

Departement of Aeronautic, Automotive
and Ocean Engineering, Faculty of
Mechanical, Universiti Teknologi Malaysia

Traditional Ship Production

Case Study in Kepulauan
Riau-Indonesia

Jaswar Koto and Syafwan bin Anah

Preface

Indonesia traditional ship is a product of an indigenous technology developed long before the advent of western culture along the Coast of Sulawesi Island. The ships are built traditionally in both method and equipment without any sketches or calculations. The building expertise is passed down from generation to generation, a knowledge that is further honed through daily practice with the help of each builder's instincts and natural gift. Still built by hand in the traditional manner, these majestic sailing ships are a living spirit of the golden age of sail, which ended in the West in the early twentieth century, but still thrives in the waters of Indonesia.

The beauty and efficiency is not a product of technical science, they are a product of the spiritual nature of these people and their culture. They are at one with their environment and they follow a path of least resistance in their lives and in their work. This philosophy contributes to the beauty and efficiency of their ship designs, and it comes from a basic and simple understanding of the world in which they live. This philosophy based nature and balance allowed the peoples of the Indonesian islands to produce solutions to practical challenges long before the societies of Europe were able to.

Alhamdulillah, I express my syukur to almighty Allah SWT for his preservation, sustenance, mercy, and wisdom for the successful completion of this book. Firstly, I would like to express my sincere gratitude to Special thanks is presented to Mr.Akun (Master) and his assistants from Kijang Traditional Shipyard, Mr.Amin (Master) and his assistants from Kelong Island Traditional Shipyard, Master and assistants from Mana Island Traditional Shipyard and warm and grateful thank you to Mr.Hikmat Andi for giving hands, time and fully support for this research. I feel greatly honoured and privileged to come across great students like Deah, Hendra, Mufti, Risandi, Eko, Sanusi and Siow. I take this opportunity to express my profound gratitude to all the special people who have been instrumental in the successful completion of this book.

Dr.Eng Jaswar CEng, CMarEng

Department of Aerospace, Automotive and Ocean Engineering
Faculty of Mechanical Engineering
Universiti Teknologi Malaysia

TABLE OF CONTENTS

PART	TITLE	PAGE
	TABLE OF CONTENT	
	LIST OF FIGURE	
PART 1	REVOLUTION OF SHIPBUILDING	1
	1.0 INTRODUCTION	2
	1.1 MODERN SHIPBUILDING INDUSTRY	10
	1.2 MODERN SHIP VARIETY	12
	1.3 TRADITIONAL SHIPBUILDING IN MALAYSIA AND INDONESIA	13
PART 2	SHIP PRODUCTION PROCESS OF TRADITIONAL SHIP	17
	2.0 INTRODUCTION	18
	2.1 SHIP CONTRACT	21
	2.2 TRADITIONAL SHIP PRODUCTION PROCESS	23

PART 3	TRADITIONAL SHIPYARD LAYOUT	37
3.0	INTRODUCTION	38
3.1	TRADITIONAL SHIPYARD LAYOUT	40
PART 4	COMPUTER APPLICATIONS IN TRADITIONAL SHIPBUILDING	45
4.0	INTRODUCTION	46
4.0	SOFTWARE IN SHIP DESIGN	50
4.2	COMPUTER APPLICATION IN SHIPBUILDING	52
4.3	RECOMMENDATION OF SUITABLE SOFTWARE FOR TRADITIONAL SHIPYARD	59
PART 5	PLANNING AND SCHEDULLING	61
5.1	INTRODUCTION	62
5.2	CRITICAL PATH METHOD	63
5.3	CRITICAL PATH METHOD IN TRADITIONAL SHIPBUILDING	65
REFERENCES		

LIST OF FIGURE

NO.	TITLE	PAGE
1	Bamboo raft	3
2	Long boat (Ceylon)	3
3	Log boat	3
4	Asian coracle	3
5	Abydos boat	4
6	Han Dynasty castle vessel	5
7	Latin sail use in the Muslim ship	7
8	The example of the Muslim ship	8
9	Model of galley in the period of Barbados Hardin	8
10	Samsung heavy industries shipyard	11
11	Traditional shipyard in Bintan Island	15
12	Sarawak River taxi	15
13	<i>Naga Pelangi II</i>	16
14	Cengal tree	27
15	Chainsaw use in the cutting process	28
16	Longitudinal main stiffener	29
17	Bottom buttock	30

18	Stem post	31
19	Stem post constructions process	31
20	Stern post of the traditional ship	32
21	Transverse framing system	32
22	Clamp is used to hold the strakes	33
23	Planking process	33
24	Hot bending technique	34
25	superstructure construction after the ship launched onto the river	35
26	Traditional shipyard warehouse	44

SHIP PRODUCTION TECHNOLOGY

PART 1: REVOLUTION OF SHIPBUILDING

JASWAR AND SYAFWAN BIN ANAH
FAKULTI KEJURUTERAAN MEKANIKAL

UNIVERSITI TEKNOLOGI MALAYSIA, SKUDAI, JOHOR

INTRODUCTION TO SHIPBUILDING

1.0 INTRODUCTION

Pre historic

A ship is one of the important transports that were used by a human to make a connection between different parts in the world. It has gone through a lot of evolution until we see the new era of shipbuilding nowadays. Shipbuilding is the term that refers to the activity involved in the ship construction process. It was done at the facilities known as a shipyard. Refer to the archaeologist, a pre historic human known as a homo erectus has reached an Indonesia archipelago at early of 800,000 years ago.

The archaeology evidence also proved on the 120,000 years ago a human presence at the Borneo island and they has reached them from the china mainland during the sea level is lower. This exploration needs a medium to move from one island to the other island, so the archaeologist has made a conclusion that the Homo erectus has built a boat to begin a journey. This shows that boat has been invented at the early age of human. The Homo erectus boat is defines as a simple boat because at that moment there were no devices that will help them in the process of boat making. So the archaeologist has made an assumption that they have used a bamboo as a main material because it easy to collect and it was workable with the blade stone.

After the Homo erectus era, the anthropologist has found the existence of the Homo sapiens and Neanderthals which has a better communication skill which can be used to spread the information and apply it for the daily benefit. The language and the abstract thought is the way of the communication that was used by them. The anthropologists also believe that the Homo sapiens have a better brain to solve any problem that they have face on that time. During this time the modern tool also has been invented such as axes or other iron based tools which can help them to improved design of a crude boat that were invented before by the Homo erectus.

The boat is built based on their function and material which is:

- Rafts is made from the bamboo
- Wooden boat is made from the timber. It has tapered shaped and odd number of a curved log has held together with sharpen wood pin.

SHIP PRODUCTION TECHNOLOGY

- Dugout canoes are produced from the hollow tree trunk and used an advanced tool like an axes. The stability of the boat is improved and they also apply a outriggers.



Figure 1 : a bamboo raft

Source: www.iro.unmontreal.ca



Figure 2: a long boat (Ceylon) source:www.iro.unmontreal.ca



Figure 3: a log boat source: www.iro.unmontreal.ca



Figure 4: Asian coracle source:
www.iro.unmontreal.ca

4th millennium BC

The Abydos boat which was constructed in Abydos is one of the early boats that were developed by the Egyptian. Refers to archaeological from the institute of America it was build from the planks of wood and it was assemble together to make a floating structure. According to the David O'Connor the Egyptologist from the university of new York, the

SHIP PRODUCTION TECHNOLOGY

woven straps was used to lash the plank together and the grass will be used to stuffed between the plank to help it seals the seam. The ship is about 75 feet long. The ships perhaps belong to the Pharaoh Aha because of the pottery jar that was found besides the vessel.



Figure 5: the Abydos boat source: www.en.wikipedia.org

3rd millennium BC

An ancient Indian also is one of the symbols in driving the development of the ship production. The relation between the Mesopotamia and the people at the India side of country also contribute to the ship building industry. There was one of the oldest docks which were located at the Indian Gujarat coast play a big role to the Harapan civilization and being a centre to the maritime trade between Mesopotamia and the other country. The ancient Indian was believed to be one of the maritime power at that time and the shipbuilding industry is the primary industry to the ancient Indian. They are also known because they have exported the teak wood which is used in the shipbuilding industry to the other countries such as Persia.

1st millennium BC

In this century a Chinese was try to take a place in the naval history. A Zhou dynasty has try built a floating fortress which is equipped with the decks and ramparts. This ship is called as castle ship. It was used in the war of china. The Han dynasty also introduced the technology of the junk ship.

SHIP PRODUCTION TECHNOLOGY

Medieval times

On this period the shipbuilding industry face a fast growing development. There a lot of improvement in the technique of the ship building process and also the instrument that was used during the ship making process. In the European side country, they were starting to develop a ship that was equipped with the rudder which was easy to use compared to the steering oar. There was also the development of the ship named galley which has both an oar and a sails. The first written information about the ship was writing by Michael of Rhodes who is the oarsman in Venetian in 1401. The treatise was written on 1436 covered a lot of aspect in the ship building process, a mathematics and also an astrology. On his treatise, he wrote about three types of galley and two types a round ship.

A china dynasty also plays a big role in the evolution of the shipbuilding. With advanced technology and philosophy, Chinese dynasties try to involve in the maritime world as a reason to make their country stronger and also as a new way to the merchant trade. The Han dynasty has developed a highly skill and highly technology navy. At one time a Han Dynasty could mobilize about 2000 castle ship and 200,000 seamen in one battle. A lot of type of the ship is constructing to meet the requirement for the battle at the sea. The castle ships become a symbol of the dynasty advanced shipbuilding. The developments of the shipbuilding technology during the Han Dynasty become the pioneer for the shipbuilding technique for the next dynasty.



Figure 6: Han Dynasty castle vessel source: www.historum.com

SHIP PRODUCTION TECHNOLOGY

In Tang and Song Dynasty, the ship building becomes more complex and matured. The complex techniques are applied to the ship such as mortise and tendon joint to make the ship more strength. It believes that this method is apply in china is 500 year compare to the European country. The artisan build a ship blue print based on the model and the function of the ship. The paddle wheel ship is improved by attached it at the both side of the hull and it increase the speed and solve the problem when the ship cannot easily sail against the wind and water.

Chinese dynasty has an interest in developing a great ship. A sung dynasty, a Yuan dynasty and also a Ming dynasty a construct a high quality ship and has a same level with the European. The vessel that was developed is larger in size to replace the usage of a small junk. With this achievement, they were able to reach the other side of the world. It was help the imperial china to increase a maritime trade until to the Egypt country. It is one of the big achievements of the china in the maritime world. They also have established the first official of the navy on the Sung dynasty period and it was help the growth of the seaport in the china such as in the Guangzhou and Fujian.

The climax in the shipbuilding industry is during the rule of the Ming Dynasty when there were a lot of ship is build by improve the technology from the Tang Dynasty and Yuan Dynasty. According to the some archaeology and history record, the distribution and the scale of the Ming Dynasty shipbuilding yards represent the highest level in the shipbuilding industries. The other industries related to the ship building also show the growth at that moment. A sails, ropes, nails and other parts of ship is produce by the small scale of workshop. It also applies a simple ship management system such as check, repair and payment of the ships. It provides job opportunities to the Chinese citizen. The great achievements of the Ming dynasty represent the contribution of the Chinese people to the human civilization

A history of the India in the maritime world exists when it was a trade relation between Indian countries with the Mesopotamia. As a main spice exporter, Indian has a relationship with the western country. The Indian commercial connection with the South East Asia proved the vital role of the Arab merchant during 7th to 8th centuries. The wealth of the india has become the main reason for the exploration of the Vasco da Gama around the Indian oceans. Shipbuilding industry become well establish around to coastline of Indian

SHIP PRODUCTION TECHNOLOGY

Ocean due to the trade activity at the Indian Ocean. It was contribute to the high level of the maritime activity at along India coastline. A ship craftwork by a local craftsman is more famous because of their quality and price is cheaper compare to the European counterparts.

A growth of the shipbuilding industry in the Islamic world is also interesting to be discussed. The growths of the maritime industry in the Middle East and also around the Indian Ocean become symbols of the maritime trade from the East Africa to South East Asia and the ports of Sindh and India during the Abbasid period. The Arab Muslim is known because of their superior knowledge in the shipbuilding technique. With this knowledge they were dominate the Mediterranean Sea and half of the divided world. A Muslim becomes one of the maritime nations during the Mu'awiyah's rule, the fifth caliph. The Byzantine navy was established and become the strongest navy in the Mediterranean Sea. They were unchallenged because of the number of ship that they have.

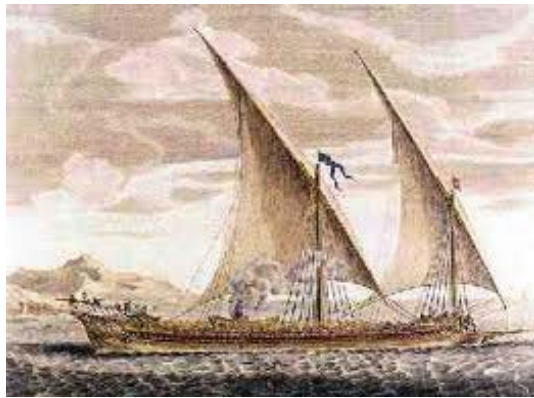


Figure 7: latin sail use in the muslim ship source: www.shoretchonology.com

The Latin sail is one of the advance techniques that apply by the Muslim in the shipbuilding. The usage of this sail is replacing the function of the carrack which is simple square sail. The Latin sail is more effective and efficient and it gets the intention from the Europe. The Indi Ocean is one of the most adventurous oceans in the world. With the high challenging navigation skill needed during sailing in the Indi Ocean, the Muslim technology is very suitable and practical. The galley which had formally been the main method of long range seafaring is not displaced but Muslim did not use the galley very much. So the European people has improved the take the technology of the Latin sail and improved it. That why the European are able to make a great journey until the finding of

SHIP PRODUCTION TECHNOLOGY

America and other part of the world because the benefit from the Indian Ocean technology that was invented by the Muslim people. It proved that Muslim is one of the greatest maritime powers during that time.



