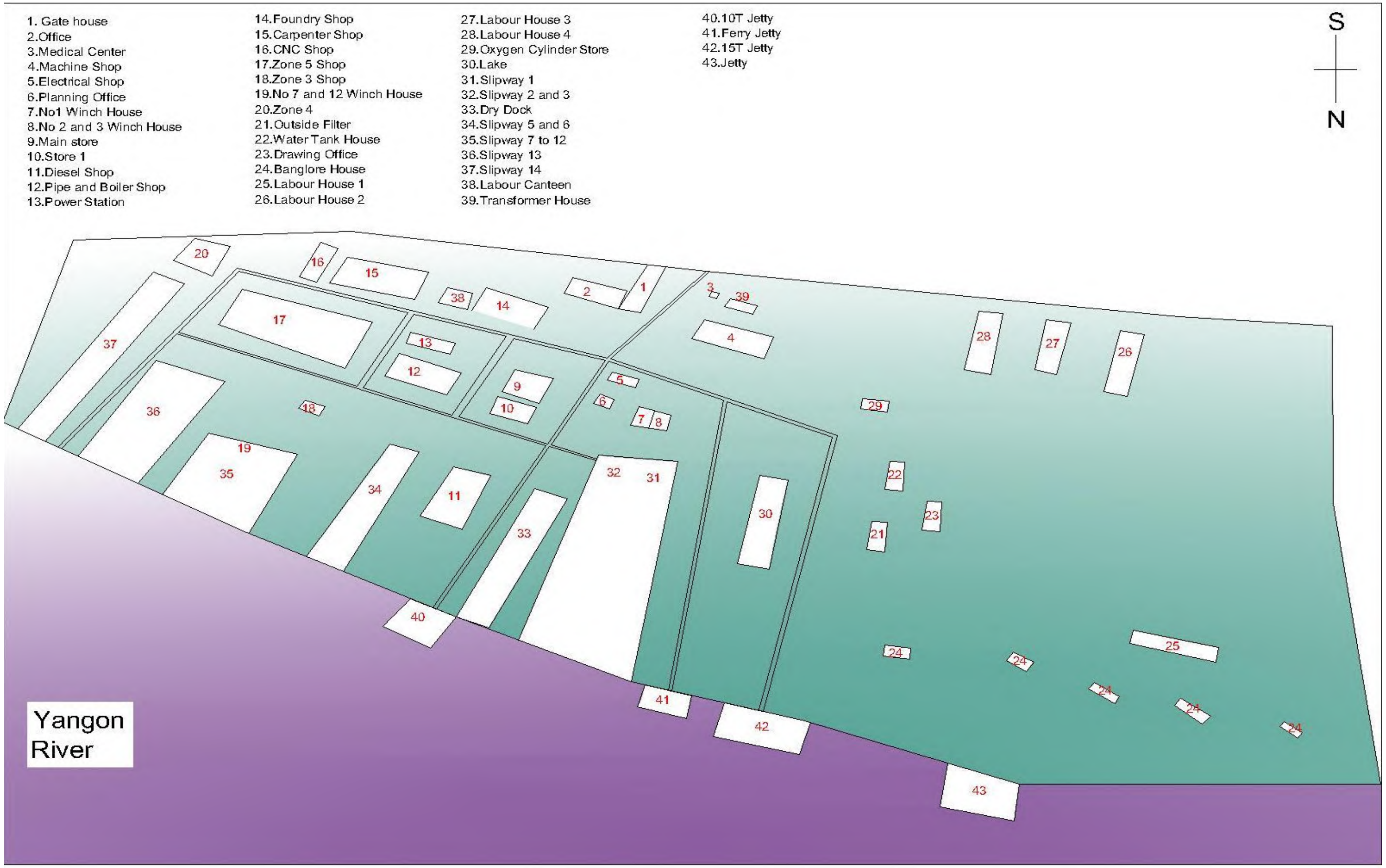

Figure 4.2 Dalla Shipyard Layout

CHAPTER 5
CAPACITY IMPROVEMENT OF SHIPYARD

5.1 Re-layout Shipyard and Shipyard Facility

The conditions of Dalla shipyard that making some changes in order to rationalize the shipyard as follows: warehouse plate, re-layout shipyard and adding dock facilities.

Re-layout is changing the existing layout according to the current requirements. The layout may be re-designed to improve the existing layout or eliminate the inconvenience of the existing layout. Purpose of the re-layout is to improve the productivity and efficiency of the shipyard. The existing shipyard layout has a lot of old facilities and lack of warehouses for storage of plates. The re-layout is also due to the preparation of the layout of the shipyard. The flow of materials fulfills reliably and can accelerate the process of repair work on this shipyard. Firstly, we try to change the existing layout of shipyard to improve capacity of shipyard. Dalla shipyard does not have steel plate warehouse until now. The shipyard cannot use foundry shop for a long time. Therefore, the first step proposes to use the foundry shop location for warehouse plate. The following figure 5.1 shows the first alternative layout of shipyard.

In the first alternative layout of shipyard, No (14) is steel plate warehouse because the shipyard keep steel plate in ground. The size of steel plate warehouse is 45 x 13= 585 m^2. This warehouse can be stored 600 plates. Zone (5) no (17) is big building because it is machinery shop and plate and frame assembly shop. The shipyard has many facilities but some are broken and old. Some buildings can be repaired and maintained. The table 5.1 shows additional area of facility for the first alternative layout.

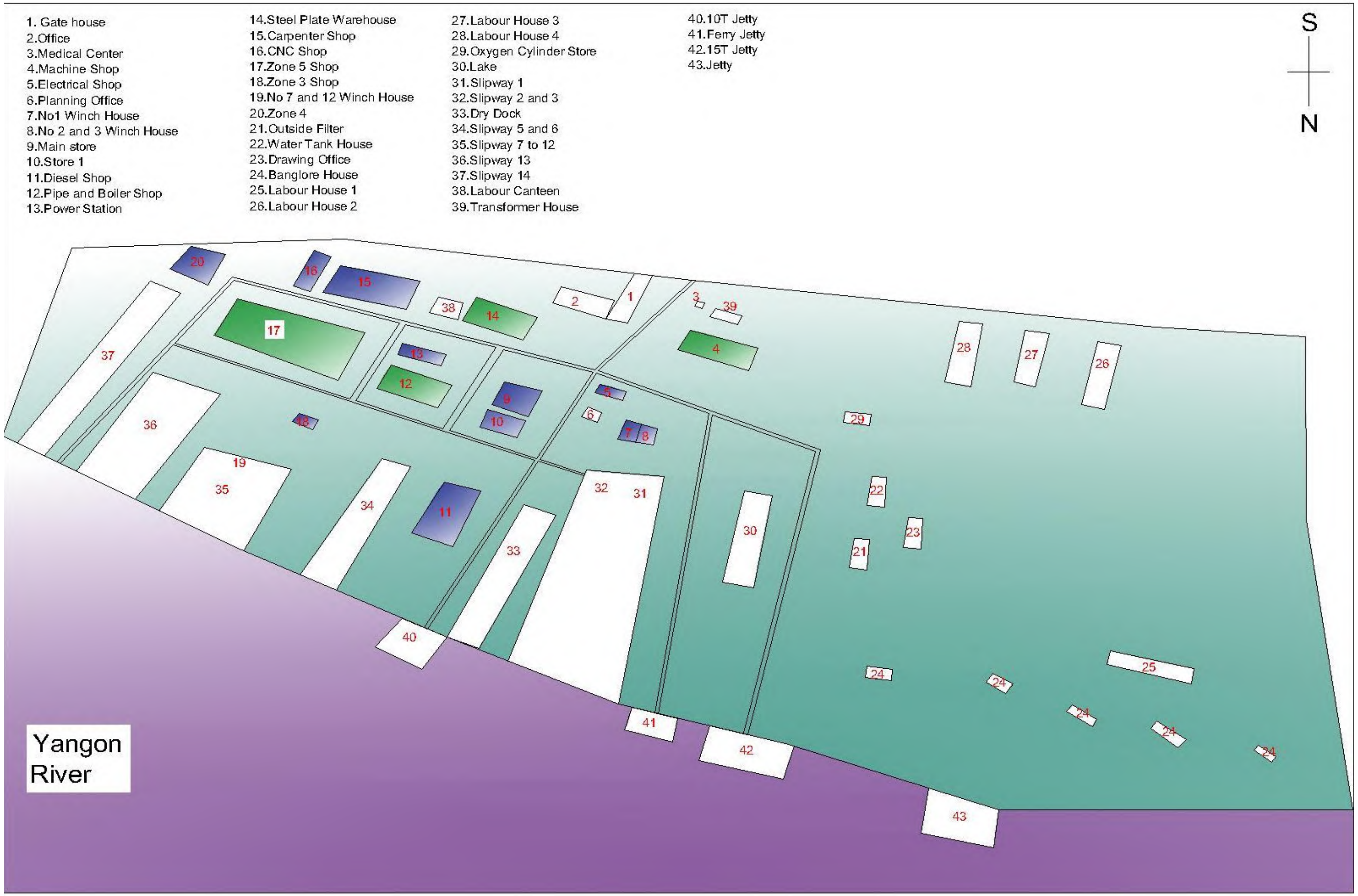

Figure 5.1 First Alternative Layout of Shipyard

Table 5.1 Additional Area of Facility for the First Alternative layout

No	Item	Size (m)	Area (m^2)	Remark
1	Steel plate warehouse	45 x 13	585	New
	Total		585	

Source: Dalla Shipyard

Total used area of shipyard = 39379 m^2

Total area of shipyard = 121406 m^2

Percentage of total used area of shipyard = (39379/121406) x 100%

= 32.4%

Therefore, Percentage of free area of shipyard is 67.6%.

The first alternative does not change the existing layout. But the material handling equipment of a mobile crane (30 Ton) and a forklift (10 Ton) are additional for the first alternative layout. The road in the shipyard has already built concrete road. The road is 4 m widths. Therefore, the transportation of material is easy in the shipyard. The following figure 5.2 shows the steel plate warehouse.

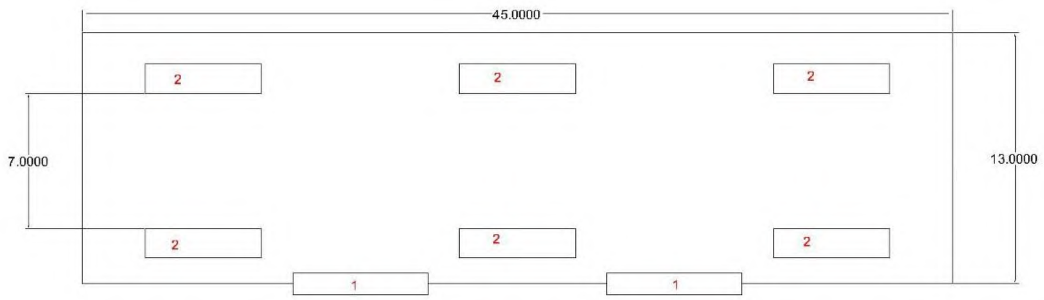

Figure 5.2 Steel Plate Warehouse

Warehouses are intended for the storage and physical protection of steel plate. The size of steel plate warehouse is 45 m (length) and 13 m (width). The plate size is 6 m (length) and 1.52 m (width). The door size is 7 m (width) and 6 m (high).

The second alternative layout of shipyard has new machine shop and new pipe and boiler shop. The old machine shop is far from the slipways. Therefore, new machine shop may be re-located near the slipways for better material handling and time consuming. The machine shop No (4) is close the pipe and boiler No (14). The size of machine shop is 1250 m^2 (50 m x 25 m) and the size of pipe and boiler shop is 900 m^2 (45 m x 20 m). The workable machine in machine shop are lathe machine L-10 m, lathe machine center type 23′x 7″, lathe center type (cone pulley drive), slotting machine, vertical drilling machine (bench type), boring machine and milling machine. Zone (5) shop has plate rolling machine, hydraulic shearing machine and sheet metal bending machine. Zone (5) has fitting and assembly for frame and flow. The following figure 5.3 shows the second alternative layout of shipyard. The table 5.2 shows area of each facility for the second alternative layout. Table 5.3 shows additional facilities for the first alternative and the second alternative layouts.

Table 5.2 Additional Area of Each Facility for the Second Alternative layout

No	Item	Size (m)	Area (m^2)	Remark
1	Machine Shop	50 x 25	1250	
2	Pipe and Boiler Shop	45 x 20	900	
	Total		2150	

Source: Dalla Shipyard

Total used area of shipyard = 36613 m^2

Total area of shipyard = 121406 m^2

Percentage of total used area of shipyard = (36613/121406) x 100%

= 30.15%

Therefore, Percentage of free area of shipyard is 69.85 percent.

The shipyard has many buildings but some building need to renovate some parts of building. The machine shop is too big because it has many facility and equipment. But the workable machines in machine shop are 6 machines now. Therefore, the second alternative layout builds new machine shop between the pipe and boiler and power station shop for better material handling and time consuming. The size of machine shop in the second alternative is small because workable machine are re-installed in the new machine shop. The pipe and boiler shop in the second alternative layout is re-located for better material handling and time consuming. The size of pipe and boiler shop in the existing layout is too big because it gives piping and boiler repair service. But now the pipe and boiler shop give piping service only. Therefore, the size of the pipe and boiler shop in the second alternative layout is small. The second alternative layout renovates the store 1for warehouse plate. The warehouse plate in the second alternative layout is the store 1.

Table 5.3 Additional Facilities for the First Alternative and the Second Alternative Layouts

Name of Item	Capacity	Number	Remark
Forklift	10 Ton	1	New (replaced one of the old ones)
Mobile Crane	30 Ton	1	New
Hydraulic Shearing Machine (3 m x 8 mm)	≥8 / min	1	New

The number of existing material handling equipment in the shipyard is sufficient but the capacity of material handling is not sufficient. Therefore, the first and the second alternative layouts are additional of a new mobile crane (30 Ton) and a new forklift (10 Ton). The new hydraulic shearing machine is additional facilities because the existing hydraulic shearing machine is broken two years ago. The first and the second alternative layout is the same material handling equipment and facilities. But the second alternative re-locates machine shop and pipe and boiler shop near the slipways for better material handling and time consuming. Therefore, the first and the second alternative layout is the different layout.

For two ways, they are mobile truck and ship. The warehouse plate location is good for truck and ship. And then, warehouse plate supply the plate each slipways. The shipyard own 30 acres or 12.146 hectare. Percentage of total used area of shipyard is 32.4 percent. Therefore, the shipyard fills and builds facilities and new buildings. But the shipyard has a lot of building near the slipways. The first alternative layout builds at location of foundry shop for warehouse plate. The first and second alternative layout use 32.4percent of land. Therefore, 67.6 percent of land can be used for further development if the shipyard received the new shipbuilding.

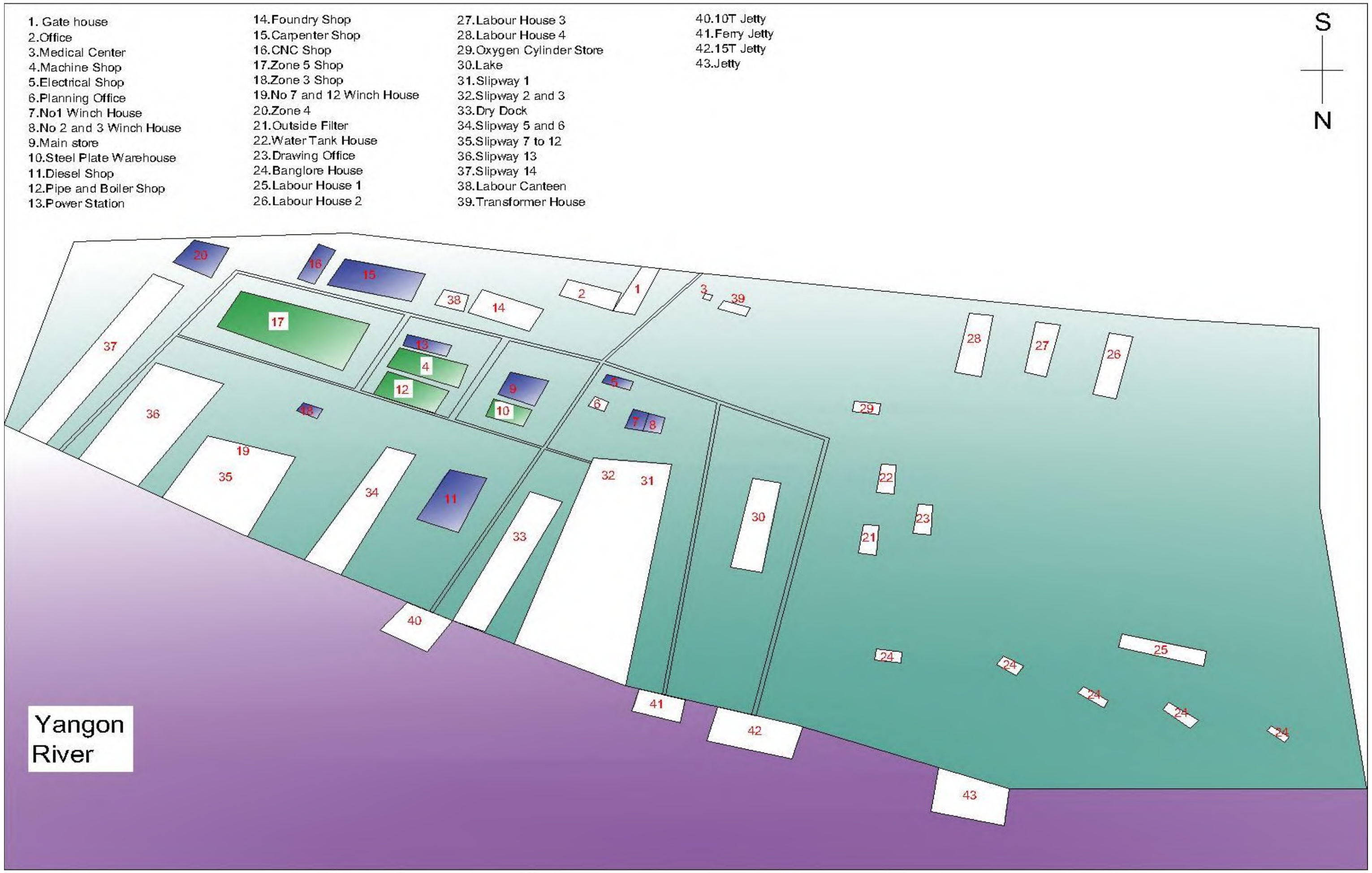

Figure 5.3 Second alternative layout of shipyard

5.2 Flow of Material

The layout problem is common to every type of enterprise – from the mall retailer to the largest manufacturing industries. The aim of each company is to obtain maximum benefit from their facilities. The adequacy of the layout directly affects the efficiency of the plant. Principal factors which affect shipyard layouts are briefly discussed. They are range of ship types to be built and number/year, space required and space available, amount of mechanization, material handling and construction methods employed (Shenoi, 2007).

The providing material is two ways in the first and the second alternative layout shipyards. They are ship transportation and mobile truck transportation. Inland Water Transport (IWT) calls material tender for all shipyards. Therefore, Dalla shipyard uses the IWT's vessels to carry material from Yangon harbor.

5.2.1 Flow of Material for Existing Layout

The existing layout does not have steel plate warehouse. The materials are stored in ground in front of machine shop. Therefore, materials become corrosion and quality is not good. Flows of materials for the existing layout are as following;

First track (green): Materials arrive at the shipyard by truck or by ship. If materials arrive by truck, it stores in ground in front of machine shop.

Second track (green): If materials arrive by ship, it stacks in a place using carne with a capacity of 30 Ton. After stacking material, forklift with capacity 10 ton carry it to warehouse plate. The distance is 270 meter from transshipment to warehouse plate.

Third track (blue): Forklift carries material from plate in ground to Zone 5 shop for shearing plate, bending plate, rolling plate and making frame and assembly.

Fourth track (black): After finished the work in third track from Zone 5, the material carried by forklift from Zone 5 to each slipways for ship repair process. The transportation distance is maximum 180 meter and minimum 33 meter.

Fifth track (red): Machine shop repair propeller shafts, tail shafts, intermediate shafts, rudder stocks and propeller. The maximum distance is 255 meter from machine shop to slipways. The minimum distance is 53 meter.

Sixth track (yellow): Pipe and boiler shop repair ballast pipe line system, fire pipe line system, cooling pipe line, fuel pipe line, fresh water pipe line, auxiliary pipe line and fuel tank. Pipe and boiler shop is close the slipways. Figure 5.4 shows flows of materials for existing layout. To improve the effectiveness of the use of equipment, facilities and manpower in the flow of material handling, it is necessary to determine a standard job and standard time. Standard time is derived by adding to normal time allowances. The following formula shows standard time.

$$\mathbf{Minimum\ Required\ Time} = \mathbf{Normal\ Time} + (\mathbf{Normal\ Time}\ \times\ \mathbf{Allowances})$$

Based on flow of material for existing layout, transportation of plate performance rating used is as follows:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.
- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

Allowance based on research and experience 10 percent of normal time (Sukanto, 1986).

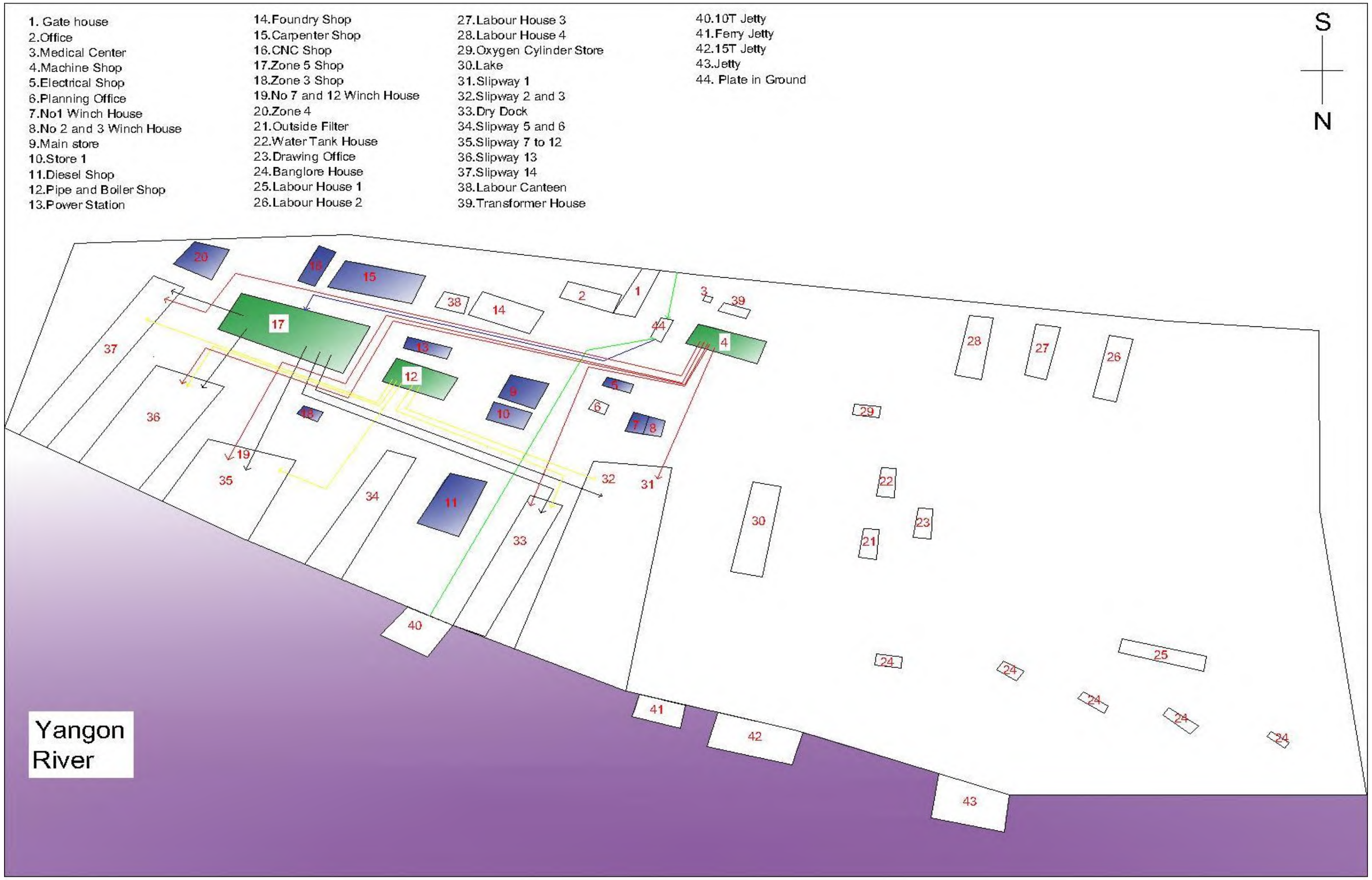

Figure 5.4 Flows of materials for existing

The distance is 230 meter from plate in ground (44) to zone 5 shop no (17).The figure 5.4 shows flow of material for existing layout. Standard time for transportation time 47 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 47 x 60%

= 47 x 0.6

= 28.2 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 28.2 + 10% (28.2)

= 28.2 + 2.82

= 31.02 minutes

For go and back = 2 x 31.02 minutes

= 62.04 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 47 x 110%

= 47 x 1.1

= 51.7 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 51.7 + 10% (51.7)

= 51.7 + 5.17

= 56.87 minutes

For go and back = 2 x 56.87

= 113.74 minutes

The difference between existing layout and first alternative layout is steel plate warehouse. The other facilities are same.