Figure 8: the example of the muslim ship

source: www.turkishculture.org

On 1170 AD Salahudin al-Ayubi has give an order to build a ship body part at the Egypt port. He also has given an order to build a port fort the Muslim navy to repair and construct a war ship that will be used in the war against the crusader team. Superiority of the shipbuilding industry also happens until the Othmani era. Government Othmani make Istanbul as a center of the navigation. Sultan Muhammad II was set up the Golden Horn Ocean as the centre of maritime industry and weapons stores. Uthmani rule also managed to build ships at Gallipoli Maritime Arsenal. Under an order from Gedik Ahmed Pasha (1480), Dawlah Uthmani has developed their naval strength in Istanbul. Therefore, not surprisingly, the Turkish army navy dominated the Black Sea and dominate Otranto.



Figure 8 : a model of galley in the period of Barbados harydin source : www.turkish.org

SHIP PRODUCTION TECHNOLOGY



Figure 9: ottoman galley in the ottoman rusian war 1737 source : www.turkish.org

A Malay peninsula and Indonesia is known as the Indonesian archipelago. It is one of the maritime powers at that time. With the importance of the Malacca straits, a lot of the maritime power tried to come to the Indonesian archipelago. A European came to south East Asian with the reason of the spice trade but the main intentions are to spread the Christianity among the people in this region. Arab merchant also come to Malacca to trade a spice and to spread Islam among the people. Malacca has become one of the important ports during that time. A traditional craftsman has set up an own workshop for the purpose of the ship repair.

At the early time, a ship building in the Malay and Indonesia archipelago was started with the wooden boat that was used to a daily usage. But after the arrival of the European trader, they also bring a technology to improve the productivity and function of the ship. After the arrival of the trader the shipbuilding industry have face a growing and it help a people to start a journey around the world.

Industrial revolution

An industrial revolution makes a lot of change to the maritime world. A demand of the raw material from the other part of the world has made a shipping industries become a very high profit industries. The increase a number of loads that was carried by the ship, it has change the material of shipbuilding from to the iron. Some parts of the ship need to be more strength compare to the other part. With the iron based frame it will long lasting and save a cost of construction. Steel also supplanted wrought iron when it became readily available in

the latter half of the 19th century, providing great savings when compared with iron in cost and weight. Wood continued to be favoured for the decks, and is still the rule as deck covering for modern cruise ships.

1.1 MODERN SHIPBUILDING INDUSTRY

Ship building industries become high income industries nowadays. A lot of high skill workers need for every day to support the growth of the industries. A nation also needs to develop their own technology to secure the strength of their country. A maritime power is one of the factor that need to be consider if we want to become a develop country.

Every day a lot of goods, material or equipment that was transport using a ship. A low cost of transportation and also a number of quantity become a factor why the shipping is still become a main reason for the transportation. Shipbuilding is therefore an attractive industry for developing nations. Japan used shipbuilding in the 1950s and 1960s to rebuild its industrial structure; South Korea started to make shipbuilding a strategic industry in the 1970s. History china shows that they have tried to be the maritime power before. China is now in the process of repeating these models with large state-supported investments in this industry.

South Korea become a world largest in the world, they have won a lot of contract for the tanker and also for the other type of ship especially the large sized container ship. It is because the effectiveness and efficiency of their shipyard. Nowadays, quality of the shipyard has played a vital role in selection of the shipyard by the ship investor. Quality is determined by the time management and also the other aspect. The world's largest shipyard in Ulsan operated by Hyundai Heavy Industries slipping a newly-built, \$80 million vessel into the water every four working days. There were three major shipbuilders in South Korea which is Hyundai heavy industries, Samsung Heavy industries and Daewoo shipbuilding and heavy industries.



Figure 10: Samsung heavy industries shipyard

Source: www.maritime-conector.com

A china try to compete with the south Korea but china is limited to win a contract for a medium and small size container ship based on their cheap price. The other country like Europe and Japan are still try to improve their performance in shipbuilding but it still consider small amount compare to the South Korea.

Modern technique in shipbuilding technology

Nowadays a lot of new technologies were explored to increase the quality of ship and also because of the safety purpose. A century ago, most of the part in the ship is build from the high quality wood, but nowadays due to the lack of the material the shipbuilder has change a material to the steel based material which is more quality compare to the wood. A cost factor also is the major factor in the selection of the ship material.

The modern ship construction technique is done by prefabricated section. Each section of the ship body part will build differently at the different place or other shipyard. Then the entire ship body will assemble in the determine slipway or yard. So the less effort required once the hull is weld together. This process is known as a block construction.

Ship design process is more easily because there was a lot of analysis software that were used to evaluate each design before the real construction is started. We can know the

weakness of each design and can be fixing before the real production is done. It really saves cost and time.

1.2 MODERN SHIP VARIETY

Nowadays a maritime sector has become one of the important industries. A demand from the users has increase due to the increase of the population in the world. The most modern ship is design with their own specification to meet up their requirement in the industry. Some of the ship is build with the specific capacity and there is also a ship that is build which is to meet the specific function.

Two types of ship may be class into two main areas which is profit area such as a merchant ship and the other is a service or non profit area such as a military service or community service which is usually owned by the government. The merchant ship can be categorized in the four types of ship which is bulk carrier ship, general cargo ship, tanker and passenger ship. Each types of ship have it owned specification and limitation based on the function and needs.

Bulk carrier Ship

At the early aged this type of the ship is using a sail and also the oarsmen as a medium of ship propulsion. Due to the transition from the medieval time to the industrial revolution, the ships also need a special modification to increase a ship power and to reduce the effect human effort. The high speed ship is very crucial on that time because of the industrial needs. At the early stage of development the machinery openings is protected by the enclosed bridge structure. The fore castle is build at the forward ship and the poop is introduced at the after end for the protection. This is called as a three island type. The size of the bulk carrier often will be referring for the classification by the following:

- Handy size (the smallest bulk carrier between 10000 and 30000 deadweight)
- Handymax (bulk carrier between 35000 to 50000 tonnes deadweight)
- Panama (designed to be maximum at the panama canal and being under 80000 tonnes deadweight)
- Capesize (size of ship is 80000 to 150000 tonnes deadweight and operation for around the atlantic through the cape of good hope)

SHIP PRODUCTION TECHNOLOGY

General arrangements of a bulkhead usually show a clear deck with machinery aft. For the loading and discharge cargo process, the steel hatch is design to help the process.

General cargo ship

The cargo ship is a carrier of a good, material or anything from the part of the world to the other part of the world. Cargo ships are usually specially designed for the task, often being equipped with cranes and other mechanisms to load and unload, and come in all sizes. The general cargo ship usually bring the garment, a motor vehicle and others general area. A dry cargo ship will be categorized based on the size and the weight and capacity of the ship.

Tanker

Tanker is design as a special purpose ship. This type of ship is used as a liquid carrier for the petroleum, liquefied petroleum gas and the other chemical substance. General arrangement of the ship is concentrated at one place of the ship to provide the clear the view of the crew man. It will avoid an accident occur. Location of the accommodation at one area is more economic from a building of view, since all services are only to be provided at the single location. Due to the disaster that cause by the Exxon Valdez in the 1989, the tanker is vital to comply with the MARPOL requirement. United State has suggested that in the MARPOL convention should be amended to make double hull compulsory for the new tankers.

1.3 TRADITIONAL SHIPBUILDING IN MALAYSIA AND INDONESIA

Traditional shipbuilding is still exist in South East Asia especially at in the Malays origin country such as Indonesia and Malaysia but the number of traditional shipyard is diminishing according to the fast expanding of the technology and the progression of the modern shipyard. Today's the traditional ship is not become the main industries because they are develop only for the purpose of tourism, small fishing vessel and leisure activity. If the there were no preservation, the unique and creative traditional ship industry will become extinct and the young generation will do not acknowledge about the function of the traditional ship.

Wood is the main material for the traditional ship. In Malaysia and Indonesia, mostly of the traditional ship is construct using a Kayu Chengal or known as Kayubesi in Indonesia. The other types of wood also is apply to the traditional ship such as Kayu resak (*Shorea spp*)

as it easy to find and the prices of this type of wood is considered low compared to the Kayu Chengal.

The production process of the traditional shipyard is still outdated because there a less shipyard that have the expertise to increase the productivity and quality of the final product. The machinery of tools is relying on the traditional approach and there are no standard procedure is applied during the production process. Even though, traditional shipyard is still far from the advance technology, but the craftsmen are able to produce the great ship. They are just depends from the experience and knowledge that is inherit from the previous generation. With the helps from the traditional tool and the loyal worker, the traditional shipyard is still relevant today's as their construction skill is priceless and useful.

There a many types of traditional ship that exist at Malaysia and Indonesia varying from the size and purpose of the ship. The big size ship is usually used as a fishing vessel or as a yacht, is known as Perahu Besar or in the specific named as a *Bedar* in Terengganu and *Phinisis* of Indonesia. For the small size of ship or boat, it used as the inland transportation that connect the people from the rural area. As the source of material is decrease today, the traditional shipyard has a problem in managing their resource and to produce the competitive ship in terms of price. Time factor also influence the ship owners to not choose the traditional ship as it take a long time to get complete.

- **Traditional Shipyard in Indonesia**

Indonesia is one of the maritime country as it geographical factor which has surrounded by a sea and consisting a thousand of big and small island. Marine transport is one of the options as a transportation to move from the place to other places. Overall, Indonesia has more than 17,508 islands with an area of sea and river waters more than 75% and reached 81,000 km of coastline (Kusumaatmadja, 1995 in Saputra et. al 2012). It shows that marine transport is the best choice of transportation.

Traditional shipbuilding in Indonesia still exists until today. Characteristic of the Indonesia traditional ship is different according to the each territory (Hadi 2010 & Firman et. al 2009 in Saputra et al 2012). A lot of factor influence the design of the traditional shipyard such as cultural and religion factor. This factor has contributed to the creative traditional shipbuilding.

SHIP PRODUCTION TECHNOLOGY

Riau Archipelago is one of the areas where it still has the existing traditional shipyard in Indonesia. Kijang –Bintan Island, Kelong Island and Mana Island is the example of the place where the traditional ship is build.



Figure 11: traditional shipyard in Bintan Island

- **Traditional Shipyard in Malaysia**

In Malaysia, the traditional shipyard is still exist even the number of the shipyard is decrease recently. The usage of the traditional ship is now only focus as the inland waterways transportation. In Sarawak, the small traditional ship is used as the transport to connect the people from the rural area with the nearest town as the alternative for the land transportation. Small traditional ship knows as sampan also are used as the tourism attraction by introduce the tourist with uniqueness of Malaysia. In Sarawak, the traditional sampan is used as the river taxi to bring the tourist across the Rajang River.



Figure 12: Sarawak river taxi

Source: <http://traditionalboat.blogspot.com/>

SHIP PRODUCTION TECHNOLOGY

In Malaysia, the traditional shipyard is concentrated at east coast of Malaysia especially at Pulau Duyong. The number of traditional shipyard in Malaysia is decrease nowadays, refers to the article of traditional shipbuilding in Terengganu writing by Eng. Chin Mee Poon in Jurutera July 2009, the number of shipyard in Pulau Duyong is decreasing from 40 of shipyard from one time and now there are only 3 shipyard existed in Pulau Duyong.

The traditional Shipyard in Pulau Duyong has known as their high quality of ship that they are produce. On 2003, the traditional Shipyard owned by Hasni Che Ali, one of the master traditional ship craftsmen in Pulau Duyong has started the construction of *Naga Pelangi II* worth RM 2 million. This *Naga Pelangi II* is owned by German people named Cristoph Swoboda. *Naga Pelangi II* is classed as a phinis boat and is a small version of galleon. It was built with the Kayu Chengal as the main material and it took 6 years to complete. Reported by Bernama, Swoboda has attracted with the creative and high skill craftsmen in the traditional ship construction where there are no nail were used instead of locks and mortise to join the part. It shows the high recognition of the foreigner to the Malaysian Craftsmen ability.

Due to the expanded of the Malaysia economy and technology, the traditional shipyard is forgetter and it believe the number will decrease if there are no further step is taken to preserved the traditional ship making industry. The young generation are not attracting to learn about the construction of the traditional shipyard and it may nobody will inherit those priceless skill.



Figure 13: *Naga Pelangi II*

Source: <http://maritime.bernama.com/news.php?id=553302&lang=en&cat=ex>

SHIP PRODUCTION TECHNOLOGY

PART 2: SHIP PRODUCTION PROCESS OF TRADITIONAL
SHIP

JASWAR AND SYAFWAN BIN ANAH
FAKULTI KEJURUTERAAN MEKANIKAL

UNIVERSITI TEKNOLOGI MALAYSIA, SKUDAI, JOHOR

SHIP PRODUCTION PROCES

2.0 INTRODUCTION

A process of construction of a ship is very complex. A ship owner and investor have invested a lot of fund to make sure the ship that they will build is fulfilling their requirement. The main function of the ship as a commercial vehicle and military purpose that will used as a defend asset for any nation. The commercial ship will be classes on three categories which is cargo ship, passenger ship and special purpose ship. As a ship owner they will need the best possible returns for their cost and investment. A lot of factor need to be consider by the ship owner before making a decision to build a suitable ship for their business. A decision must be made within the consideration of the ship task, ship capacity and the world economy environment. Any wrong decisions that have been making will cause a lost a lot of money and it will affect the business such as a reputation of the ship yard.