5.2.2 Flow of Material for the First Alternative layout

Flows of materials of the first alternative layout are as following;

First track (green): Materials arrive at the shipyard by truck or by ship. If materials arrive by truck, it stores in warehouse plate.

Second track (green): If materials arrive by ship, it stacks in a place using carne with a capacity of 30 Ton. After stacking material, forklift with capacity 10 ton carry it to warehouse plate. The distance is 250 meter from transshipment to warehouse plate.

Third track (blue): Forklift carries material from the warehouse to Zone 5 shop for shearing plate, bending plate, rolling plate and making frame and assembly.

Fourth track (black): After finished the work in third track from Zone 5, the material carried by forklift from Zone 5 to each slipways for ship repair process. The transportation distance is maximum 180 meter and minimum 33 meter. The figure 5.5 shows flow of material for the first alternative layout.

Fifth track (red): Machine shop repair propeller shafts, tail shafts, intermediate shafts, rudder stocks and propeller. The maximum distance is 255 meter from machine shop to slipways. The minimum distance is 53 meter.

Sixth track (yellow): Pipe and boiler shop repair ballast pipe line system, fire pipe line system, cooling pipe line, fuel pipe line, fresh water pipe line, auxiliary pipe line and fuel tank. Pipe and boiler shop is close the slipways. Small shop is close each slipway to store welding machine, electrode, electric grinders and others. CNC shop sometimes use for new shipbuilding. Carpenter shop repair such as tables, chairs, window, door and furniture. Electrical shop repair electric motor, steering control system, electric bulbs, searchlight, pilot light and lighting system. To improve the effectiveness of the use of equipment, facilities and manpower in the flow of material handling, it is necessary to determine a standard job and standard time. Minimum required time is derived by adding to normal time allowances. The following formula shows standard time.

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

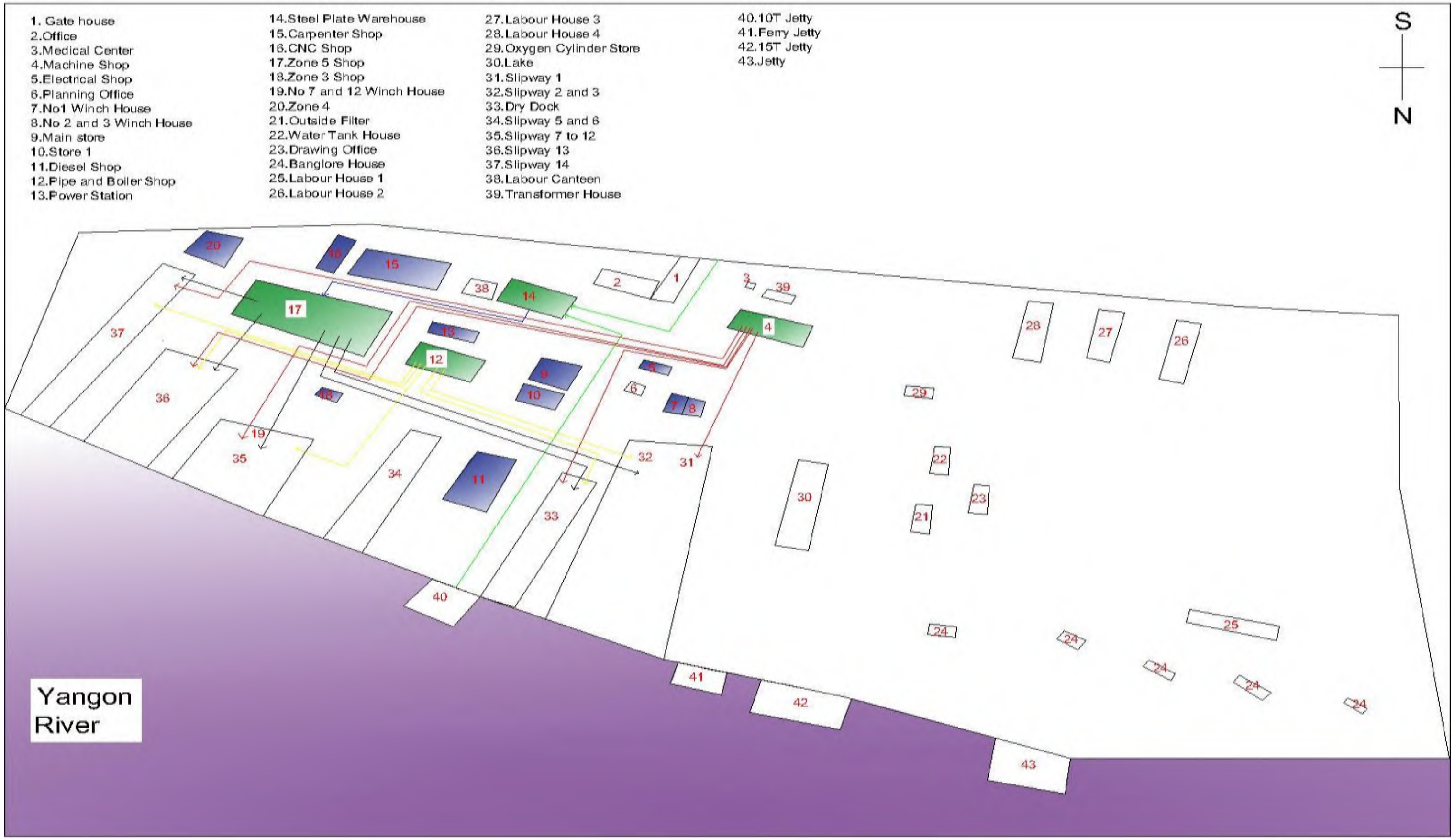

Figure 5.5 Flow of material for first alternative

Based on flow of material for fist alternative layout, transportation of plate performance rating used is as follows:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.
- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

Allowance based on research and experience 10 percent of normal time (Sukanto, 1986). The distance is 90 meter from **steel plate warehouse** (14) to **zone 5** shop no (17). Standard time for transportation time 18 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 18 x 60%

= 18 x 0.6

= 10.8 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 10.8 + 10% (10.8)

= 10.8 + 1.08

= 11.88 minutes

For go and back = 2 x 11.88 minutes

= 23.76 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 18 x 110%

= 18 x 1.1

= 19.8 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 19.8 + 10% (19.8)

= 19.8 + 1.98

= 21.78 minutes

For go and back = 2 x21.78

= 43.56 minutes

The difference between existing layout and first alternative layout is steel plate warehouse. The other facilities are same.

The distance is 33 meter from **Zone 5** (17) to slipways **No 14**. Standard time for transportation time 8 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 8 x 60%

= 8 x 0.6

= 4.8 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 4.8 + 10% (4.8)

= 4.8 + 0.48

= 5.28 minutes

For go and back = 2 x 5.28 minutes

= 10.56 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 8 x 110%

= 8 x 1.1

= 8.8 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 8.8 + 10% (8.8)

= 8.8 + 0.88

= 9.68 minutes

For go and back = 2 x 9.68

= 19.36 minutes

For 22 meter distance from **Zone 5** (17) to slipways **No 13**, Standard time for transportation time 5 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time } = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 5 x 60%

= 5 x 0.6

= 3 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time } \times \textbf{ Allowances})$$

= 3 + 10% (3)

= 3 + 0.3

= 3.3 minutes

For go and back = 2 x 3.3

= 6.6 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time } = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 5 x 110%

= 5 x 1.1

= 5.5 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time } \times \textbf{ Allowances})$$

= 5.5 + 10% (5.5)

= 5.5 + 0.55

= 6.05 minutes

For go and back = 2 x 6.05

= 12.1

For 70 meter distance from **Zone 5** (17) to slipways **No 7-12**, Standard time for transportation time 15 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 15 x 60%

= 15 x 0.6

= 9 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 9 + 10% (9)

= 9 + 0.9

= 9.9 minutes

For go and back = 2 x 9.9

= 19.8 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 15 x 110%

= 15 x 1.1

= 16.5 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 16.5 + 10% (16.5)

= 16.5 + 1.65

= 18.15 minutes

For go and back = 2 x 18.15

= 36.3 minutes

For 150 meter distance from **Zone 5** (17) to **dry dock**, Standard time for transportation time 30 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 30 x 60%

= 30 x 0.6

= 18 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 18 + 10% (18)

= 18 + 1.8

= 19.8 minutes

For go and back = 2 x 19.8

= 39.6 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 30 x 110%

= 30 x 1.1

= 33 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 33 + 10% (33)

= 33 + 3.3

= 36.5 minutes

For go and back = 2 x 36.5

= 72.6 minutes

For 180 meter distance from **Zone 5** (17) to slipways **no 1-3**, Standard time for transportation time 40 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 40 x 60%

= 40 x 0.6

= 24 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 24 + 10% (24)

= 24 + 2.4

= 26.4 minutes

For go and back = 2 x 26.4

= 52.8 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 40 x 110%

= 40 x 1.1

= 44 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 44 + 10% (44)

= 44 + 4.4

= 48.4 minutes

For go and back = 2 x 48.4

= 96.8 minutes

For 255 meter distance from **Machine shop** (4) to slipways **no 14**, Standard time for transportation time 55 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 55 x 60%

= 55 x 0.6

= 33 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 33 + 10% (33)

= 33 + 3.3

= 36.3 minutes

For go and back = 2 x 36.3

= 72.6 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 55 x 110%

= 55 x 1.1

= 60.5 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 60.5 + 10% (60.5)

= 60.5 + 6.05

= 66.55 minutes

For go and back = 2 x 66.55

= 133.1 minutes

For 270 meter distance from **Machine shop** (4) to slipways **no 13**, Standard time for transportation time 60 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 60 x 60%

= 60 x 0.6

= 36 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 36 + 10% (36)

= 36 + 3.6

= 39.6 minutes

For go and back = 2 x 39.6

= 79.2 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 60 x 110%

= 60 x 1.1

= 66 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 66 + 10% (66)

= 66 + 6.6

= 72.6 minutes

For go and back = 2 x 72.6

= 145.2 minutes

For 220 meter distance from **Machine shop** (4) to slipways **no 7-12**, Standard time for transportation time 45 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 45 x 60%

= 45 x 0.6

= 27 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 27 + 10% (27)

= 27 + 2.7

= 29.7 minutes

For go and back = 2 x 29.7

= 59.4 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 45 x 110%

= 45 x 1.1

= 49.5 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 49.5 + 10% (49.5)

= 49.5 + 4.95

= 54.45 minutes

For go and back = 2 x 54.45

= 108.9 minutes

For 110 meter distance from **Machine shop** (4) to **dry dock**, Standard time for transportation time 23 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 23 x 60%

= 23 x 0.6

= 13.8 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 13.8 + 10% (13.8)

= 13.8 + 1.38

= 15.18 minutes

For go and back = 2 x 15.18

= 30.36 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 23 x 110%

= 23 x 1.1

= 25.3 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 25.3 + 10% (25.3)

= 25.3 + 2.53

= 27.83 minutes

For go and back = 2 x 27.83

= 55.66 minutes

For 53 meter distance **Machine shop** (4) to slipways **no 1 - 3**, Standard time for transportation time 10 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 10 x 60%

= 10 x 0.6

= 6 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 6 + 10% (6)

= 6 + 0.6

= 6.6 minutes

For go and back = 2 x 6.6

= 13.2 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 10 x 110%

= 10 x 1.1

= 11 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 11 + 10% (11)

= 11 + 1.1

= 12.1 minutes

For go and back = 2 x 12.1

= 24.2 minutes

For 140 meter distance from **Pipe and boiler shop** (12) to slipways **no 14**, Standard time for transportation time 27 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 27 x 60%

= 27 x 0.6

= 16.2 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 16.2 + 10% (16.2)

= 16.2 + 1.62

= 17.82 minutes

For go and back = 2 x 17.82

= 35.64 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 27 x 110%

= 27 x 1.1

= 29.7 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 29.7 + 10% (29.7)

= 29.7 + 2.97

= 32.67 minutes

For go and back = 2 x 32.67

= 65.34 minutes

For 90 meter distance from **Pipe and boiler shop** (12) to slipways **no 13**, Standard time for transportation time 18 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 18 x 60%

= 18 x 0.6

= 10.8 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 10.8 + 10% (10.8)

= 10.8 + 1.08

= 11.88 minutes

For go and back = 2 x 11.88

= 23.76 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 18 x 110%

= 18 x 1.1

= 19.8 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 19.8 + 10% (19.8)

= 19.8 + 1.98

= 21.78 minutes

For go and back = 2 x 21.78

= 43.56 minutes

For 60 meter distance from **Pipe and boiler shop** (12) to slipways **no 7-12**, Standard time for transportation time 15 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 15 x 60%

= 15 x 0.6

= 9 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 9 + 10% (9)

= 9 + 0.9

= 9.9 minutes

For go and back = 2 x 9.9

= 19.8 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 15 x 110%

= 15 x 1.1

= 16.5 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 16.5 + 10% (16.5)

= 16.5 + 1.65

= 18.15 minutes

For go and back = 2 x 18.15

= 36.3 minutes

For 85 meter distance from **Pipe and boiler shop** (12) to **dry dock**, Standard time for transportation time 18 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 18 x 60%

= 18 x 0.6

= 10.8 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 10.8 + 10% (10.8)

= 10.8 + 1.08

= 11.88 minutes

For go and back = 2 x 11.88

= 23.76 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 18 x 110%

= 18 x 1.1

= 19.8 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 19.8 + 10% (19.8)

= 19.8 + 1.98

= 21.78 minutes

For go and back = 2 x 21.78

= 43.56 minutes

For 120 meter distance from **Pipe and boiler shop** (12) to slipways **no 1-3**, Standard time for transportation time 25 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 25 x 60%

= 25 x 0.6

= 15 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 15 + 10% (15)

= 15 + 1.5

= 16.5 minutes

For go and back = 2 x 16.5

= 33 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 25 x 110%

= 25 x 1.1

= 27.5 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 27.5 + 10% (27.5)

= 27.5 + 2.75

= 30.25 minutes

For go and back = 2 x 30.25

= 60.5 minutes

5.2.3 Flow of Material for the Second Alternative layout

Flow of material for second alternative layout is shown in figure 5.6. Flows of material for the second alternative layout are as following;

First track (green): Materials arrive at the shipyard by truck or by ship. If materials arrive by truck, it stores in warehouse plate.

Second track (green): If materials arrive by ship, it stacks in a place using carne with a capacity of 30 Ton. After stacking material, forklift with capacity 10 ton carry it to warehouse plate. The distance is 100 meter from transshipment to warehouse plate.

Third track (green): Forklift carries material from the warehouse to Zone 5 shop for shearing plate, bending plate, rolling plate and making frame and assembly.

Fourth track (black): After finished the work in third track from Zone 5, the material carried by forklift from Zone 5 to each slipways for ship repair process. The transportation distance is maximum 180 meter and minimum 33 meter.

Fifth track (red): Machine shop repair propeller shafts, tail shafts, intermediate shafts, rudder stocks and propeller. The maximum distance is 150 meter from machine shop to slipways. The minimum distance is 53 meter.

Sixth track (yellow): Pipe and boiler shop repair ballast pipe line system, fire pipe line system, cooling pipe line, fuel pipe line, fresh water pipe line, auxiliary pipe line and fuel tank. Pipe and boiler shop is close the slipways.

To improve the effectiveness of the use of equipment, facilities and manpower in the flow of material handling, it is necessary to determine a standard job and standard time. Standard time is derived by adding to normal time allowances. The following formula shows standard time.

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

Based on flow of material for fist alternative layout, transportation of plate performance rating used is as follows:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.
- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

Allowance based on research and experience 10% of normal time (Sukanto, 1986). The distance is 95 meter from **steel plate warehouse** (14) to **zone 5** shop no (17). Standard time for transportation time 18 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 18 x 60%

= 18 x 0.6

= 10.8 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 10.8 + 10% (10.8)

= 10.8 + 1.08

= 11.88 minutes

For go and back = 2 x 11.88 minutes

= 23.76 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 18 x 110%

= 18 x 1.1

= 19.8 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 19.8 + 10% (19.8)

= 19.8 + 1.98

= 21.78 minutes

For go and back = 2 x21.78

= 43.56 minutes

The distance is 33 meter from **Zone 5** (17) to slipways **No 14**. Standard time for transportation time 8 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 8 x 60%

= 8 x 0.6

= 4.8 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 4.8 + 10% (4.8)

= 4.8 + 0.48

= 5.28 minutes

For go and back = 2 x 5.28 minutes

= 10.56 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 8 x 110%

= 8 x 1.1

= 8.8 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 8.8 + 10% (8.8)

= 8.8 + 0.88

= 9.68 minutes

For go and back = 2 x 9.68

= 19.36 minutes

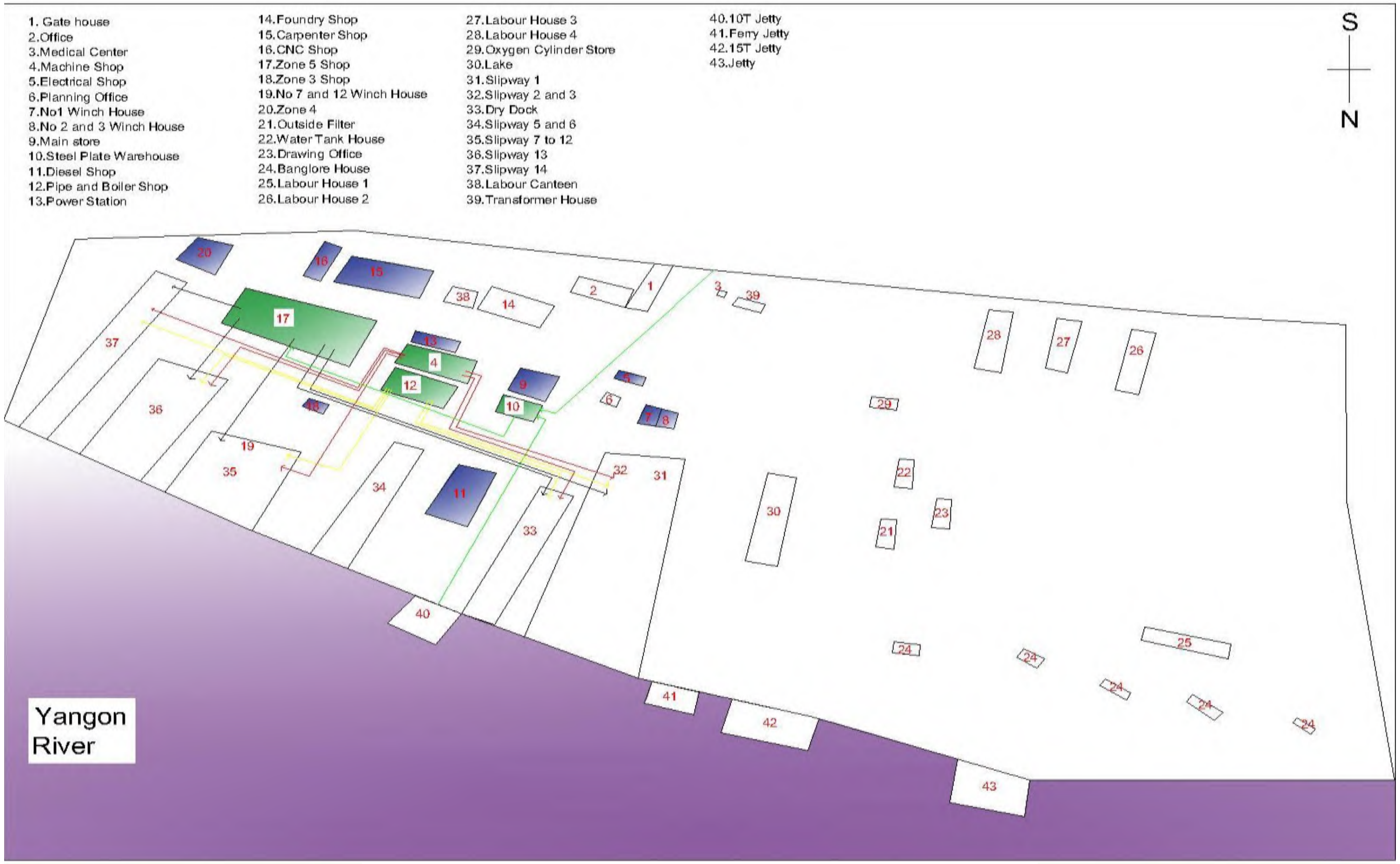

Figure 5.6 Flow of Material for Second Alternative

For 22 meter distance from **Zone 5** (17) to slipways **No 13**, Standard time for transportation time 5 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 5 x 60%

= 5 x 0.6

= 3 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 3 + 10% (3)

= 3 + 0.3

= 3.3 minutes

For go and back = 2 x 3.3

= 6.6 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 5 x 110%

= 5 x 1.1

= 5.5 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 5.5 + 10% (5.5)

= 5.5 + 0.55

= 6.05 minutes

For go and back = 2 x 6.05

= 12.1

For 70 meter distance from **Zone 5** (17) to slipways **No 7-12**, Standard time for transportation time 15 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 15 x 60%

= 15 x 0.6

= 9 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 9 + 10% (9)

= 9 + 0.9

= 9.9 minutes

For go and back = 2 x 9.9

= 19.8 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 15 x 110%

= 15 x 1.1

= 16.5 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 16.5 + 10% (16.5)

= 16.5 + 1.65

= 18.15 minutes

For go and back = 2 x 18.15

= 36.3 minutes

For 150 meter distance from **Zone 5** (17) to **dry dock**, Standard time for transportation time 30 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 30 x 60%

= 30 x 0.6

= 18 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 18 + 10% (18)

= 18 + 1.8

= 19.8 minutes

For go and back = 2 x 19.8

= 39.6 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 30 x 110%

= 30 x 1.1

= 33 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 33 + 10% (33)

= 33 + 3.3

= 36.5 minutes

For go and back = 2 x 36.5

= 72.6 minutes

For 180 meter distance from **Zone 5** (17) to slipways **no 1-3**, Standard time for transportation time 40 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 40 x 60%

= 40 x 0.6

= 24 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 24 + 10% (24)

= 24 + 2.4

= 26.4 minutes

For go and back = 2 x 26.4

= 52.8 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 40 x 110%

= 40 x 1.1

= 44 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 44 + 10% (44)