A lot of process and manpower will be involved in the ship making process. The designers must be fully recognise where these exist and the resulting limitation and risk so that improvement and refinements can be made later in the design process. A previous design and data is important during determining the capacity of the ship. this data will decrease a time to make a research on each part of the ship. It is important the people involved in the ship production to follow all the flow of the process in order to avoid a delay of the ship delivery that will affect the profit of the company.

A ship owner should employ their own technical staff to prepare the tender specification and they are needed to submit it to the shipbuilders who wish to tender for building the ship. Consultant will assist the owner in evaluating the tender and oversees the tender on their behalf.

Preliminary design

During process of determination the design of the ship, a ship owner and also an investor will discussed with the ship design consultant to find the best design that will suit the requirement of the business. A propose the design based on the information provided by the ship owner. the design and specification of the ship will be determine by the :

- I. Dimension
- II. Displacement

- III. Stability
- IV. Propulsive characteristic and hull form
 - V. Preliminary general arrangement
- VI. Principle structure details.
- VII. Geography origin of the vessel.

Dimension

Capacity of the ship will be evaluate to determine the dimension of the ship. The dimension of the ship will based on the length (L), beam (B), and depth (D) which is distance between the crown of the weather deck and the top of the keelson. When the length of the ship is increase, it will also increase the bending stress of the ship. So the capacity of the ship is very important in design the ship structure. If the length increase it will increase a cost because more material needed hence it will increase the cost of shipbuilding. Depth of the ship will control by draft and also the statutory freeboard. When the depth of the vessel is increase it will caused the longitudinal bending stress of the ship increase.

The depth of the ship was influenced by the routes and area operation of the ship. The geography condition at the area of the operation of the ship will affect of the ship depth. The depth of water is important to ensure the safety of the ship and to avoid any condition that will cause an accident. The ship that will operate at the certain canals need the specific specification and this will place a limitation to the dimension of the ship. The ship that will used the Manchester canal has limitation on their main dimension the bridge that is build across the canals will give a limitation to the height above the waterline. A Suez canals apply a limit draft for the ship and the locks in the panama and St. Lawrence has set up a limit length. Beam and draft to the users.

Displacement

A displacement of the ship is a total of the lightweight and deadweight. A lightweight is a total of the weight of the vessel as a built, a boiler system, lubricating oil and the other system involve in the operation of the ship. Hence the deadweight is defines as a different between the lightweight and loaded displacement such as a weight of cargo, weight of fresh water and the total crewman in the ship.

Stability

The weight distributions on the vessel are important and contribute to the stability of the weight. A load distribution factor is very important in the arranging the ship layout. Beam and the depth is main factor influences' the dimension static stability.

Propulsive performance

The hull performance will determine the weight of the ship. The design of the hull will decrease the resistance of the ship and increase the speed of the ship. A speed is a main issue today regarding in design of the ship. During designing process of the hull even the speed is very important but the cargo capacity should be maintained.

The definition of the service speed is a normal speed of the ship at the open sea under the good weather condition. The trial speed is obtained by apply a maximum power over a measured course in calm weather with the clean hull and specific load condition.

Preliminary general arrangement

During designing an arrangement at the respective ship, a ship builder should make a discussion with the representative from the shipboard employer and it should the shipboard crew requirement. The arrangement should make the crew feel comfortable using working in the ship but it must obey the regulation by the various authorities. A standard requirement of the must be kept in mind during making an arrangement.

Principle structure details

Structure of the ship is very crucial to make sure the safety of the ship. it should comply the thickness and material requirement by the classification societies. In the modern ship design, the analysis and the calculation of the ship structural will be carried by the computer software. It will produces a prediction data that will consider in determine the material and design of the ship structure. The design should comply with the classification society regulatory such as Lloyd's Register. Lloyd's Register is one of the oldest classification societies in the world.

2.1 SHIP CONTRACT

A shipbuilder will prepare a contract which is containing a technical specification of the ship for the approval of the ship owner or his behalf. This technical specification will consider as a contract between the two people and it should have the legal status. The contract should cover following information:

- i. A description of the characteristic of the ship
- ii. A principle dimension
- iii. Deadweight or capacities
- iv. Speed and power requirement
- v. Quality requirement
- vi. A certificate
- vii. Stability requirement
- viii. Trial condition
- ix. Accommodation detail
- x. Machinery detail requirement
- xi. Equipment that need to be installing
- xii. Electrical installation

Normally the shipbuilding contract will follow one of the standard contract which is develop by the establish association. It will make sure the similarity and standardise form in the contract relationship between the shipbuilder and the purchaser. The societies that establish the contract is:

- a) AWES (association of West European Shipbuilder)
- b) MARAD Maritime Administration USA
- c) SAJ (Shipowners Association of Japan)

One of the standard forms of the contract that prepared by the AWES should contain:

- i. Subject of contract
- ii. Inspection and approval
- iii. Modification
- iv. Trials
- v. Guarantee
- vi. Delivery of the vessel
- vii. Price

SHIP PRODUCTION TECHNOLOGY

- viii. Property
- ix. Insurance
 - x. Defaults by the purchaser
 - xi. Defaults by the contractor
 - xii. Guarantee after delivery
- xiii. Contract expenses
- xiv. Patents
 - xv. Reference to expert and arbitration
- xvi. Condition for contract
- xvii. Legal dominical
- xviii. Assignment (transfer of purchaser's right to third party)

Before proceeding with the construction of the ship, the ship owner also consider a fund for purchasing a ship. They should have an enough fun to make sure there will no problem regarding to the budget during ship making process. The ship owner should make a to the ship builder according to the contract. A normal schedule is:

- 10 percent on signing contract
- 10 percent on arrival of material on site
- 10 percent on keel lying
- 20 percent on launching
- 50 percent on delivery

Insurance is used to cover any lost or damage during the shipbuilding process. It is important to the ship owner to be covered by the insurance because the shipbuilding processes involve a high funding. It is risky activity and will cause a lot of losing to the company. QBE is one of the insurance providers in the marine industry. It policy has cover up of the shipbuilding process based on the individual needs. It's provided the ship owner and ship operator coverage of the machinery and physical damage of the hull. The Laveratus as a underwriting company also provide an insurance coverage for the ship owner. this company also covered a delay in the delivery which is cover the shipbuilder in respect of any penalties or damage for which may be liable. The Laveratus has cover the costumers depend on the size and record of the yard.

- It will held simultaneously of the load line survey
- The surveyor will examine the condition of the closing appliances, the minimum freeboard, watertight door and watertight bulkhead.
- The general condition of the ship and the fire protection also will be inspected

2.2 TRADITIONAL SHIP PRODUCTION PROCESS

A traditional ship is widely used in the Malaysia and Indonesia country. During the Malacca sultanate era, they have used a ship as a medium of transportation for the trade and as defender for the country. The traditional ship is built by the local craftsmen based on their experience and skill. The influence of the modern technology in the traditional ship production is less and it also the traditional instrument and tool. The ship is made from the wood and timber. With the high skill that own by the craftsmen, they are able to build the beautiful ship and strong ship. Today the traditional ship is only used by the small scale fisherman or as the tourism element because of the lack of the material such as a quality wood and the introduction of new material such as steel and fibreglass. A large traditional ship need lots of material and required a long time production time.

Construction method in the wooden traditional ship

There are several method used in the traditional ship production process. This process based on the size of the ship and the type of the material that they have used. The methods used in the traditional ship construction based on the geographical and the location of the shipyard. Some of the shipyard is located at the river and others located at the island or at the beach.

Methods of construction of hull are different for the different type of ship. The method is depends on the size of the hull and the type of the ship. The different method is used to construct the hull which is:

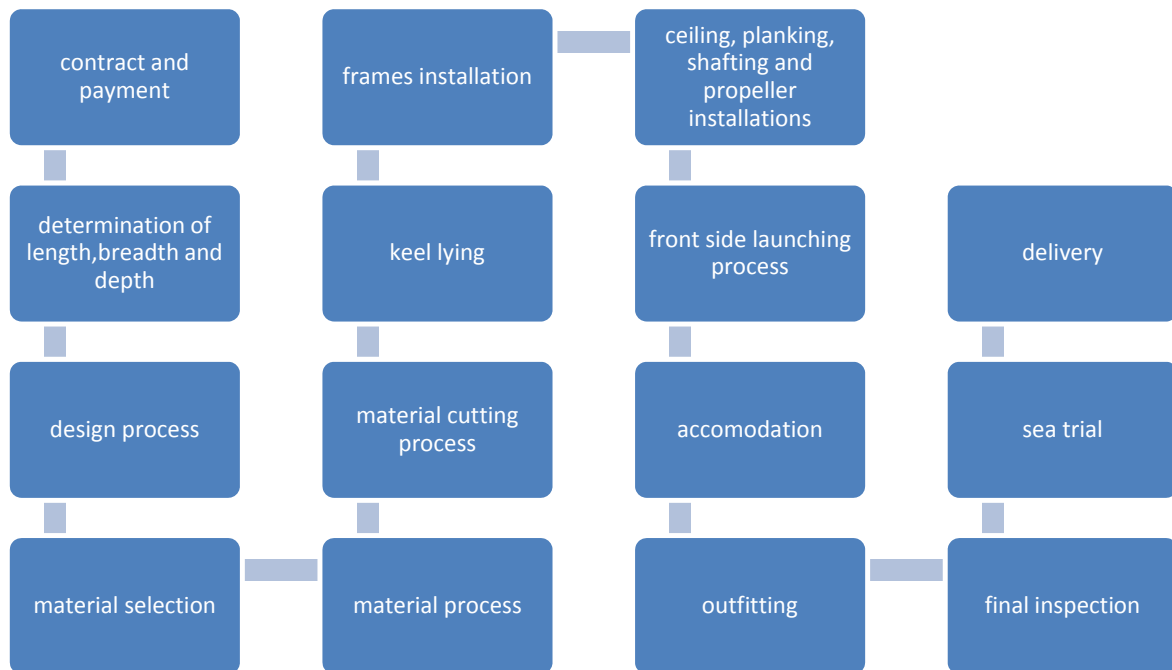
- I. Traditional lapstrake
- II. Traditional carved
- III. Glued lapstrake
- IV. Glued carvel
- V. Strip planking

SHIP PRODUCTION TECHNOLOGY

- VI. Multiple veneer construction
- VII. Cold moulded construction
- VIII. plywood construction

The carvel planking is a method of constructing wooden boats and ship by fixing plank butt against each other, edge to edge gaining support from the frame and forming the smooth hull. The lapstrake construction is a method where strakes are fastened onto a skeleton of the rib. The keel is laid first and adding strakes and fitting the internal timber as the last stages. This is much lighter than the carvel at the same size.

Flow of the Traditional Ship Production Process



➤ CONTRACT AND PAYMENT

Same as modern shipyard, traditional shipyard also has made a contract between the ship owner and the master of the shipyard. In the contract they will make a decision about the payment method and also the supposed delivery date. Some of the traditional shipyard is make an oral contract which means the contract is based on the discussion and trust between the ship owner and master Craftsmen. After some negotiation is made, the witness will be appointed to approve the agreement. An important people such as religion leader or village leader will appointed as the witness.

There were two method of payment will be done, whether the owner provide all the material needed and only pay the shipbuilder the cost of construction or other method is all the process of production is handle by the Master Craftsmen and they payment will be pay based on the progress of the construction. All the contract is carried out based on the trusts form both side.

➤ DETERMINATION OF LENGTH, BREADTH AND DEPTH

During the contract was in dealing process, the ship owner will decide the purpose of the ship. They also decide the specification required for the ship. Based on the discussion with the shipyard master Craftsmen, they will decide the important features of the ship such as length, breadth, and drafts. These three indicators are important because all of the design and material order is done based on that specification.

Usually the design process is done by the Master Craftsmen, but in some condition, the ship owner has provide a blueprint for their order and master Craftsmen will follow and start the construction process based on the blueprint present by the ship-owner.

➤ DESIGN PROCESS

The master craftsmen will start the design process based on the specification required by the ship owner. if the blueprint is already present by the ship owner, the production process will start immediately but if the ship owner required the design from the master craftsmen, the design will be proposed by Master Craftsmen. The design process by the

SHIP PRODUCTION TECHNOLOGY

master Craftsmen is very unique because there were no formal design and blueprint produce by the master Craftsmen. The master only design the required ship based on the knowledge that come from the previous Master and also based on their experience.

The skill is inherited from the previous generation and no numerical approach has been used in the design process. Working pattern which rely more on the experience of the Master Craftsmen is tends to result product inherent with the feature cultures based rather than technology based product. There is no formal consideration on the strength integrity and also the safety feature of the design ship.

Based on the research conduct by Mufti et. al (2012), they have conduct a survey at the traditional shipyard located at the Bintan Island, Riau Archipelago, Indonesia. The research is conduct by a direct interview with the Master Craftsmen to get the information about the design process of the traditional ship. Comparison has made between the traditional and modern shipbuilding which is:

No	Aspect	Traditional	Conventional
1	Method	instinct	numerical
2	Tool	Mal	Drawing tool and CAD

From the table, the different between the method of design for traditional ship and conventional modern ship is showed. Traditional ship is design based on the instinct and experience from the master craftsmen. To get compete in the future market, the traditional ship must consider applying the technology based method in their design process.