= 44 + 4.4

= 48.4 minutes

For go and back = 2 x 48.4

= 96.8 minutes

For 150 meter distance from **Machine shop** (4) to slipways **no 14**, Standard time for transportation time 30 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 30 x 60%

= 30 x 0.6

= 18 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 18 + 10% (18)

= 18 + 1.8

= 19.8 minutes

For go and back = 2 x 19.8

= 39.6 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 30 x 110%

= 30 x 1.1

= 33 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 33 + 10% (33)

= 33 + 3.3

= 36.3 minutes

For go and back = 2 x 36.8

= 72.6 minutes

For 100 meter distance from **Machine shop** (4) to slipways **no 13**, Standard time for transportation time 20 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 20 x 60%

= 20 x 0.6

= 12 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 12 + 10% (12)

= 12 + 1.2

= 13.2 minutes

For go and back = 2 x 13.2

= 26.4 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 20 x 110%

= 20 x 1.1

= 22 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 22 + 10% (22)

= 22 + 2.2

= 24.2 minutes

For go and back = 2 x 24.2

= 48.4 minutes

For 70 meter distance from **Machine shop** (4) to slipways **no 7-12**, Standard time for transportation time 15 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 15 x 60%

= 15 x 0.6

= 9 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 9 + 10% (9)

= 9 + 0.9

= 9.9 minutes

For go and back = 2 x 9.9

= 19.8 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 15 x 110%

= 15 x 1.1

= 16.5 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 16.5 + 10% (16.5)

= 16.5 + 1.65

= 18.15 minutes

For go and back = 2 x 18.15

= 36.3 minutes

For 95 meter distance from **Machine shop** (4) to **dry dock**, Standard time for transportation time 18 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 18 x 60%

= 18 x 0.6

= 10.8 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 10.8 + 10% (10.8)

= 10.8 + 1.08

= 11.88 minutes

For go and back = 2 x 11.88

= 23.76 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 18 x 110%

= 18 x 1.1

= 19.8 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 19.8 + 10% (19.8)

= 19.8 + 1.98

= 21.78 minutes

For go and back = 2 x 21.78

= 43.56 minutes

For 130 meter distance **Machine shop** (4) to slipways **no 1 - 3**, Standard time for transportation time 25 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 25 x 60%

= 25 x 0.6

= 15 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 15 + 10% (15)

= 15 + 1.5

= 16.5 minutes

For go and back = 2 x 16.5

= 33 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 25 x 110%

= 25 x 1.1

= 27.5 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 27.5 + 10% (27.5)

= 27.5 + 2.75

= 30.25 minutes

For go and back = 2 x 30.25

= 60.5 minutes

For 130 meter distance from **Pipe and boiler shop** (12) to slipways **no 14**, Standard time for transportation time 25 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 25 x 60%

= 25 x 0.6

= 15 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 15 + 10% (15)

= 15 + 1.5

= 16.5 minutes

For go and back = 2 x 16.5

= 33 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 25 x 110%

= 25 x 1.1

= 27.5 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 27.5 + 10% (27.5)

= 27.5 + 2.75

= 30.25 minutes

For go and back = 2 x 30.25

= 60.5 minutes

For 80 meter distance from **Pipe and boiler shop** (12) to slipways **no 13**, Standard time for transportation time 16 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 16 x 60%

= 16 x 0.6

= 9.6 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 9.6 + 10% (9.6)

= 9.6 + 0.96

= 10.56 minutes

For go and back = 2 x 10.56

= 21.12 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 16 x 110%

= 16 x 1.1

= 17.6 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 17.6 + 10% (17.6)

= 17.6 + 1.76

= 19.36 minutes

For go and back = 2 x 19.36

= 38.72 minutes

For 50 meter distance from **Pipe and boiler shop** (12) to slipways **no 7-12**, Standard time for transportation time 13 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 13 x 60%

= 13 x 0.6

= 7.8 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 7.8 + 10% (7.8)

= 7.8 + 0.78

= 8.58 minutes

For go and back = 2 x 8.58

= 17.16 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 13 x 110%

= 13 x 1.1

= 14.3 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 14.3 + 10% (14.3)

= 14.3 + 1.43

= 15.73 minutes

For go and back = 2 x 15.73

= 31.46 minutes

For 75 meter distance from **Pipe and boiler shop** (12) to **dry dock**, Standard time for transportation time 15 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 15 x 60%

= 15 x 0.6

= 9 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 9 + 10% (9)

= 9 + 0.9

= 9.9 minutes

For go and back = 2 x 9.9

= 19.8 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 15 x 110%

= 15 x 1.1

= 16.5 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 16.5 + 10% (16.5)

= 16.5 + 1.65

= 18.15 minutes

For go and back = 2 x 18.15

= 36.3 minutes

For 110 meter distance from **Pipe and boiler shop** (12) to slipways **no 1-3**, Standard time for transportation time 23 minutes are as following:

- The highest rating for the use of this type of equipment and manpower good level of proficiency: 60% to 80%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 23 x 60%

= 23 x 0.6

= 13.8 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 13.8 + 10% (13.8)

= 13.8 + 1.38

= 15.18 minutes

For go and back = 2 x 15.18

= 30.36 minutes

- The lowest rating for the use of this type of equipment and manpower sufficient proficiency: 110% to 120%.

$$\textbf{Normal Time} \quad = \frac{\textbf{Time worked}}{\textbf{No of unit porduced}} \times \textbf{Performance rating}$$

= 23 x 110%

= 23 x 1.1

= 25.3 minutes

$$\textbf{Minimum Required Time} = \textbf{Normal Time} + (\textbf{Normal Time} \times \textbf{Allowances})$$

= 25.3 + 10% (25.3)

= 25.3 + 2.53

= 27.83 minutes

For go and back = 2 x 27.83

= 55.66 minutes

5.3 Improved Material Handling System

One of the definitions adopted way back by the American Materials Handling Society is: Materials handling is the art and science involving the moving, packaging and storing of substances in any form. Material handling as such is not a production process and hence does not add to the value of the product. It also costs money; therefore it should be eliminated or at least reduced as much as possible. However, the important point in favors of materials handling is that it helps production. Depending on the weight, volume and throughput of materials, mechanical handling of materials may become unavoidable. In many cases, mechanical handling reduces the cost of manual handling of materials, where such material handling is highly desirable. All these facts indicate that the type and extent of use of materials handling should be carefully designed to suit the application and which becomes cost effective (Ray, 2008).

Material handling equipment has a very important role in the shipyard. There are four categories of material handling equipment, namely, conveyor, cranes and hoists, industrial vehicle and container. There are all or almost them in modern shipyard. But there are only a few parts of the equipment used in small shipyards to perform various production processes (Manfaat, 1990).

The material handling equipment help the ship repair process good well. If the alternative layout does not have a good material transfer, this layout is not good for production. This shipyard has a plan with good material transfer. Advantages of good material transfer are fall the rate of material damage by carrying material. It has to increase the efficiency of material received and delivery. This shipyard can be considered to get more support for material handling equipment. This shipyard has three mobile cranes but one mobile crane is damaged and two mobile cranes cannot use full efficiency. Therefore, this shipyard needs some material handling equipment. They are one mobile crane with capacity 30 Ton and one forklift with capacity 10 Ton.

5.4 Capacity Improvement

The first and the second alternative layout have steel plate warehouse. Therefore, material supply is enough stores for a year. The steel plate warehouse can be stored 600 (6 m x 1.52 m x 16 mm) sheets. The materials for expected no of ship repair are stored in warehouse plate for a year. Therefore, the docking time can be reduced because there is no waste time for waiting material supply. The following table 5.4 shows the list of plate for 2015.

Table 5.4 List of Plate for 2015 ship repair

No	Plate	Sheets	Ton
1	5 mm x 6 m x 1.52 m	215	78.41
2	6 mm x 6 m x 1.52 m	624	272
3	8 mm x 6 m x 1.52 m	341	194.83
	Total	1180	545.24

Source: Dalla shipyard

In addition, the first and second layouts have hydraulic shearing machine, a forklift and a mobile crane. Therefore, the shipyard must be reduced the propane and oxygen for cutting material because of shearing machine. The material transportation and lifting can be done quickly because of a forklift and a mobile crane. The existing forklift and crane is very old and capacity is very low. The requirements of material handling equipment in Dalla shipyard become increase because the shipyard has a plan to improve ship repair service. The following table 5.5 shows the capacity of machine.

Table 5.5 Capacity of Machine, Crane and Forklift

No	Name	No of Item	Capacity
1	Hydraulic Shearing Machine (8 mm x 3200 mm)	1	≥ 8 / min
2	Mobile Crane	1	30 Ton
3	Forklift	1	10 Ton

The comparison of the existing, the first and the second alternative layout are shown in the following table.

Table 5.6 Comparison for the Existing, the First alternative and the Second alternative

No	Item/ Facility	Existing Layout		First Alternative Layout		Second Alternative Layout	
		No	Capacity	No	Capacity	No	Capacity
1	Warehouse	-	-	1	600 Plates	1	600 Plates
2	Mobile Crane	2	< 10 Ton	1	30 Ton	1	30 Ton
3	Forklift	2	< 4 Ton	1	10 Ton	1	10 Ton
4	Hydraulic Shearing Machine	1	Not Workable	1	≥ 8 / min	1	≥ 8 / min
5	Machine Shop	1	127.38 minutes	1	127.38 minutes	1	71.28 minutes
6	Pipe Shop	1	67.98 minutes	1	67.98 minutes	1	60.72 minutes

The shipyard has to improve material handling equipment because existing equipment of capacity is very low. The existing layout and the first layout does not change required time because machine shop and pipe shop does don't change the location. The second alternative layout changed the location of machine shop and pipe shop to close the slipways for good flow of material. According to above the table, the shipyard has to choose the second alternative layout because the second is better productivity. According to calculation of the total required time compare with the existing layout, the first alternative layout and the second alternative layout. Transportation times of the first alternative layout for machine shop and pipe shop is same as transportation times of the existing layout for which because the machine shop and pipe shop in the first alternative layout is not re-located. Transportation times of the second alternative for the machine shop and pipe shop is different as the others layout because the machine shop and pipe shop is re-located. The transportation time of the second alternative is the shortest of all. The following table 5.7 shows the difference of required time for the existing, the first alternative and the second alternative.

Table 5.7 Minimum Required Time for the Existing, First and Second Layout

No	Layout	Total Distance	Total Required Time
1	Existing Layout	2098 m	293.04 minutes
2	First Alternative Layout	1948 m	271.92 minutes
3	Second Alternative Layout	1540 m	208.56 minutes

The second alternative is the shortest others. The required time difference of the first alternative is 21.12 minutes from the existing. After all additions and renovations shipyard above, expected productivity to be achieved. The average docking time is 33 days. Therefore, average docking time can be reduced 0.352 hours per day for each slipway.

For slipway 1 the average docking time = 33 day

Working hours per day = 8 hrs/day

For 33 day = 264 hrs

Therefore, it can be reduced 0.352 hours per day of transportation times because to reduced docking time.

264 hrs -11.616 hrs = 252/8 days=31.5 days

Then, the number of ship repair K = F1.F2.TC/H

K = 0.8 x 0.8 x 300 (274)/31.5

K = 1670 DWT

K = 1670/ 140

K= 12 vessels

For slipway 3, the average docking time = 43

Working hours per day = 8 hrs/day

For 43 day = 344 hrs

Therefore, it can be reduced 0.352 hours per day of transportation times because to reduced docking time.

344 hrs – 15.136 hrs = 328.864/8=41 days

Then, the number of ship repair K = F1.F2.TC/H

K = 0.8 x 0.8 x 300 (205)/41

K = 960 DWT

K = 960/ 57

K= 17 vessels

For slipways 4 (Dry dock) = 7 vessels

For Slipways 7, 12, the average docking time = 38

Working hours per day = 8 hrs/day

For 38 day = 304 hrs

Therefore, it can be reduced 0.352 hours per day of transportation times because to reduced docking time.

304 hrs – 13.376 hrs =290.6/8= 36 days

Then, the number of ship repair K = F1.F2.TC/H

K = 0.8 x 0.8 x 300 (462)/36

K = 2464 DWT

K = 2464/ 200

K= 12 vessels

For slipway 13, the average docking time = 20

Working hours per day = 8 hrs/day

For 20 day = 160 hrs

Therefore, it can be reduced 0.352 hours per day of transportation times because to reduced docking time.

160 hrs - 7 hrs = 153/8=19 days

Then, the number of ship repair K = F1.F2.TC/H

K = 0.8 x 0.8 x 300 (125)/19

K = 1263 DWT

K = 1263 / 120

K = 11 vessels

For slipway 14, the average docking time = 30

Working hours per day = 8 hrs/day

For 30 day = 240 hrs

Therefore, it can be reduced 0.352 hours per day of transportation times because to reduced docking time.

240 hrs – 10.56 hrs =229/8= 29 days

Then, the number of ship repair K = F1.F2.TC/H

K = 0.8 x 0.8 x 300 (274)/29

K = 1814 DWT

K = 1814 / 140

K= 13 vessels

The total vessels of first alternative from average docking time (31 days) are 72 vessels. The required time difference is 84.48 minutes or 1.408 hrs for second layout. Therefore, the second alternative supports to reduce docking time. After all additions and renovations shipyard above, expected productivity to be achieved. The average docking time is 33 days. Therefore, average docking time can be reduced for each slipway.

For slipway 1 the average docking time = 33 day

Working hours per day = 8 hrs/day

For 33 day = 264 hrs

Therefore, it can be reduced 1.408 hours per day day of transportation times because to reduced docking time.

264 hrs – 46.464 hrs =217.536/8= 27 days

Then, the number of ship repair K = F1.F2.TC/H

K = 0.8 x 0.8 x 300 (274)/27

K = 1948.4444 DWT

K = 1948.4444/ 140

K= 14 vessels

For slipway 3, the average docking time = 43

Working hours per day = 8 hrs/day

For 43 day = 344 hrs

Therefore, it can be reduced 1.408 hours per day because to reduced docking time.

344 hrs – 44.72 hrs = 299.28/8 = 37 days

Then, the number of ship repair K = F1.F2.TC/H

K = 0.8 x 0.8 x 300 (205)/37

K = 1063.7837 DWT

K = 1063.7837/ 57

K= 19 vessels

For slipways 4 (Dry dock) = 8 vessels

For Slipways 7, 12, the average docking time = 38

Working hours per day = 8 hrs/day

For 38 day = 304 hrs

Therefore, it can be reduced 1.408 hours per day because to reduced docking time.

304 hrs – 53.504 hrs = 250.496/8=31 days

Then, the number of ship repair K = F1.F2.TC/H

K = 0.8 x 0.8 x 300 (462)/31

K = 2861.4194DWT

K = 2861.4194/ 200

K= 14 vessels

For slipway 13, the average docking time = 20

Working hours per day = 8 hrs/day

For 20 day = 160 hrs

Therefore, it can be reduced 1.408 hours per day because to reduced docking time.

160 hrs – 28.16 hrs = 131.84/8=16 days

Then, the number of ship repair K = F1.F2.TC/H

K = 0.8 x 0.8 x 300 (125)/16

K = 1500 DWT

K = 1500 / 120

K = 13 vessels

For slipway 14, the average docking time = 30

Working hours per day = 8 hrs/day

For 30 day = 240 hrs

Therefore, it can be reduced 1.408 hours per day because to reduced docking time.

240 hrs – 42.24 hrs = 197.76/8=25 days

Then, the number of ship repair K = F1.F2.TC/H

K = 0.8 x 0.8 x 300 (274)/25

K = 2104.32 DWT

K = 2104.32 / 140

K= 15 vessels

The total vessels of the existing from average docking time (33 days) are 70 vessels. The total vessels of the second layout from average docking time (27 days) are 83 vessels. The forecast vessel is 58 vessels based on forecast calculation. To improve productivity the ship repair must work overtime above calculation. The rate of growth docking ship repair and maintenance is 70 /58 = 1.2 times. When compared with the result of docking (27 days), the rate of growth docking ship repair and maintenance is 83/58= 1.43 times. The forecast vessel 58 is the next year target vessel number. After reducing the docking times from 33 to 27, the rate of growth docking ship repair and maintenance is from 1.2 times to 1.43 times. The following table shows the ship repair number for the existing, the first and the second layout.

Table 5.8 Ship Repair for the existing, the First and the Second layouts

No	Layout	Number of vessels	Rate of Docking
1	Existing layout	70 vessels	1.2 times
2	First Alternative layout	72 vessels	1.24 times
3	Second Alternative layout	83 vessels	1.43 times

5.5 Investment Calculations for Shipyard Layout

For fist alternative layout, this layout adds renovation of buildings procurement of equipment and supporting facilities. Therefore, the expense budget recapitulation lists are as follows:

Table 5.9 List of Facilities and Equipment for First Alternative Layout

No	Shipyard Facilities	Cost (Kyats)
1	Renovation cost for Machine shop	30 million
2	Renovation cost for Zone 5	30 million
3	Building cost for Warehouse plate	90 million
4	Renovation cost for Carpenter shop	20 million
5	Renovation cost for Pipe and boiler shop	20 million
6	Renovation cost for slipway no 1 and 14	30 million
No	**Material Handling Equipment**	
1	Forklift Truck (10 Ton)	66 million
2	Mobile Crane (30 Ton)	121 million
No	**Machine**	
1	Hydraulic Shearing Machine	21.411 million
	Total	440.311 million

For second alternative layout, this layout adds renovation of buildings procurement of equipment and supporting facilities. Therefore, the expense budget recapitulation lists are as follows:

Table 5.10 List of Facilities and Equipment for Second Alternative Layout

No	Shipyard Facilities	Cost (Kyats)
1	Building cost for Machine shop	90 million
2	Building cost for Pipe and boiler shop	90 million
3	Renovation cost for Warehouse plate	30 million
4	Renovation cost for Carpenter shop	20 million
5	Renovation cost for Zone 5	30 million
6	Renovation cost for slipways no 1 and 14	30 million
No	**Material Handling Equipment**	
1	Forklift Truck (10 Ton)	66 million

2	Mobile Crane (30 Ton)	121 million
No	**Machine**	
1	Hydraulic Shearing Machine	21.411 million
	Total	548.9 million

The cost is calculated based on Myanmar Kyat Unit and current market price. Money changer price is based on Central Bank of Myanmar for changing US dollar to Myanmar Kyat Unit. One US dollar is equal 1170 kyats. Shipyard need above facilities, equipment and machine for increasing ship repair process.

5.6 Evaluation for Layout and Facilities of Shipyard from Economic Aspect

Economic feasibility helps shipyard assess the viability, cost, and benefits associated with projects before financial resources are allocated. It helps decision to determine the positive economic benefits to the organization that the proposed layout will provide, and helps quantify the problem. For fist alternative layout, the initial investment of shipyard is Myanmar Kyat K 440.311 million. Shipyard applies 50% (discount rate 12%) of investment for loan from bank and 50% (discount rate 14%) of investment is its capital money. The table 5.11 shows calculation of discounted Cash Flow (DCF) and Net Present Value (NPF) for first alternative layout. The average cost for ship repair is K 5 million per ship. First year forecast ship is 58. Therefore, first year revenue is 290 million.

After calculation of Discounted Cash Flow (DCF), the results show the payback period and benefit cost ratio. The payback period is 2018 and benefit/cost ratio is 1.19. The benefit/cost ratio is greater than 1. Therefore, the layout is advantageous for shipyard. The following table 5.12 show Payback period, Net Present Value and Cumulative Present Value. Positive cumulative present value is K. 83,516,000. The feasibility of the proposed layout generated economic benefits.

Description	0	1	2	3	4	5
Investment	440,311,000					
Revenue statement +		290,000,000	295,000,000	305,000,000	310,000,000	315,000,000
Another income (5% Fs) +		14,500,000	14,750,000	15,250,000	15,500,000	15,750,000
Total Forecast Revenue =		304,500,000	309,750,000	320,250,000	325,500,000	330,750,000
Miscellaneous expenses (3%) -		9,135,000	9,292,500	9,607,500	9,765,000	9,922,500
Operating costs (10% TFR) -		30,450,000.0	30,975,000.0	32,025,000.0	32,550,000.0	33,075,000.0
Net revenue (Netto)=		(264,915,000)	(269,482,500)	(278,617,500)	(283,185,000)	(287,752,500)
Tax 25% -		(66,228,750)	(67,370,625)	(69,654,375)	(70,796,250)	(71,938,125)
Cash Flow After Taxes		198,686,250	202,111,875	208,963,125	212,388,750	215,814,375
Discount rate (12%)		1.12	1.25	1.4	1.57	1.76
Discounted Cash Flow (DCF)		177,398,438	161,689,500	149,259,375	135,279,459	122,621,804
Total	440,311,000	177,398,438	339,087,938	488,347,313	623,626,771	746,248,575
Net Present Value		(262,912,563)	(101,223,063)	48,036,313	183,315,771	305,937,575
Benefit cost Ratio		0.402893495	0.770110076	1.109096326	1.416332481	1.694821558

Table 5.11 Calculation of Discounted Cash Flow (DCF) for First Alternative Layout

Table 5.12 First Alternative Results for Payback Period, Present Value and Cumulative Present Value

Year	Cash Flow	Present Value	Cumulative Present Value
	440,311,000		
2016	198,686,250	177,398,438	-227,432,875
2017	202,111,875	161,689,500	-101,223,063
2018	**208,963,125**	**149,259,375**	**48,036,313**
2019	212,388,750	135,279,459	183,315,771
2020	215,814,375	122,621,804	305,937,575

For second alternative layout, the initial investment of shipyard is Myanmar Kyat K. 548.99 million. Shipyard applies 50% (discount rate 12%) of investment for loan from bank and 50% (discount rate 14%) of investment is its capital money. The table 5.13 shows calculation of discounted Cash Flow (DCF) and Net Present Value (NPF) for first alternative layout. The average cost for ship repair is K 5 million per ship. First year forecast ship is 58. Therefore, first year revenue is 290 million.

After calculation of Discounted Cash Flow (DCF), the results show the payback period and benefit cost ratio. The payback period is 2019 and benefit/cost ratio is 1.13. The benefit/cost ratio is greater than 1. Therefore, the layout is advantageous for shipyard. The following table 5.14 show Payback period, Net Present Value and Cumulative Present Value. Positive cumulative present value is K. 74,726,771. The feasibility of the proposed layout generated economic benefits.

Description	0	1	2	3	4	5
Investment	548,900,000					
Revenue statement +		290,000,000	295,000,000	305,000,000	310,000,000	315,000,000
Another income (5% Fs) +		14,500,000	14,750,000	15,250,000	15,500,000	15,750,000
Total Forecast Revenue =		304,500,000	309,750,000	320,250,000	325,500,000	330,750,000
Miscellaneous expenses (3%) -		9,135,000	9,292,500	9,607,500	9,765,000	9,922,500
Operating costs (10% TFR) -		30,450,000.0	30,975,000.0	32,025,000.0	32,550,000.0	33,075,000.0
Net revenue (Netto)=		(264,915,000)	(269,482,500)	(278,617,500)	(283,185,000)	(287,752,500)
Tax 25% -		(66,228,750)	(67,370,625)	(69,654,375)	(70,796,250)	(71,938,125)
Cash Flow After Taxes		198,686,250	202,111,875	208,963,125	212,388,750	215,814,375
Discount rate (12%)		1.12	1.25	1.4	1.57	1.76
Discounted Cash Flow (DCF)		177,398,438	161,689,500	149,259,375	135,279,459	122,621,804
Total	548,900,000	177,398,438	339,087,938	488,347,313	623,626,771	746,248,575
Net Present Value		(371,501,563)	(209,812,063)	(60,552,688)	74,726,771	197,348,575
Benefit cost Ratio		0.323188992	0.617759041	0.889683572	1.136139135	1.35953466

Table 5.13 Calculation of Discounted Cash Flow (DCF) for Second Alternative Layout

Table 5.14 Second Alternative Results for Payback Period, Present Value and Cumulative Present Value

Year	Cash Flow	Present Value	Cumulative Present Value
	548,900,000		
2016	198,686,250	177,398,438	-371,501,563
2017	202,111,875	161,689,500	-209,812,063
2018	208,963,125	149,259,375	-60,552,688
2019	**212,388,750**	**135,279,459**	**74,726,771**
2020	215,814,375	122,621,804	197,348,575

5.7 Evaluation for Layout and Facilities of Shipyard from Technical Terms

The technical feasibility assessment is centered on the technical resources available to the organization. It helps organizations assess if the technical resources meet capacity and whether the technical team is capable of converting the ideas into working systems. Technical feasibility also involves evaluation of the hardware and the software requirements of the proposed system

For fist alternative layout, a simple technical aspect include workmanship factor. Ship repair processes include technical aspect that is labor, raw materials, equipment, road and environmental factors. The technical aspect is very influential in the smooth process of ship repair, for labor amounted to 51 people are still feasible because they meet the standards of small shipyard (50-150 workers) (Schlott, 1985), and raw material get from local. Propane, oxygen and wood get from local market. Steel plate and angle iron rock can be purchased in local market. Yangon region is economic area and development area of Myanmar. Therefore, shipyard gets all material from local market. For material handling equipment can be ordered through the sales agents of engineering tools in Yangon. Environmental factor can see due to the land of shipyard is 32.3 %. Therefore, the remaining 67.7% is to the preservation and further development environments. The shipyard increase ship repair process due to fill facilities and equipment for forecast ship repair.