➤ MATERIAL SELECTION

Main material in traditional ship construction is wood. Usually the best quality of wood is chosen to ensure the quality of the final product. In Malaysia, *Kayu Chengal* (Neobalanocarpus heimii sp.) is used as a main material while in Indonesia *Kayu Chengal* is known as *KayuBesi* or iron wood. This type of wood is choose because of their strength is proven and also their incredible resistant. According to Surhan et. al (2012), *Kayu Cengal* is the strongest timber in the world and can last up to 100 years. With its reputation in the resistant and durability, *Kayu Chengal* is choose as a main material for traditional

SHIP PRODUCTION TECHNOLOGY

shipbuilding. This tree is a slow growing tree and it required a long time to grow. In 75 years it will achieved 64 cm in diameter. Nowadays, source of Kayu chengal or *Kayubesi* is decrease. According to Orwa C, et al (2009) in Surhan et al, Kayu Chengal is heavily exploited either by legal or illegal logging or without the proper forest management; the source of *Kayu Chengal* is decrease nowadays. Price for the *Kayu Chengal* is the most expensive in the timber category which is more than RM 15000 per tonnes (Tony N, 2011)



Figure 14: Cengal tree

Source: <http://wannura.wordpress.com/2012/06/15/cengal-neobalanocarpus-heimii/>

Due to the price and availability, the craftsmen has find the other alternatives to replace the usage of *Kayu Chengal* . *Resak* tree (*Shorea* spp) was used instead of *Kayu chengal* because of the availability and lower price compare to other type of wood. *Resak* tree also have the high strength and good durability. Traditional shipyard at Bintan island, Indonesia are prefer to used *Kayu Resak* which is ordered from Lingga Island because of the requirement from the ship owner.

➤ MATERIAL PROCESS

The ordered material will transport to the shipyard based on the order list from the Craftsmen. To increase the strength of the wood, it must be dried up under the sun within the required period. If the material is wet and dumps, it will easily affected by the microorganism which will lead to the easily brittle and reduce the durability of the wood. The fresh wood which is contained water can be dry when it exposed to the sun. If the fresh wood is used, the quality issues of the traditional ship should be considered. The wood might chance their shapes of strength when the composition of water is decrease. To avoid the quality problem, the wood must be dried up to 12 month to make sure the wood is properly dry.

➤ MATERIAL CUTTING PROCESS

Wood that was delivered by the supplier to the traditional shipyard is already cut into the certain length. In order to ensure it suited the design, the wood will cut again into the required length and specification. The craftsmen will refer to their previous experience to determine the suitable length for the required wood. There are no numerical machine is used in the cutting process. The process is conducted by using only the chainsaw or traditional saw. Sometimes this practices has cause the quality of cutting wood is not good and the accuracy is the main issues for the cutting material. It may cause the material cost is increase as they are need to replace the defect wood.



Figure15: Chainsaw use in the cutting process

➤ KEEL LAYING

After all the material is cut into the required length, the keel lying process is proceed. Usually the traditional shipyard already prepared the building slip for the construction process of traditional ship. it consist of one slip or incline plane which is the vessel in its cradle is supported while on the stocks in the construction process or upon the ship is hauled for the ship repaired process. The keel is like the backbone of the ship. It is the main and the most important part of the ship. in Indonesia it is known as Lunas. The wood that will selected as a keel should as long as possible depends on the length of the ship. The keel is cut from 5 x 5 inches or larger and then it will lay on the floor. It will supported by the wood block. It is vital to ensure the keel structure is dry enough to avoid the deformation which may lead to the structural fail.



Figure 16: Longitudinal main stiffener

Source: Nofrizal et. al (2012)

➤ FRAME INSTALLATION

Frame installation process is done after the keel laying process is complete. The purpose of frame is to strengthen the structure of the traditional ship. There were three important main parts of frames in the traditional ship which are:

- Bottom frame
- Stem
- Stern post

SHIP PRODUCTION TECHNOLOGY

The first buttock is located at the bottom of the ship which is fastened to the keel and it called as *Gading Bawah* in Indonesian Language. The first buttock will followed by the second and third buttock according to the height specification of the ship. Buttock will act as a height section for the traditional ship. The number of buttock will determine according to the height of the ship.

Bottom/first buttock

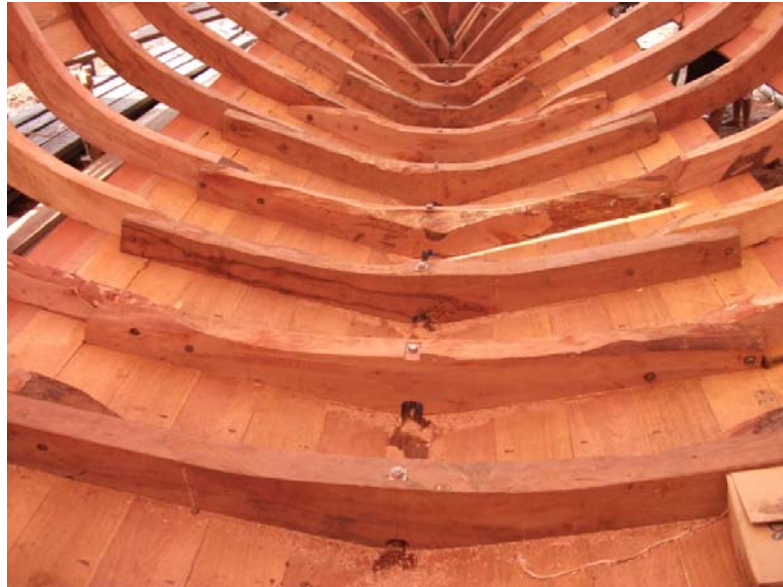


Figure 17: bottom buttock

Bottom frame

To make the bottom frame, craftsmen will choose the best shape of wood according to his experience. The best shape is determined using the drawing tool which is called 'mould'. The selected wood will go through the shape refined using the adzes to make the shape is more smooth and to clear off the wood chip. The futtock will scarfed with small press before they were bolted together into one place one by one forming the basic skeleton of the ship.

Stem

Stem is locating at end of the keel and assemble as diagonally to the keel. Stem is known as the *haluan* in the Malay's language. Stem is the foremost boundary in the vessel. Usually there were five types of stem construction for the traditional ship which is cutwater, rabbet, false, round brass and nose type. L joint technique is used to connecting the stem with

SHIP PRODUCTION TECHNOLOGY

the keel. The inner side of the stem is called as apron and it bevelled to form a rabbet to scarf planks.



Stem

Figure 18: stem post

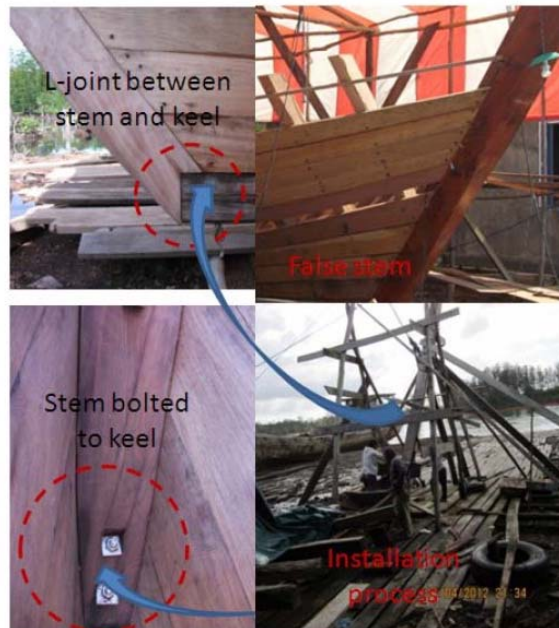


Figure 19: stem post constructions process

Source: Source: Nofrizal et. al (2012)

Stern Post

Stern post is located at the back of the traditional ship. it know as a *buritan*. It is one of the critical parts as it was need to withstand the external force and resistance. The stern post forms the after boundary of the frame of the ship, being the after continuing of the keel to the height of the deck and forms a receptacle for the after ends of the outside planking.

Stern post



Figure 20: Stern post of the traditional ship

After all of the three main frames were complete, the other installation of framing system in the traditional ship is proceeding. This framing system will call as transverse framing as the traditional ship is not are not so long. The small plank will installed beginning from the stem until the stern part as the guidance to the others frames installation.



Figure 21: Transverse framing system

➤ PLANKS FASTENING PROCESS

Upon the process of frame installing is done, the plank fastening process will start. There were two main parts in the plank fastening which is ceiling and planking.

Ceiling

Foot walling is the inside skin of vessel between the deck beam and the limberstrake on each side of the keelson. Otherwise, the outside planking is known as skin. A clamp is used to support the decks beams.

Planking

Planking is used as the skin to cover the exterior and interior surfaces of the frames. A line of planking is a strake and is named from its position as garboard strake, sheer strake and other parts. Process of the planking is as below

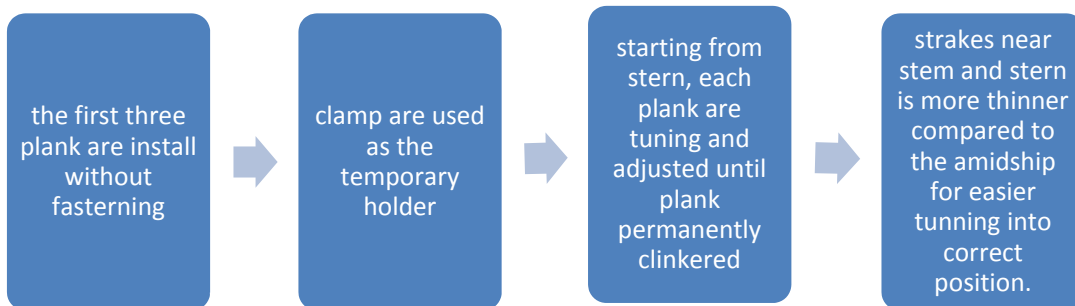


Figure 22: Clamp is used to hold the strakes



Figure 23: Planking process

Hot Bending Technique

Hot bending technique is applied to shaping and bending the strips into the required shapes. Usually the diesel oil and fire is use as the medium of the hot bending technique. Hot bending technique used at the time of bending of the wood to avoid its breaking during the bending process. The diesel oil will spreads onto the wood to enable it absorbed into the wood. As the fire is exposed to the surface of the wood, the craftsmen will curing the wood into the required shaped. Then the wood will joining into edge on edge using ironwood dowels.



Figure 24: Hot bending technique

Source: Nofrizal et. al (2012)

Calking

To make the ship is watertight; the calking process is done to the traditional ship. the cotton and oakum is used to filling the spaces between the plank of vessels and of spreading the ends of the treenails. Oakum is made by cutting old ropes and cables into the short length called junks and picking that to the pieces. The seam is opened with a dumb-iron or deck iron driven with a calking mallet and threads of oakum driven in, one after another.

Painting

After the caulking process is done, next is the painting process. The painting process is done to cover the caulking material and serves as the binder for the putty. Painted will be

SHIP PRODUCTION TECHNOLOGY

done in the moderately thick as it needs to cover the caulking material. After the paint is dry, the planking will be planned again.

➤ FRONT SIDE LAUNCHING PROCESS

As the hull construction is complete, the hull structure will launch to the river due to the space constraint. All the next process will be done on the river. The location of the traditional shipyard which is near the river gives the advantages to the launching process. The heavy crane or machine is needed if the size of the traditional ship is considered big.

➤ ACCOMODATION, OUTFITTING AND FINAL INSPECTION

The outfitting and accommodation process will be done once the ship is launch on the river. The superstructure construction also is carried out after the launching process. The piping and electrical system is carried out as the requirement sets by the owner. Even, it is the traditional ship, to adapt with the purpose and mission of the ship, the modern equipment is used as the additional fixtures. The propulsion system is select based on the required speed and size of the ship. After all the outfitting and superstructure construction process is done, the final inspection is take apart to ensure all the safety feature and requirement is fulfilled.



Figure 25: superstructure construction after the ship launched onto the river

Source: Nofrizal et. al (2012)

➤ SEA TRIAL AND DELIVERY

Sea trial process is done to evaluate the manoeuvring capability and also to test the speed of the ship. If the required speed is not achieved or the ship is not functioning as the requirement, the reworks process will be carried out to repair the problem. If all of the specification is fulfilled, the ship is ready to deliver to the ship owner.

SHIP PRODUCTION TECHNOLOGY

PART 3: TRADITIONAL SHIPYARD LAYOUT

JASWAR AND SYAFWAN BIN ANAH
FAKULTI KEJURUTERAAN MEKANIKAL

UNIVERSITI TEKNOLOGI MALAYSIA, SKUDAI, JOHOR

SHIPYARD LAYOUT AND ACTIVITIES

3.0 INTRODUCTION

Shipyard is a place when the ship production activity is done. Ship will be built from the zero condition until it will launch and sea trial at the open sea. In the modern world, shipyard has gained an evolution since there was an increase in the size and function of the ship. An efficient shipyard will have an advantage in the shipbuilding process activity. An operation of the shipyard will be at the smooth condition if the shipyard is well managed and in a good condition. A customer trustworthy will increase if their orders are delivered at the exact time. The quality of ship that builds by a shipyard is vital in order to increase a number of the customer. The well managed shipyard will decrease a cost and at the same time it will increase the revenue of the shipyard company so the company will get a higher profit.

A layout of the shipyard should be revised simultaneously with the order from the customer. A revised shipyard will increase the ability of the shipyard to build a larger ship, reduce the time cycle of the ship and economically increase in construction practices. It can be achieved with the suitable design of shipyard layout and a flow of the material from the one production process to the another process.

Usually shipyard is built at the suitable place such as straits, a large and deep riverbank or at the suitable area along the coastline. Nowadays, there were shipbuilders that build their shipyard at the small area of places and continue the ship construction process in the water. But this construction process will proceed when the hull of the ship is able to floating. This situation will reduce the shipyard area and it is suitable for the coastline that is surrounded by the high hill or mountain.

When the shipyard receives an order from the ship owner, the existing shipyard will be re designed and revised according to the size and function of the ship. It rarely for the shipyard to design find a new site and constructs a new shipyard. It is due to the place constraint and the cost of construction. An ideal shipyard layout is based on the production flow and the yard will be extended back from the river or shore. There were located a berth or building dock at the shore or river. Sometimes there were required a modified production flow lines if there were restriction in the location such as the physical river bank slopes is too high and there were another geographical constraint that will affect the production flow. During the planning of the shipyard, the decision will be made based on the:

SHIP PRODUCTION TECHNOLOGY

- Size and type of the ship to be built.
- Material production per year
- Material handling equipment to be supplied
- Machining process to be installed
- Unit size and weight to be fabricated and erected
- Amount of the outfit and engine installation system
- Control services to be supplied
- Administration facilities required

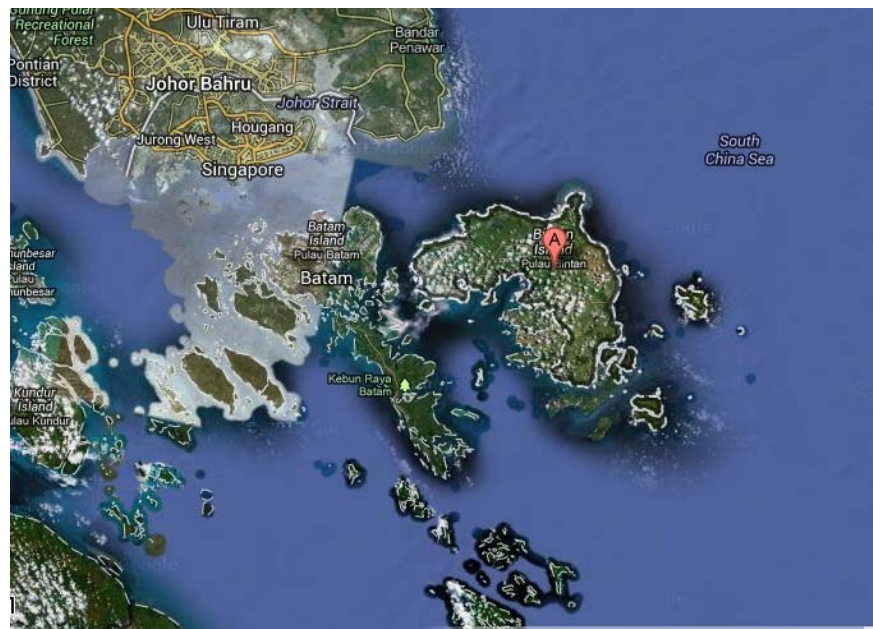
In order to be competing in the modern ship building industry, a shipyard need to be more technology friendly which is required a shipyard to apply a sophisticated technique and using a heavy machineries and tools. An introductory of the welding technique also has change the layout of the shipyard. Hence, application of the advance technology in the shipbuilding process has increase the quality of the ship and also has reduced a time cycle with the effective in the production cost.

In many shipyards practices, there were three main areas which can be identified. The three main areas are:

- First area consists of steel storage and processing area such as a machine to bend a pipe, a cutting process of metal according to the ship requirement. Storage for the process metal also available at this area.
- Second area consists of main assemblies building project where located the production line which is involve the activity of the subassemblies and assemblies.
- The third area of the shipyard is for outfitting and warehousing. This area is focused on the outfitting process step of the ship which is completion process of outfitting before its ready launch.

3.1 TRADITIONAL SHIPYARD LAYOUT

Traditional shipyard is a unique and creative enterprise. With only based on the experience, the traditional craftsmen are able to build amazing ships which are able to use for a long time. In Malaysia, the traditional shipyard still exists along the east coast region such as Kelantan and Terengganu. In Terengganu, the famous traditional shipyard is located at the Pulau Duyung Besar which is near the Sungai Terengganu. Otherwise, in Indonesia, there a still a lot of traditional shipyard are operate especially at the Bintan Island located at Riau Archipelago



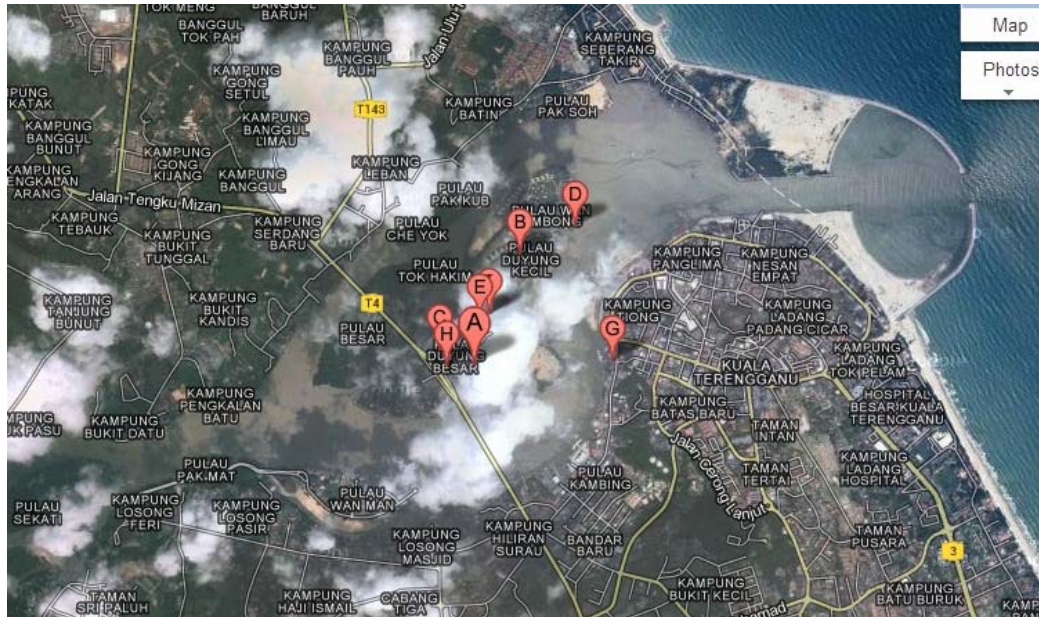
Bintan Islan, Riau Archipelago, Indonesia. The Bintan Island is surrounded by sea and it is suitable as a shipyard location source: Google maps

Traditional shipyard usually produces the small and medium size vessel which is made from the wood. The ship will used as the small fishing vessel or as the leisure yacht. According to Deah at al, the traditional shipyard do not have the special place for the production process, sometimes it will located at the riverbank, at the waterfront or behind their house.

Location of the traditional shipyard is usually influence by the geographical factor and material resources. As we know, most of the traditional ship is produces by the wood. To reduce the operation cost, the shipyard is located not far from wood factory where the log

SHIP PRODUCTION TECHNOLOGY

was cut into the desired size of wood. The Craftsmen will order the desired quantity of wood from the wood factory based on the specification required by the customer.



Pulau duyung Terengganu. Located at the main river and near the sea is suitable as shipyard.

Source: Google maps

The sizes of the shipyard usually not as big as the modern shipyard as they are not produce the traditional ship as a mass production. They are only able to build only one of traditional ship depends on the size and specification from customer. They traditional shipyard consist of the Master Craftsmen which will lead as the leader at the ship yard. There was only one or two worker that will help the master in the construction process.

In the production process, there are no applications of the big machineries in the ship yard. They are usually used only the small tools such as chainsaw, electric plane hammer and electric borer. All of this small tools and equipment will store at the certain part of the shipyard. As the number of tool applied is less, they are only need a small space compares to the modern shipyard.

Usually a wood that is used in the traditional shipbuilding is seldom available and the masters usually orders in a bulk quantity. They will store the wood at the closed spaced as to avoid the wood to defect and it will affect the quality of the wood. So the traditional

SHIP PRODUCTION TECHNOLOGY

shipyards have the specific places to store of the material. Sometimes the woods that send to the traditional shipyard is wet and damp. So to improve the quality of the wood, it must be dry up at the outside of the yard in order to avoid the wood from easy brittle. This drying process usually took up four months or more so it needs the special space to avoid it block the construction process.

The riverbank and waterfront is the important factor in designing the traditional shipyard as it will help them to launch the ship easily without using the heavy equipment or crane. When the traditional ship is ready for launching, it will directly move up to the river.

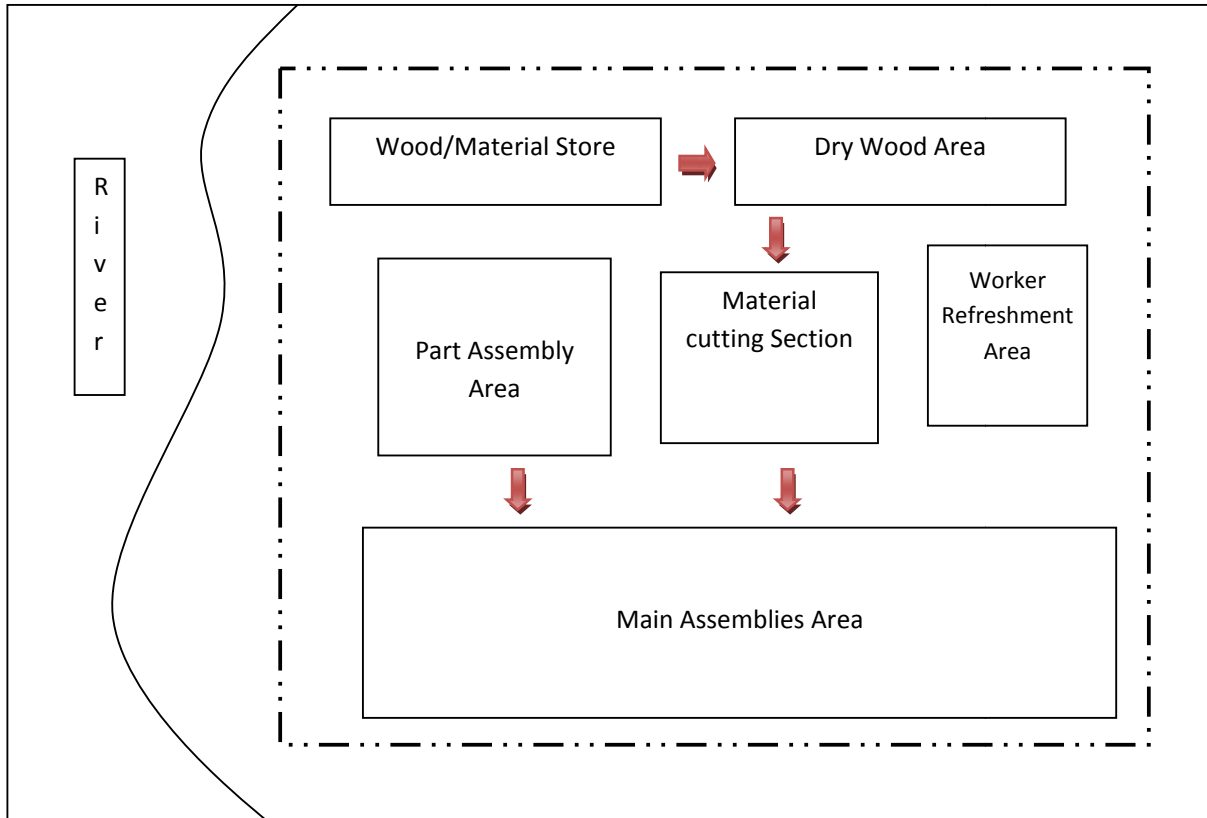


Shipyards at Bintan Island located near the river



Traditional Shipyards layout at Bintan Island

Example of Traditional Shipyard Layout



Material Store/Warehouse

Ironwood/Cengal will be store at the warehouse after the delivery form the wood supplier and each wood will be classes into the length and size

Dry Wood Area

Material will be clean and dried otuside of the yard under the sun, this nautre dry up process to increase the quality of the wood. The process of dried up material will be tokk a times up to a year

Material Cutting Section

Usually the material that deliver by supplier is ready cut into the certain length and to adapt with the design, the wood will cut into the suitable length using the chainsaw.



Main Assemblies Area

At this area all the assemblies process is done. from the keel lying process until the process of the superstructure construction. sometimes, if the shipyard do not have the enough space, the hull will be launch into the river and the outfitting process will start immediately

There are other areas that available at the traditional shipyard such as:

Part Assemblies Area

- At this area, the small assemblies process is done small compartment assemblies before it install at the superstructure
- small part will be painting before it was installed at the main hull

Worker Refreshment Area

- area for worker to take a refreshment
- rest area for the shipyard worker



Figure 26: Traditional shipyard warehouse source: Nafrizal et. al (2012)

SHIP PRODUCTION TECHNOLOGY

PART 4: COMPUTER APPLICATION IN SHIPBUILDING

JASWAR AND SYAFWAN BIN ANAH
FACULTY OF MECHANICAL ENGINEERING

UNIVERSITI TEKNOLOGI MALAYSIA, SKUDAI JOHOR

COMPUTER APPLICATION IN SHIPBUILDING

4.0 INTRODUCTION

The processes of ship production are complex process today. Designers should perform a lot of complex calculation in order to satisfy the customer requirement in terms of capacity, stability and also a safety of the ship. In the early age of the ship building process, the designers are design a ship based on the empirical and experienced. Due to the rapid progress in the technology and the demand of the more complex application of the ship, the computer is one of the fast and suitable solutions to complete a difficult task that face by the designers. Computer not just applied during the technical design and analysis process but computer also required to perform the operation and production in the design process.