The first alternative layout does not change layout of building and equipment but it fill additional features such as warehouse plate and renovation building. This layout refers to current layout but all of the criteria or factors above are seen.

For second alternative layout, a simple technical aspect include workmanship factor. Ship repair processes include technical aspect that is labor, raw materials, equipment, road and environmental factors. The technical aspect is very influential in the smooth process of ship repair, for labor amounted to 51 people are still feasible because they meet the standards of small shipyard (50-150 workers) (Schlott, 1985), and raw material get from local. Propane, oxygen and wood get from local market. Steel plate and angle iron rock can be purchased in local market. Yangon region is economic area and development area of Myanmar. Therefore, shipyard gets all material from local market. For material handling equipment can be ordered through the sales agents of engineering tools in Yangon. Environmental factor can see due to the land of shipyard is 32.4 %. Therefore, the remaining 67.6% is to the preservation and further development environments. The shipyard increase ship repair process due to fill facilities and equipment for forecast ship repair.

The second alternative layout change layout of building and equipment but it fills additional features such as warehouse plate and renovation building. Machine shop move to close the slipways and to reduce transportation time. Machine shop is close Zone 5 and Pipe and boiler shop. Therefore, second alternative layout is different from fist alternative layout. All of the criteria or factors above are seen. Company operates with the expectations set goals and objectives will be achieved.

5.8 Layout Selection from Alternatives

Before selecting the chosen alternative we need to know in advance Understanding the layout and the benefits of a good layout, is the layout according to Taylor (1995) is the layout of the entire facility owned by the company, where this arrangement includes the determination of the location of any existing department, layout engines (workstation), the location of the warehouse, hallway (corridor) and the whole a good working environment which shells are used or will be proposed. The layout of all elements of this facility needs to be done to ensure that the flow of work, raw material, or information worker walking / running smoothly in production systems.

There are several benefits to be obtained by the company, if the facility is owned already arranged with well, among others:

1. Material handling raw materials are minimal
2. Efficient use of space
3. Efficient use of labor
4. Eliminating congestion for the flow of materials.
5. Facilitate communication and interaction between workers and supervisors and workforce and customers.
6. Reducing the time required in the manufacturing process or to serve consumers.
7. Eliminate damage or excessive movements.
8. Facilitating the entry, exit and replacement of raw materials, product or person.
9. Ensuring the safety and security.
10. Giving priority to quality products and services.
11. Make it easy to carry out proper maintenance activities.
12. Will enable to control the operations or activities visually.
13. Providing the flexibility to adapt to environmental changes.

Policy formulation company-owned facilities are basically depends on the process to be used and depending on the characteristics of products to be produced.

It is usually tailored to the demand and the level of competition going on. Thus the choice of a layout will affect the election process, the volume and diversity of products, the level of interaction and components, the amount and type of equipment and the level of automation. The rules apply to employees, the vast space available, the stability of the existing system, and the purpose of the system.

Before choosing between two alternatives above need to know the power ratings between the two are as follows:

For fist alternative layout, strength of the first alternative must be considered is that does not many changes to the layout of the existing shipyard when compared to the second alternative. The layout of the first alternative is based on the layout of the shipyard original, only a few additional facilities, and the investment cost is not too high.

Weakness of this first alternative layout is not arranged properly. Warehouses plate and machine shop placed at the entrance of the shipyard and the distance between the workshops is still far apart.

For second alternative layout, strength of second alternative layout is prepared properly. Machine shop is located close to the zone 5 and pipe and boiler shop.

Weakness of second alternative is high investment cost than fist alternative layout.

Furthermore, we will take the decision to choose the best solution or selected based on the layout of the shipyard and evaluation based with technical and economic aspects. These two alternatives will have one of the best. According to the best results of the two alternatives above, we choose the second alternative. The second alternative layout is good organized. The flow of material is good than the first alternative. Therefore, second alternative layout is eliminating damage or excessive movements. According to calculations by the method of Discount Cash Flow (DCF) and Net Present Value (NPV) with system payback period, the second alternative is also feasible for Dalla shipyard project.

Criteria for the selection layout also refer to the Flow of Materials, using a new material handling equipment, material handling existing at this time. By determining the standard work time and standard time, the rating time taken by the level of skill that is used 60% to 80% (the highest rating for the use of this type of equipment and manpower good skill level). The following tables show required time difference and total track difference.

Table 5.15 Comparison of Required Time at Rate of Speed 60% to 80%

No	Layout	Total Distance	Total Required Time
1	Existing Layout	2098 m	293.04 minutes
2	First Alternative Layout	1948 m	271.92 minutes
3	Second Alternative Layout	1540 m	208.56 minutes

Table 5.16 Comparison of Required Time at Rate of Speed 110% to 120%

No	Layout	Total Distance	Total Required Time
1	Existing Layout	2098 m	537.24 minutes
2	First Alternative Layout	1948 m	498.52 minutes
3	Second Alternative Layout	1540 m	382.36 minutes

The revenue is the same amount for the first and the second alternative layouts. The revenue is based on ship repair forecasting for (2016-2020). But the cost is different for the first and the second alternative layouts. The first alternative layout is lower than the second alternative because second alternative layout has new building for machine shop and piping shop. But the first and the second alternatives are economically feasible because the shipyard got payback period in the project time (2016-2020). According to economic and technical considerations, both layouts are economically feasible, better flow of material and higher capacity of ship repair, compared to those in the existing one. The first alternative is economically feasible but the number of ship repair is lower than the number of ship repair of the second alternative. The total number of vessels repair for the first layout is 77 vessels, while the total number of vessels repair for the second layout is 89 vessels. Therefore, the second alternative is the best alternative in terms of economically feasible, good flow of material and perfect of technical term and the most number of ship repairs. Therefore, we choose the second alternative layout.

According to the above results, the shipyard needs to apply the second alternative layout for of shipyard capacity improvement. Therefore, the shipyard should allocate some financial investment to re-locate the machine shop and pipe shop, as well as a new buy the material handling equipment. For initial investment, the shipyard should be loaned 50 percent of initial investment from the government's bank. The 50 percent of initial investment is its capital money. The material handling equipment should be imported directly from foreign because tax is free for state owned enterprise.

This research focuses on ship repair and maintenance of Dalla shipyard in Yangon region. This research developed Dalla shipyard to improve total number of ship repair, the material handling equipment and facilities. The situations of the shipyard were calculated based on actual data from Dalla shipyard. However, we don't know future market volume and all of machine equipment actual capacity. This research use simple calculation. Further research can consider details about the planning layout and equipment at the workshops, it is necessary to further study.