The application of the computer in shipbuilding process can be classed into three group which:

- To perform a detailed calculation include the routine calculation such as stability and hydrostatic calculation
- To find a solution for a particular problem such as structural analysis and motion prediction
- As a integrated design system to deal with the major section at the ship

In the late 1950's the designers used a computer to perform a routine calculation such as stability and also a problem involve the hydrostatic calculation. Only the linear calculation will be completed by the computer and the problem is same employ by the hand calculation. The limited of the technology and ability of a computer to perform a complete task has made a designer more depends on the traditional method.

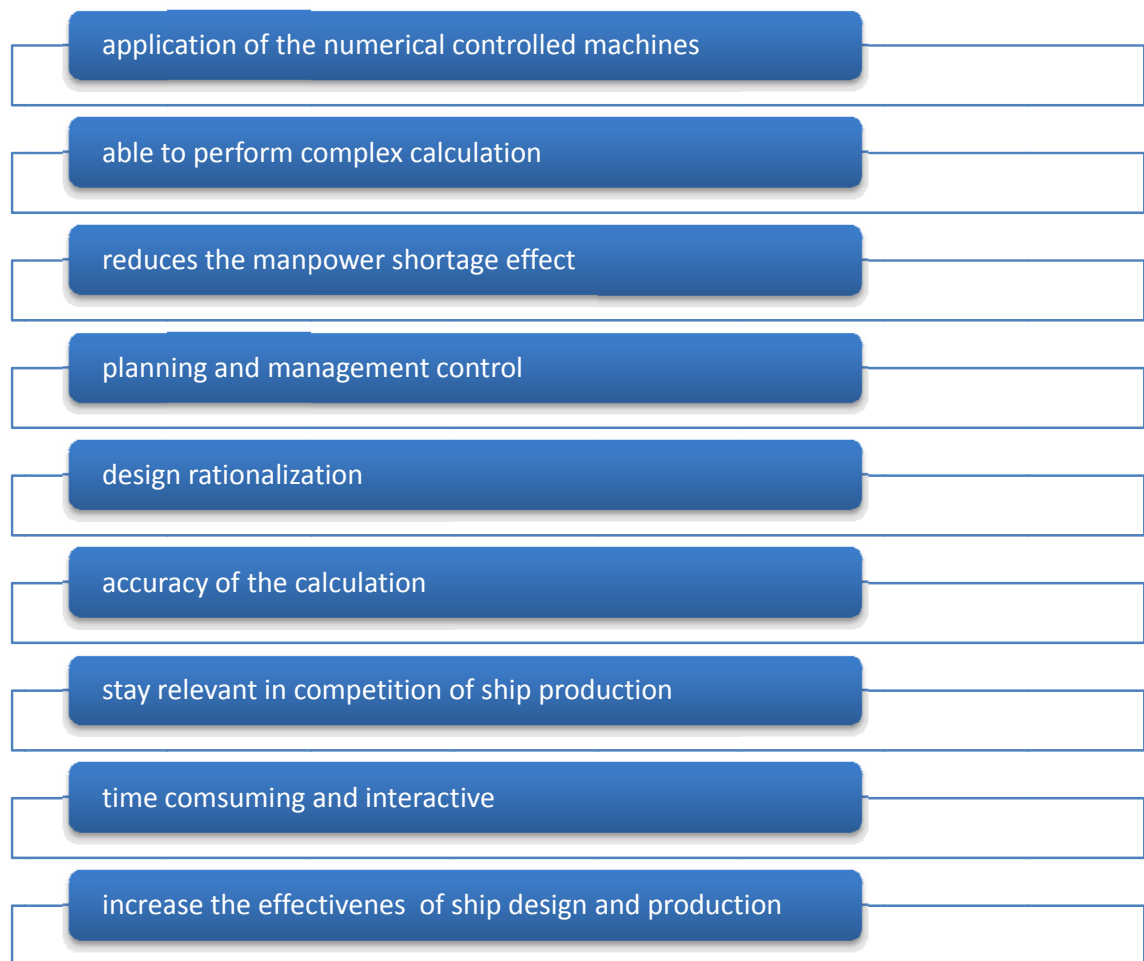
However, due the rapid development in the computer chip and computer technology, it has changed the environment in the ship design and ship production process. The complex requirement of the ship specification by the ship owner and some ship are designed to perform a specific task also contribute to the application of the computer. A complex specification of ship will required a designers to perform a complex calculation to make sure that the ship are able to perform the assigned task and will carry the task safely.

The computers are able to perform a complex task and calculation and this was increase a confident of the designer to apply the computer method in the ship production

SHIP PRODUCTION TECHNOLOGY

process. A better understanding of the computer function was lead to the development of the software package to help the designer and the people in the daily ship making process. The computer was change the landscape of the shipbuilding process. The software is developing to help the ship design and production process but some selected activities are remain and control by decision that will decide by the designer based on their skill and experienced. Only the selected process will be automated by the computer.

Advantages of application of computer in shipbuilding industry



➤ **Application of the numerical controlled machine**

The application of the numerical controlled machine will produce more accurate cutting and welding part. Any deviation or problem in the cutting process and also in the assemblies' process will cause a delay and increase the production cost. The production flow will run smoothly and the material will be controlled effectively. Operations of the numerical control machine need the control information. The computer can help to generate the control information which is necessary to operate the numerical controlled machine.

➤ **Able to perform the complex calculation**

During the process of designing the ship a lot of calculation will perform by the engineer and the designers. It will involve the processing a lot of raw data from the part of the ship. it cannot be perform by the human. A computer will help to perform a calculation involve the large data. The calculation important to produce a check and balance between the correctness of the design and for the economic consideration. The matrix manipulation need to be perform by the computer to produces the accurate results.

➤ **Man power shortage**

Manpower is important to perform the specific task in the shipbuilding process. Nowadays, there were shortages in the number of the high skilled worker in the marine industry. By replacing manpower with a computer it will able to reduce the effect of manpower shortage. The high skill worker just need to complete only the complex task which is involve the decision making and experience consideration. Computers are only need to perform the routine task which not required the experience of the worker.

➤ **Planning and management control**

Planning and management control will lead to the effective and high efficient production lines. In a shipbuilding industry, the large group of data need to be manipulated and organize in order to achieve the high quality of construction. Computers are able to perform this task

by using the advanced chip and technology. It will ensure the data will be kept safely and the data in well organize.

➤ **Design rationalization**

A computer has made the design process of the ship become easier and logic. The flow diagram of will be replace by the synthesis model which is represent the design. The numerical control in the computer also associates algorithm have facilitated more methodical ship design process.

➤ **Accuracy of the calculation**

Designers are always face the problem when deal with the calculation that need to try a different value for the different parameters. They need to apply the formula based on the empirical to choose the most suitable design option. With the computer, they will reduces the importance of the approximate formulae. When in possession of well tested subroutines designers can comfortably use them repeatedly to find directly an appropriate value of a parameter.

➤ **Stay relevant in the ship production competition**

In order to stay compete in the ship building industry, the shipyard need to be more effective and efficient in terms of time delivering and fulfil the customer requirement. The designers should carry out some optimisation to achieve the customer requirement. The best ships that will design depend on the goal from the customer requirement. The best ship maybe of high speed, light weight or lower building cost. All these requirements need to be manipulating from a lot of data and calculation. Some manual calculations required a lot of times and involve complex definition. To reduce the time constraint, some of the calculation will be perform by the computer which is able to generate more accurate result and the best option of the ship design.

➤ **Time consuming and interactive**

Delivery time in the shipbuilding is very crucial part. Shipyard performances are be evaluated from the time of delivery of the ship. With the application of the computer, some of the ordinary ship production process will be performing by the computer application and it will consume the time. Trials and modification will be more interactive using the computer software. Designers are able to evaluate the pre- model of the ship before the final fabrication is made. It will save a time and reduces the used of material. In the manual approach the designers do not have a time to evaluate the design possibilities.

➤ **Increase the effectiveness of ship design and production**

When the ship design is introduces the understanding of relation between the ship design and the production implication is important. The economy implication is very crucial in the shipbuilding process. Any factors that effect the production process will be give the effect to the cost of production. The economy view is important to relate the ship design with the production process. Computers are able to perform this task by integrating the ship design with the effect of the production process. So the designers are able to evaluate any modification that they have made will affect the production process.

4.1 SOFTWARE IN SHIP DESIGN

In the ship design process, there was software available to make the ship design process easier and help a lot of the designers. The ability of software is different and it will perform the specific task required by the designers.

The Foran

This software is develop by Spanish company named Sener and widely use by the shipyard around the world. This software includes the technology of CAE (computer Aided Engineering) and CAM (Computer Aided Manufacturing).

The NAPA System

The objectives of this software are to create and promote the best ship design. It was developed by the group experience engineer at the Finnish company, NAPA Oy Ltd. This software will expose the user with the usage of 3D CAD to develop the unique ship design.

3D Boat Design Software

A 3D model will be easier to create and evaluate by using this software. The 3D model will help the creator to analyze their design of the ship unlike the 2D design version.

Auto Ship's System

The ship design process is a complicated process. Using this software application, the concept of the ship building process will be better understood in both technical and non-technical ways. This software is developed by the well-known company in ship design, Auto Ships.

Nupas-Cadmatic System

This software is able to deal with all aspects of ship designing from the basic level up to the production stage.

4.2 COMPUTER APPLICATION IN TRADITIONAL SHIPBUILDING

Traditional shipbuilding is existed since a long time ago. Even though the function of the traditional ship is replace by the modern ship marvel but with the historical value, the traditional ship is still in demands even it is in small quantity. According to Ingram K. 2007 and Chin M.P. 2009 in Jaswar et .al 2012, in Malaysia and Indonesia shipbuilding, the traditional ship is retained because of the historical value rather than its function towards the modern society. Traditional shipyards usually produce a traditional boat for leisure activity, small vessel for the fishing activity or as the inland waterways transportation. The unique and creative process to complete the traditional ship is the factors to attract the tourist to get visit the traditional shipyard to learn and understand the practice of the traditional shipyard.

With the long history and heritage, traditional shipyard should not be neglected without any attempt to bring back to their glory age. To adapt with the current modern situation and economy scenario, traditional shipyard must have the initiative to apply the current technology in their ship production process. Most of the traditional shipyard has their own expert craftsmen which is able to design and manage the production process using their experience and skill. Most of them are does not have the formal education about the shipbuilding process or technique but they are able to build an amazing ship sailing for a last long. According to Jaswar et al the construction process of the traditional ship is follow the skill of master shipwright or shipbuilder that were handed down from generation to generation.

In order to get compete and relevant with the modern world, a traditional shipbuilding industry should open their door to apply the advances technology in their production process especially a computer based production which has proven to increased the quality of build ship and reduced the cost of production. As the number of traditional ship craftsman was decrease nowadays, it is important to preserve their valuable knowledge and experience because they are less number of person who able to build the traditional ship as they are.

In Malaysia and Indonesia, the traditional shipbuilding is still far from the advance technology application especially in computer application. Most of the traditional ship craftsmen are design their ship with only based on the generation to generation experience. With no proper design, planning and blueprint, they are just relying on the previous experience to complete the design process and production process of the ship building. No formal instruction and procedure is apply by the craftsmen and they are depends based on the

try and error concept. From the beginning of the process then the material selection until the delivery process of a ship, it just depends on the experience and helping hand from the trustworthy employed. If there are something happen with the master craftsmen, all the production process will stop and the delivery process will delayed because all the process are based on the instruction from the master craftsmen. It will affect the reputation of the traditional shipyard.

The systematic approach in shipyard management and design process is believed will increase the productivity of the traditional shipbuilding. A shipyard will gain a lot of advantages and the reputation of the traditional shipyard will increase. The ship owners are analyzing their future ship maker based on the delivery performance. If they computer application is apply into the traditional shipyard. It believes that a lot of delivery problem solves and it increase confident level of the ship owner to choose the suitable shipyard.

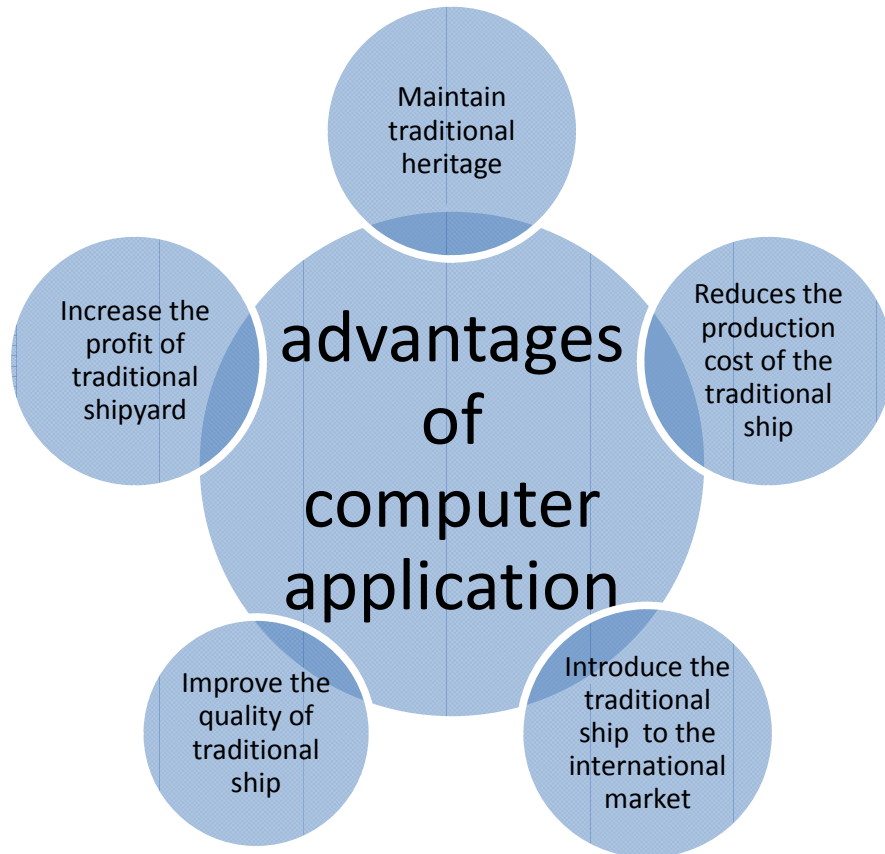
How the computer will apply in traditional ship production process? Computer application is widely use in the modern shipbuilding process. Even the process of production for traditional ship is not same as the modern steel ship but the computer application is still applicable to the traditional ship process. Most of the traditional ship is build from wood compared to the modern ship which is build from the steel and other advance material.

The application of computer aided design and computer aided manufacturing (CAD/CAM) is relevant to the traditional ship production process. CAD/CAM is the powerful software and tool to use in design and geometric modelling of product and components. The designing process become easier and it will reduced the cost and time consumption. Application of the CAD/CAM technique will increase the quality of design and the performance of the product will be analyzed. It will reduce the defect for the final product. The computer application will promote the better understanding on design process in traditional shipbuilding process.

The Benefits of Computer Application in Traditional Shipyard

From the application of the computer in the production of the traditional boat, some of the issues raised in the production process will solve. The shipyard will gain a lot of benefit from the computer application. It will attract a suitable investment from the business sector or from

the government in order to make the traditional shipyard is exist for the future generation. The benefits and advantages of the introduction of the computer application are:



Maintain Traditional Heritage

The traditional heritage in the traditional shipyard is very valuable. With the technique is passed down from generation to generation, it believes that the skill and technique should be preserve for the future generation. The traditional ship craftsman does not have the standard method to documentation all the knowledge that they have. They are built the traditional ship without the formal blueprint, design and procedure. If they are not document all the knowledge, the future generation will do not have a right guide and procedure to built a good ship as they are. They knowledge of building the traditional ship will lost through the time.

SHIP PRODUCTION TECHNOLOGY

The documentation is the best way to preserve the heritage of the traditional shipbuilding. Computer can help the traditional ship craftsmen to stored all the valuable technique and method in designing and handling the traditional ship production process flow. It will give the opportunity for the next young generation to inherit their skill and ability in the shipbuilding.

Computer applications help the traditional Craftsmen to create the blueprint and the formal design as the references in the future. Every Craftsman has their owned identity in designing the good traditional ship. It is important to stored all their skill into the proper manner to keep the unique heritage is preserved.

Reduces the Production Cost of building Traditional Ship

Production cost in traditional shipbuilding is one of the main issues which have faced by the tradition ship craftsmen. The production of the traditional ship is not a mass production process. In a year, one traditional shipyard may complete only one traditional ship depends on the size and the availability of the material. As there is no computer application in the traditional ship production process, the cost of production is cannot be optimized and it will cause the final product price is high and not reasonable.

With the introduction of the computer application into the traditional ship production process it may help the traditional craftsmen to maintain their production cost and the management of the traditional shipyard become more efficient and effective.

Introduce the Traditional Boat to the International Market

When the demands are increase, the profit also will increase. Malaysia and Indonesia traditional boat is very unique and creative artwork. Most of the foreign people are very interested with the traditional ship produce by Malaysia and Indonesia craftsmen. In Malaysia the traditional shipyard are located most at the east coast region centred at Terengganu and in Indonesia, Bintan island located at Riau Archipelago Province is one of the area where the traditional shipyard are still exists. To introduce this traditional activity to the outside world, the application of computer in the production practices is one of the solutions.

When the computer is applying within the production activity of traditional ship, it may help to optimize the requirement based on the customer's specification. To integrate the customer requirement and the production process, computer can help to perform the complex calculation and it may improve the time constraint for the production process. As they are achieved the international standard, the traditional shipyard can compete with the modern shipyard and it is not impossible to be a same level with the modern shipyard. The traditional ship is very suitable for leisure activity and with the improved the reputation of the traditional shipyard it may attract the ship owner from around the world to experience the sailing with traditional ship.

Improve the Quality of Traditional Ship

Computer application in the traditional shipbuilding can improve the quality issue of the traditional ship. For stay with the modern ship, the quality control and improvement is a vital part. According to the E. Prayento et. al, from the survey that was conduct at the Kepulauan Riau –Indonesia, one of the traditional shipyard, many discrepancies occur to the quality of the traditional ship and the traditional shipbuilder only using their visualize to analyse the quality of their traditional ship. As we know, the traditional ship is made from the wood as their main material. If the wood not undergoes the perfect process it can cause a leakage which can cause the disaster and accident.

Quality control is the routine activities in the execution of a project including new ship construction projects or ship repair. To control the quality of the traditional ship, the good quality management system should be applied. Computer is a device that can perform the complex management and calculation system. To ensure the quality of the traditional ship is at the high level of quality, the use of computer software is the best method.

Computer can perform a complex calculation for the structural integrity and hydrodynamic analysis which consume a lot of time. The result from the computer analysis is more accurate and it may help to increase the confident of the ship owner about the traditional ship qualities.

Increase the Profit of Traditional Shipyard

Profit will increase if the revenue increase and the cost is decrease. To increase the revenue, the traditional shipyard should increase their performance and reputation. The main customer is not only from the local segment but they also needed to attract the customer from the international market. Traditional ship is known as their ability to be the luxury yacht. The *Naga Pelangi II* is the example of the traditional ship that is build at the Pulau Duyung, Terengganu for the purpose as the yacht. It is owned by the German national, Cristoph Swaboda. He is believed that the traditional ship that they are owned is one of the high quality ships in the world. It shows that the traditional ship is get the recognition from international market.

With the application of the computer in the traditional shipbuilding it may help to increase the profit of the traditional shipyard. A delay of delivery is solving as the computer can manage well the project management and the quality issues will be not the big problem. When the orders from the customer increase, it will increase the profit of the traditional shipyard.

Steps to Apply the CAD/CAM at Traditional Shipyard

The traditional shipyard could continue to improve their performance by adapting a new and advances technology in the traditional ship production process. Computer Aided Design/ Computer Aided Manufacturing is the approach to improve the productivity and management of the traditional shipyards. To become the high standard of ship building, the traditional shipyard should apply the new approach in their production process. Barry et. al has identified 8 keys in order to applying the approach of CAD/CAM in the small shipyard which are:

- **Process- re engineering**

This process will use to determine the needs and capabilities of member in organisation. CAD/CAM improves the communication between the process as well as allowing improvement within the processes.

- **The integrated product model**

The re-engineering process will develop the information of the product develop while the CAD/CAM will enable the construction the model based on the data which is already stored at the centre of database.

- **Design for Numerical Control Cutting (NCC)**

The NCC is the process to improve the quality of the material and control the production process. The product model is used to develop the NCC data and process re engineering is required to achieve this mission.

- **Advance outfitting/Group Technology**

This process is including the installing of the machinery and outfit as early as possible and classification the task by location and types of process.

- **A Flexible Standard Product Line**

This is a process of building the different ships by using standardized system, preferably with parameterized details and standard components and thus predictable work,cost and process content.

- **Concurrent engineering**

The design will doing simultaneously across discipline and includes all aspect of production as well as final product.

- **Advanced workflow control**

These technique is depends on the product model for information on sequencing and on group technology for resource allocation, cost and schedule prediction.

- **Statistical process measurement and control**

This technique is the process of the measurement and application of statistic to the result of all the other process and changes. It provides feedback to improve schedule and cost reliability and guide further process re-engineering

4.3 RECOMENDATION OF SUITABLE SOFTWARE FOR TRADITONAL SHIPYARD

The application of computer application such as computer software will enhance the quality of ship produce. There are numerous software's that available at the recent market. This software is developing based on the mission and objective that need to be achieved. As the traditional shipyard is usually small and medium enterprises which do not operate with the high expertise and cost, there selection of software is important to ensure the maximum efficiency is gain. There are a software application that suitable to apply and used by the traditional shipyard.

DESIGN

Design of the traditional ship is usually based on the experience and knowledge of traditional craftsmen. No formal method is used to design and modelling the traditional ship. From the Mufti et. al, they were discussed about the design method that is apply by the traditional ship. There were comparisons of the traditional and modern ship design method.

	Method	Tool
Traditional ship	Instinct	Mal
Modern ship	Numerical	Drawing tool and CAD

From the table we can see that the traditional ship is design based on instinct and experience. There were no application of software and drawing tool. Sometimes, the design process will be taking a long time and it is not consistent. With the application of the computer software, the design process will consume less times and will produce a good ship which is suitable and fulfil the customer requirement. Some of the design software is:

- **AutoCAD**

AutoCAD is computer aided design (CAD) software which is enabling the drafting process is done in the 2D and 3D model. This software was developed by Autodesk, Inc.

ANALYSIS

As we know, the analysis process is important especially to evaluate the strength of the ship structure. Analysis software is widely used in the modern shipyard. Some of the analysis software is quite complicated and it needs an expertise to handling and evaluates the software. The introduction of the analysis software at the traditional shipyard is encouraged as it will increase the quality of the traditional ship structure and it will increase the confident level of the ship owner. Some of the analysis software is:

- **ANSYS**

ANSYS is the computational fluid dynamic program (CFD) that is used to perform the analysis for the mechanical part. There are a lot of functions of ANSYS and of the application of ANYSYS is the analysis for the marine vehicle. The analysis will able to be simulating at the real condition and environment depends on the purpose of the analysis. The simulation analysis will produce the high accuracy of result compare with the calculation.

PLANNING AND SCHEDULLING

Planning and scheduling is important to ensure the production process flow is running smoothly. The proper planning and scheduling will reduces the cost of operation and increase the productivity of the traditional shipyard. With the application of the computer software, the planning process becomes more manageable and easy to handle. The traditional shipyard with the good planning and scheduling will avoid the delivery delay and the usage of the shipyard sources will be efficient. The optimum material handling also will contribute to the increase of profit for the traditional shipyard. Some of the planning and scheduling software which is suitable to apply at the traditional shipyard is:

- **Microsoft Office Project**

Microsoft Office Project is one of the famous project management software for the purpose of planning and scheduling. It was widely use in the industries and in the research and development area. It was develop by Microsoft Company. This software is design to assists a project manager in developing plan, assigning resources and managing the budget.

SHIP PRODUCTION TECHNOLOGY

PART 5: PLANNING AND SCHEDULING

JASWAR AND SYAFWAN BIN ANAH
FAKULTI KEJURUTERAAN MEKANIKAL

UNIVERSITI TEKNOLOGI MALAYSIA, SKUDAI, JOHOR

PLANNING AND SCHEDULLING

5.0 INTRODUCTION

The production process at the traditional shipyard is still influenced by traditional method and without the proper management system. The traditional shipyard is owned and managed by the Master Craftsmen who will act as a manager for their worker. Usually there were one or two workers that help the master craftsmen in the traditional ship production process. Seldom are the permanent worker hired to help the production process. The worker will assist the master Craftsmen in a different work according to their abilities and knowledge. The Master Craftsmen do not apply any formal and standard planning or schedule for the manpower management during the construction of the traditional ship. Sometimes it might cause the problem for the traditional shipyard when the shortage of the manpower becomes the issues.

Material handling at the Traditional Shipyard also will contribute to the productivity of the traditional shipbuilding. As the material should have undergone the certain process such as drying process before it can be used in the assemblies' process. Drying process for the wood consumes a lot of time. Maybe some parallel activity can be done at the same time to save the time and increase the productivity. The preparation of the area for the keel lying and maintenance activity for the shipyard are the example of the parallel activity that can be done during the dried up material process.

Weather condition will be the factor that will affect the production process. A good weather condition will contribute to the smooth production flow and process. Weather condition is the Mother Nature business but the Craftsmen should have the good weather forecasting about the weather condition and including it into during the planning process. The weather forecasting can be obtained from the meteorology agency which can be considered in the planning process. The material drying process is the example of the activity at the traditional shipyard that depends on the weather condition. A good planning will avoid the late delivery of the ship.

Material availability is one of the factors that cause the problem in the traditional ship production process. The main material of the traditional ship construction is wood which is subjected to the availability as the iron wood is rarely found. The craftsmen at the Bintan Island usually used the Resak wood instead of the Ironwood. Resak wood is inexpensive compared to ironwood and is easy to be found in the market. A good material management is the required skill that needs to be mastered by the Craftsmen in order to maximise the

productivity of the shipyard. Project management and scheduling process will assist the traditional shipyard to get compete with the modern shipyard today. The scheduling in the steel ship production process is already applied a long time ago yielding an efficient modern shipyard. It is not impossible to apply the CPM in the traditional ship production process because the process is still same as the modern ship but some modification must be made in order to suitable with the situation.