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APPENDIX 1 A

CURRENT SITUAION OF DALLA SHIPYARD

Zone 5 shop

Mobile Crane

Winch

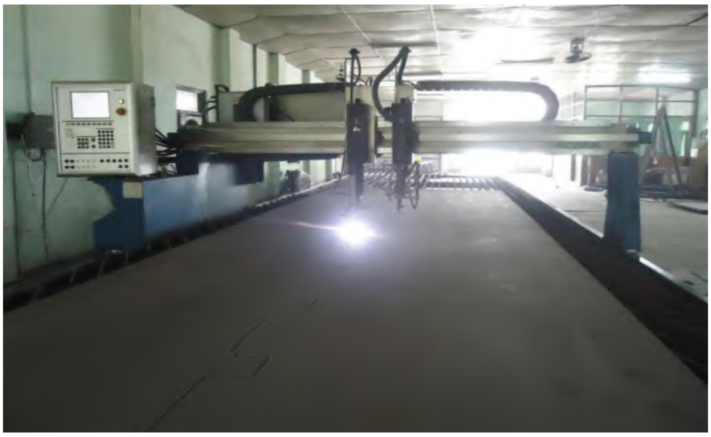
Steel Plate

No.1 Slipway

Dry Dock

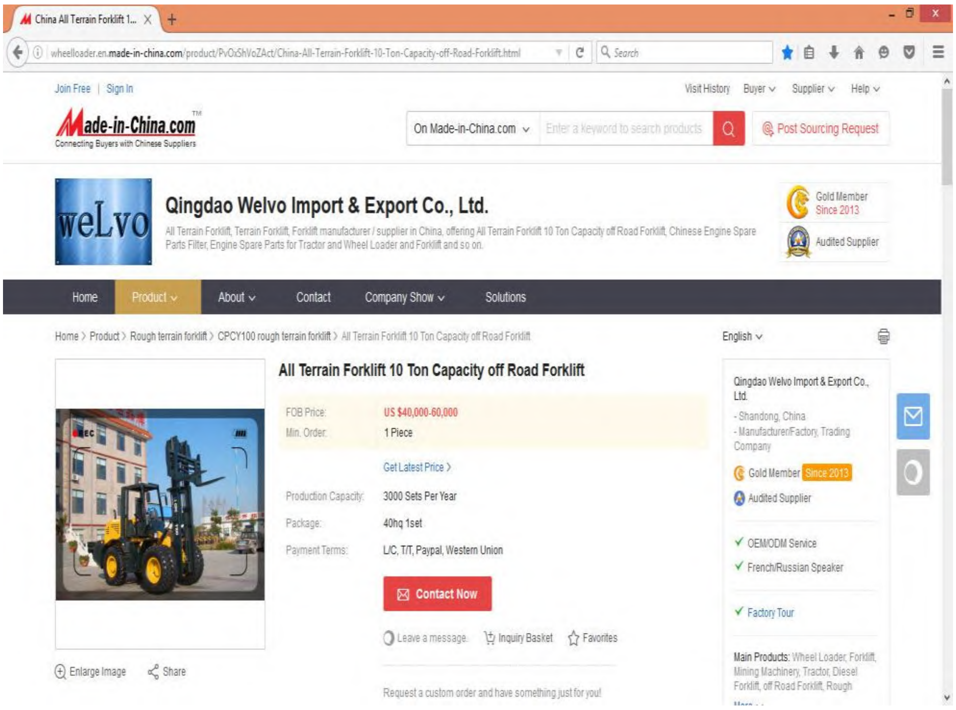
No 14 Slipway

15 Ton Jetty

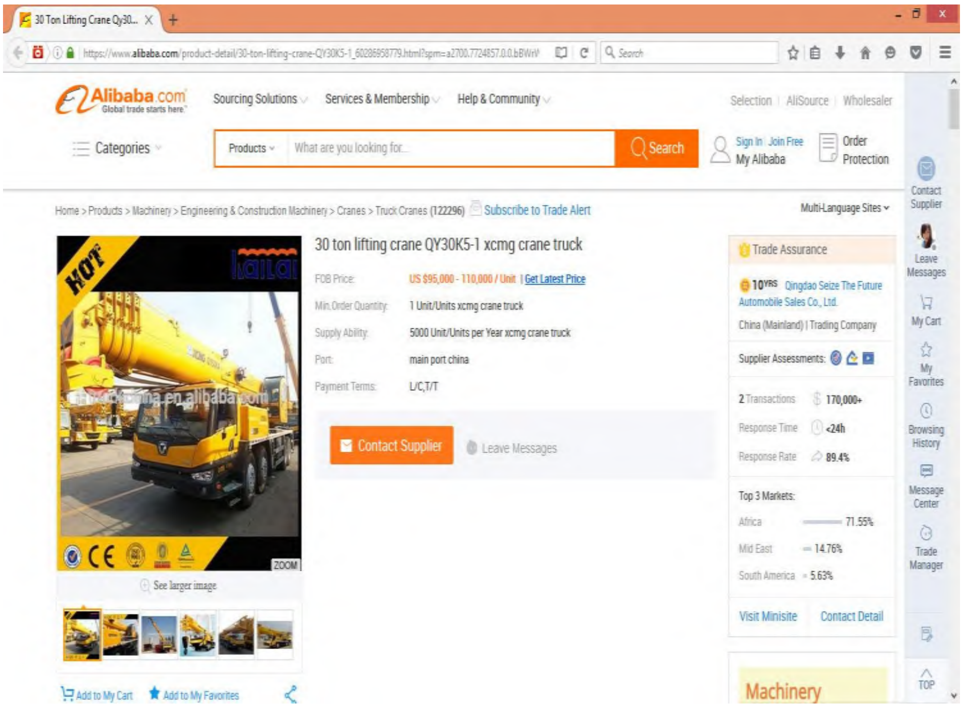


CNC Shop

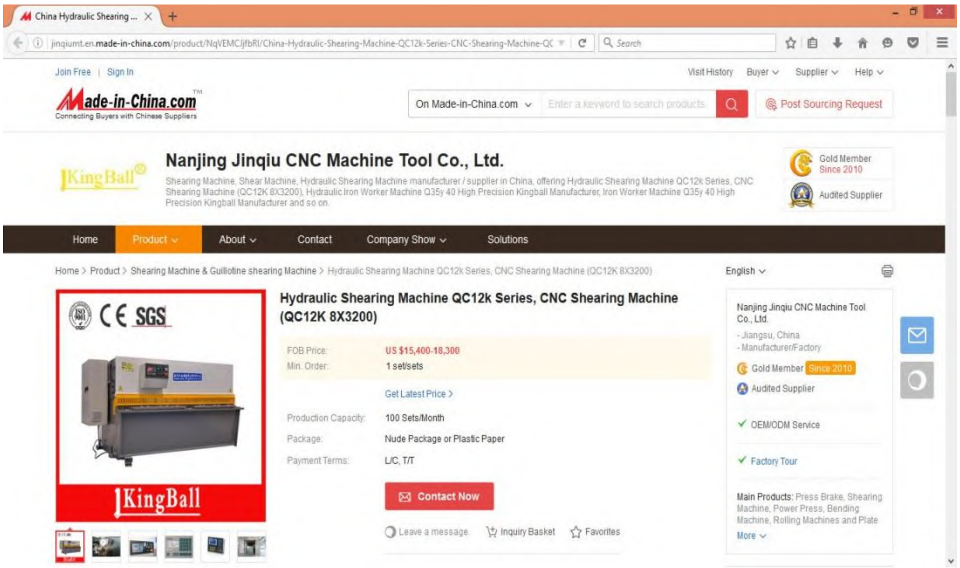
APPENDIX 1 B



Made-in-China.com
Qingdao Welvo Import & Export Co., Ltd.
All Terrain Forklift 10 Ton Capacity off Road Forklift
FOB Price: US $40,000-60,000
Min. Order: 1 Piece
Production Capacity: 3000 Sets Per Year
Package: 40hq 1set
Payment Terms: L/C, T/T, Paypal, Western Union
Contact Now



Alibaba.com
30 ton lifting crane QY30K5-1 xcmg crane truck
FOB Price: US $95,000 - 110,000 / Unit
Min.Order Quantity: 1 Unit/Units xcmg crane truck
Supply Ability: 5000 Unit/Units per Year xcmg crane truck
Port: main port china
Payment Terms: L/C,T/T
Contact Supplier
Qingdao Seize The Future Automobile Sales Co., Ltd.


China Hydraulic Shearing ...
jinqiumt.en.made-in-china.com/product/NqVEMCljfbRl/China-Hydraulic-Shearing-Machine-QC12k-Series-CNC-Shearing-Machine-QC
Join Free | Sign In
Visit History Buyer Supplier Help
Made-in-China.com
Connecting Buyers with Chinese Suppliers
On Made-in-China.com
Post Sourcing Request
Nanjing Jinqiu CNC Machine Tool Co., Ltd.
Gold Member Since 2010
Audited Supplier
Home Product About Contact Company Show Solutions
Home > Product > Shearing Machine & Guillotine shearing Machine > Hydraulic Shearing Machine QC12k Series, CNC Shearing Machine (QC12K 8X3200)
English
Hydraulic Shearing Machine QC12k Series, CNC Shearing Machine (QC12K 8X3200)
FOB Price: US $15,400-18,300
Min. Order: 1 set/sets
Get Latest Price
Production Capacity: 100 Sets/Month
Package: Nude Package or Plastic Paper
Payment Terms: L/C, T/T
Contact Now
Leave a message Inquiry Basket Favorites
KingBall
Nanjing Jinqiu CNC Machine Tool Co., Ltd.
- Jiangsu, China
- Manufacturer/Factory
Gold Member Since 2010
Audited Supplier
OEM/ODM Service
Factory Tour
Main Products: Press Brake, Shearing Machine, Power Press, Bending Machine, Rolling Machines and Plate
More

CHAPTER 6
CONCLUSION AND SUGGESTION

6.1 CONCLUSION

Based on the problems, objectives and discussion of the problem will be able to be concluded as follows:

1. Total weight score of IFE is 2.73 above 2.5 indicated that the company has a strong internal position. Total weight score of EFE is 2.59 above 2.5 indicated that the company has a high response to its external business environment. According to IFE and EFE, the shipyard faces strong business position in the market.
2. The first alternative layout have new steel plate warehouse, renovation for machine shop, carpenter shop, Zone 5 shop, pipe and boiler shop and slipways repair. The second alternative layout have new steel plate warehouse, new machine shop, new pipe and boiler shop, renovation for carpenter shop, zone 5 shop and slipways repair.
3. The first and the second alternative layout have the same material handling equipment and facilities. The additional facilities and equipment for the first and the second alternative are a mobile crane, a forklift and hydraulic shearing machine. But the layout of the first alternative is the different layout of the second alternative. Therefore, the first alternative for (31 days) is 72 vessels and the second alternative for (27 days) is 83 vessels. The rate of growth docking ship repair and maintenance is 1.43 times. After reducing the docking times from 33 days to 27 days, the rate of growth docking ship repair and maintenance is from 1.2 times to 1.43 times.
4. Ship repair forecasting based on actual data is the future ship repair capacity.
5. Re-layout is one of the best methods in the shipbuilding industry through re-alignment shipbuilding, renovations, additions material handling equipment.
6. Based on the feasibility study using the Discount Cash Flow, NPV (Net present Value) with system payback period where the proportion of loans with 50% (interest rate of 12%) and its own capital of 50% (interest rate of

14%), and an investment of K 440.311 million for the layout of alternative first, from results of calculations using the investment costs shows project viable and feasible, due to the return of capital contained in 3^{rd} year.

7. Based on the feasibility study using Discount Cash Flow NPV (Net Present Value) with System Payback Period in which the proportion of loans with 50% (interest rate of 12%), and its own capital of 50% (14% interest), and an investment of K 548.9 million for the layout alternative second, then the result of the calculation using the cost of these investments project viable and feasible, due to the return of capital are in 4^{th} year.

6.2 SUGGESTION

To achieve maximum results of improvement capacity of Dalla shipyard, the some following consider:

1. Re-layout shipyard need to be applied detail above analyzed.
2. Dalla shipyard need to change private organization.
3. To view details about the planning layout and equipment at the workshops, it is necessary to further study.

REFERENCES

Andjar Soeharto and Soejitno, (1996). "Shipyard", Publisher Faculty of Marine Technology ITS, Surabaya.

Arif, Mohammad Sholikan, (2014). Productivity Analysis of State and Non State Owned Shipbuilding with Multifactor Productivity Measurement, Faculty of Marine Technology ITS, Surabaya.

Celik, Metin, (2009). Fuzzy Axiomatic Design-based Performance Evaluation Model for Docking Facilities in Shipbuilding Industry: The Case of Turkish Shipyards, Applications 36:599–615.

Chabane, Hamid (2004). Design Of Small Shipyard Facility Layout Optimized For Production and Repair, Symposium International, Qualima01-Tlemcen.

Chaiwat, P (2012). Economic Feasibility Evaluation of Government Investment Project by Using Cost Benefit Analysis: A Case Study of Domestic Port Port A), Laem-Chabang Port, Chonburi Province. Available online at www.sciencedirect.com

Chiang, C Y (2014). An empirically-simulated investigation of the impact of demand forecasting on the bullwhip effect: Evidence from U.S. auto industry, www.sciencedirect.com.

Dana, B, G. (2012) SWOT analysis to improve quality management production, www.sciencedirect.com. Social and Behavioral Sciences 62 (2012) 319 – 324.

David, F (2015). Strategic Management Concepts and Cases, Fifteenth edition, http://www.pearsonmylabandmastering.com

DMA (Department of Marine Administration) 2014, Current Status on Safe Regulation of River Transport and Challenges in Myanmar, Seminar for Promoting River Water Transport in Myanmar.

Heger, Robert (2005). Dock master Training Manual, Preparation of a Pumping Plan , Heger Dry Dock, Inc.@ June.

Ikhsan, Muhammad (2015). A Study Rationalization of Shipyard in Riau Province, Thesis,Faculty of Marine Technology ITS, Surabaya.

Ilela, Daud (2010). Rationalization of Small Fish Shipyard in Maluku Province, Faculty of Marine Technology ITS, Surabaya.

IWT (Inland Water Transport), 2015.
Available Source: http://www.iwt.gov.mm/en/services-inland-water-Transport-iwt

Manfaat, Djauhar (1990). Material Handling Equipment Study in Small Shipyard, MSc Thesis Department of Ship and Marine Technology University of Strathclyde, Glasgow.

Ma'ruf, Buana (2006). Environmental-Based Strategic Management Model for Indonesia's Medium-Sized Shipyards, Published in The Journal of Ship Production, Vol. 22, No. 4, November.

Novizhilova, N. (2010) Use of SWOT Analysis for Insurer Risk Manger", the 10th International Conference "Reliability and Statistics in Transportation and Communication.

Rafiy, Muhammad (2015). Study of Improvement Fishermen Welfare Through Improved Productivity And Model Development In The Costal North Konawa, The International Journal of Engineering And Science (IJES), Vol 4, Issue 12: 62-67.

Ray, Siddhartha (2008). Introduction to Material Handling, National institute of Technical Teachers' Training and Research.

Schlott, H.W (1984). Plant Layout Equipment for Shipyard, Faculty of Marine Technology ITS, Surabaya.

Sople, V.V (2007). Material Handling Equipment: Exploiting Productivity Potential in Supply Chain, Article published in SEARCH, Vol 10, No.10, and October.

Sukanto, 1986, Production Management, Publisher BPFE, Yogyakarta.

Sundaravadivelu,R (2000). Design of Slipways Facility for Repair and Maintenance of Port Crafts, 4th international conference on coasts, ports & marine structure.

Storch, R.L (1995). Ship Production. The Society Naval Architects and Marine Engineers.

Shenoi, R. A (2007), Ship Production Technology, School of Engineering Sciences, University of Southampton, UK.

Taylor, F.W (1995). Production and Operation Management. Sri Joko, Muhammadiyah University, Malang.

Than, C (2009). Myanmar Shipbuilding, Naval Architects and Marine Engineers. https://spruz.academia.edu/CharlieThan.

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