5.1 CRITICAL PATH METHOD (CPM)

Introduction

Critical Path Method (CPM) is one of the available methods in project planning and scheduling. It was widely used in the areas of project management and research industries such as construction industries, research and development, maritime industry and other related industries. By the application of CPM all the dependent activities will be determine and the process period can be calculate. This method is use the mathematical approach to solve the required planning activities. All the dependent activities are considered as it will effect the other activities in the production process.

The critical path method (CPM) is develop in 1950 by Morgan R. Walker of Dupont and James E. Kelley, Jr. Of Remington Rand. In 1951 it was apply by the US Navy as a planning method. On 1961, john Fondahl has published a paper about CPM for the US Navy titled Non Computer Approach to the critical Path Method For the construction industry. Today's, the original method of CPM has experience a lot of modification to suit with the current situation. Although the original method is not yet apply in the modern management method but the approach is still apply to analyze the network logic diagram.

Method of CPM

Applying CPM as the project management in traditional shipyard is a good step to increase the efficiency of the production process. There were techniques for using CPM to construct the model of the project includes the following:

- List of all activities involve in the production process within the work breakdown structure

SHIP PRODUCTION TECHNOLOGY

- The durations of each activity to complete
- The dependent between the activities

The critical path consists of the longest path of planned activities to the end of the project.

There were four parameters define in each schedule where:

- Earlier start (ES) = is the earliest possible point of the activity to start.
- Earlier finish (EF) = is the earliest possible of the activity to finish
- Late start (LS) = latest point were the activity will start
- Late finish (LF) = latest possible point when the activity will finish

There were other terms that were used in the CPM approach which is:

➤ CASH DURATION

This term is defined as the shortest possible time for which the activity can be scheduled. Crash duration is modelled the linear relationship between cost and activity duration.

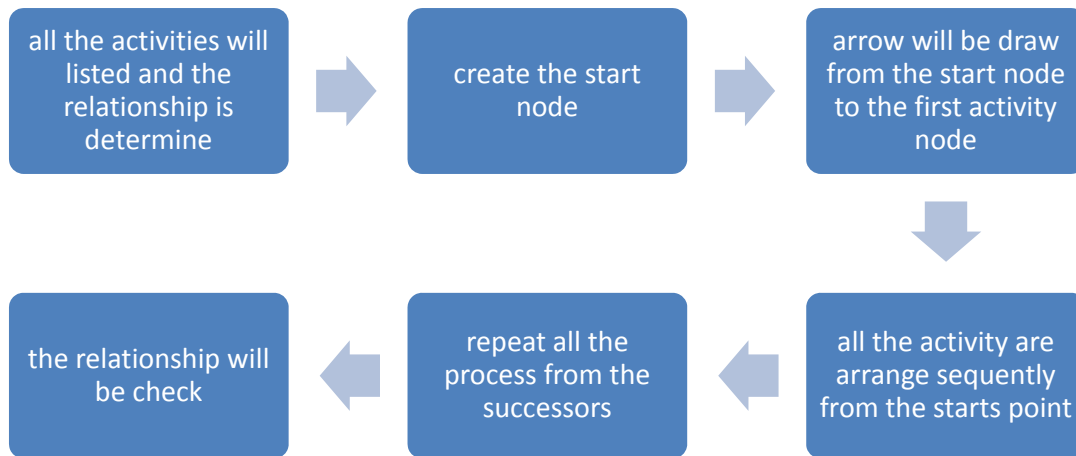
➤ EXPANSION

The CPM method is considered only logical dependencies between terminal elements. Resource levelling is the process where the activity is allowed for the inclusion of the resources. A resource levelled scheduled may include delays due to resource bottleneck and will cause the shorter path to become the longest path. CPM allows tracking the critical activities and alerts the project which is uncritical and possible to delay.

➤ FLEXIBLE

Flexibility is the terms where sometimes the activities include in the CPM are not show the correct prediction. The schedule generated is not accurate and it will affect the results of the analysis. However, the structure of critical path analysis is such that the variance from the original schedule caused by any change can be measured, and its impact either ameliorated or adjusted for.

Steps of CPM Approach



Figures show the steps to build the critical path method (CPM) for the project. The relationship between the activities is important as it will affect the result in determining the critical path.

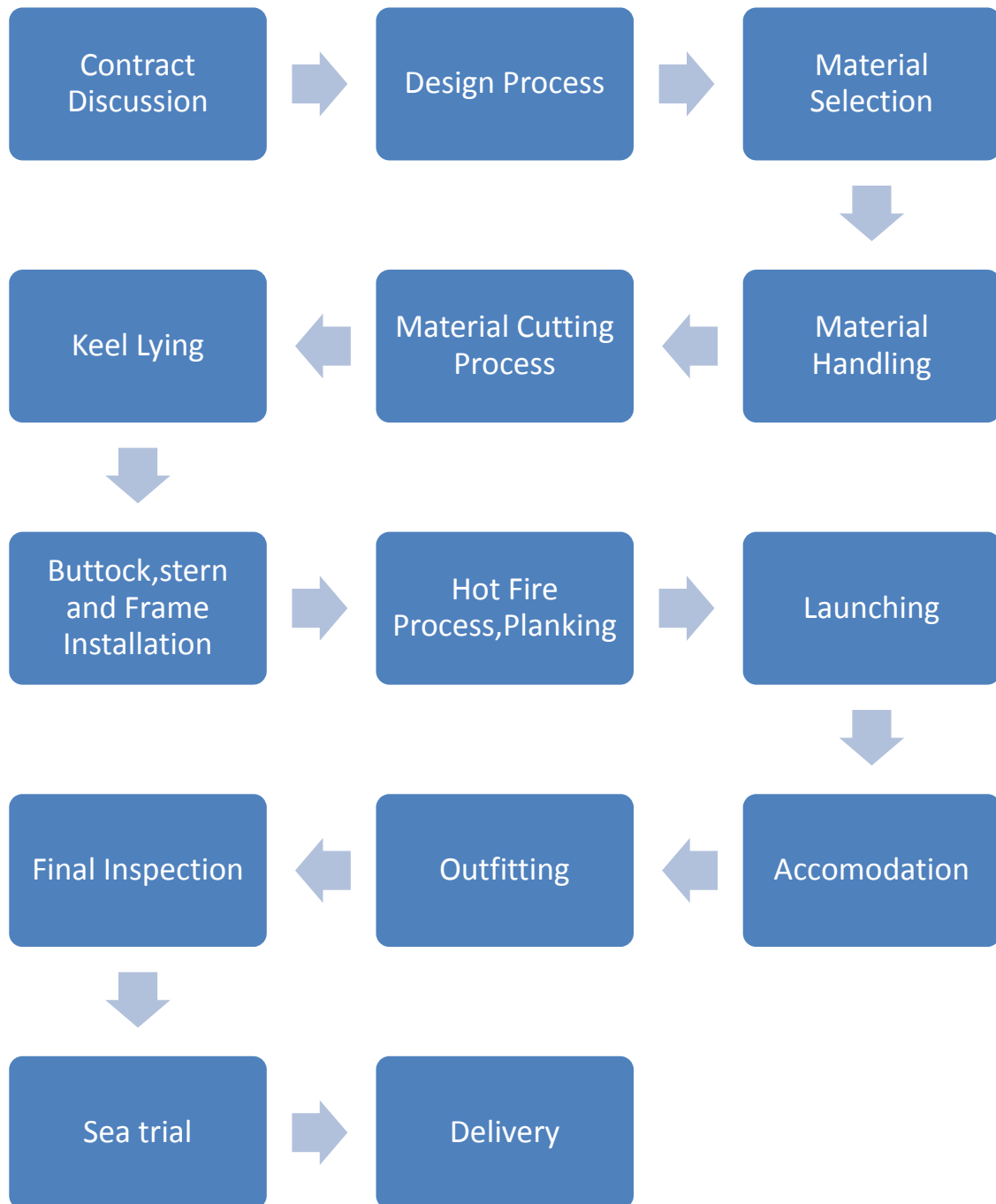
5.2 CRITICAL PATH METHOD IN TRADITIONAL SHIPBUILDING

In the traditional ship production process, the CPM approach is still no applied as the Master Craftsmen or the traditional shipyard owner do not exposed with this method. CPM approach will give a lot of benefits to the traditional shipyard in planning and scheduling process. The advantages of CPM are:

- It will reduce the risk during the production of the traditional ship
- The cost of operation will be optimum as all the recourses is used efficiently
- The time management become appositve as the CPM will help the Master Craftsmen to determine which activity can be done parallel with the other activities.
- A quality of product is improved when the management is effective.
- The reputation of the traditional shipyard will increase as they are able to complete the assign project within the duration and reduces the risk of delay delivery.

SHIP PRODUCTION TECHNOLOGY

Activities involve in the traditional shipbuilding process must be listed and the relationship of each activity must be determine. The work breakdown method is applied during listing the required activities. The activity involve in the traditional ship building are:



SHIP PRODUCTION TECHNOLOGY

From Saputra et. al. They were study about the planning and scheduling of traditional ship process. the traditional ship capacity is 300 gross tonnage, principle dimension with 25 meter length and 8 meter breadth. From their study, they have developed the project activity table. This is the first degree of CPM. The first degree CPM is including only the main activities and task that perform in the construction process.

Activities	Code	Predecessor	Day
Main principle dimension	A0	None	10
Wood cutting	A1	A0	4
Keel process	A2		
Stem and stern			
Stem post assembling	A3	A2	2
Stern post assembling	A4	A2	2
frames			
Button futtocks	A5	A2	10
Second and third frames	A6	A5	10
sheering	A7	A6	
Hull planking fastening	A8	A6	2
Hot fire process	A9	A6	40
Hull lubrication	A10	A8	40
varnish	A11	A8	2
deck			
Deck frame	A12	A8	5
Deck Planking Frame cover	A13	A12	15
Inside frame cover	A14	A8	20
Floor assembly	A15	A8	10
Ship launching	A16	A15	1
Accommodations/superstructure	A17	A16	15
Outfitting (piping/ventilation)	A18	A17	15
engine	A19	A8	9
Propeller installation	A20	A19	6
delivery	END		

SHIP PRODUCTION TECHNOLOGY

The second degree CPM is involving the more specific activity in the production process. It will provide more details data and more accurate times about the production process. This is the example of the second degree CPM. Due it includes all the details activity; the usage of the computer application is more applicable. Microsoft Office Project is the suitable application of developing the CPM. The process of developing the CPM using Microsoft office project using save the times and the data evaluated is more accurate.

REFERENCES

- [1] Chin M.P 2009, Travel-Traditional Shipbuilding in Terengganu, Jurutera, 32p.
- [2] Naga Pelangi II-History. 2011, Diethelm Travel Malaysia, Malaysia
- [3] Christopher D.B et al 1999, Keys to CAD/CAM in Small Shipyards
- [4] E.Prayetno, Jaswar, H. Saputra, Mufti F.M, Sanusi, A.Deah, Risandi.D.P, Nofrizal, Zulkarnain, Surhan, and Bayo, 2012, Quality Issues in Traditional Ship Production in Kepulauan Riau-Indonesia, The 6th Asia-Pacific Workshop on Marine Hydrodynamics.
- [5] Surhan Jamil Haron, Jaswar, Nofrizal, and Zulkarnain, 2012, Delivery issues in Malaysia Traditional Ship Production Process, The 6th Asia-Pacific Workshop on Marine Hydrodynamics.
- [6] A.Deah, Jaswar, E.Prayetno, H. Saputra, Mufti F.M, Sanusi, Risandi.D.P, Nofrizal, Zulkarnain, Surhan, and Bayo, 2012, Safety Issue in Production of Traditional Ship in Kepulauan Riau-Indonesia, The 6th Asia-Pacific Workshop on Marine Hydrodynamics.
- [7] Nofrizal, Zulkarnain, Jaswar, E.Prayetno, H. Saputra, Mufti F.M, Sanusi, A.Deah, Risandi.D.P, Surhan, Bayo, Yasser.M.A, 2012, Production Process of Traditional Ships in Kepulauan Riau-Indonesia, The 6th Asia-Pacific Workshop on Marine Hydrodynamics.
- [8] H. Saputra, Jaswar, Nofrizal, Zulkarnain, E.Prayetno, Mufti F.M, Sanusi, A.Deah, Risandi.D.P, Surhan, Bayo, 2012, Critical Path Method Analysis of Traditional Ship Production in Kepulauan Riau-Indonesia, The 6th Asia-Pacific Workshop on Marine Hydrodynamics.
- [9] Mufti F.M, Jaswar, E.Prayetno, H. Saputra A.Deah, Sanusi, Risandi.D.P, Surhan, Bayo, Nofrizal, Zulkarnain, 2012, Design Process of Traditional Ship in Kepulauan Riau-Indonesia, The 6th Asia-Pacific Workshop on Marine Hydrodynamics.
- [10] Risandi.D.P, Jaswar, Mufti F.M, E.Prayetno, H. Saputra A.Deah, Sanusi, Surhan, Bay, Nofrizal, Zulkarnain, 2012, Planning of Traditional Ship Production in Bintan-Indonesia, The 6th Asia-Pacific Workshop on Marine Hydrodynamics.
- [11] <http://smallbusiness.chron.com/history-critical-path-method-55917.html>
- [12] <http://www.stanford.edu/class/cee320/CEE320B/CPM.pdf>

[13] Eyres David J. 2007. Ship construction, Published by Elsevier Ltd. Department Oxford. UK

[14] <http://www.marineinsight.com/sports-luxury/equipment/list-of-important-ship-design-softwares/>

[15] <http://en.wikipedia.org/wiki/AutoCAD>

[16] http://en.wikipedia.org/wiki/Microsoft_Project

[17] <http://traditionalboat.blogspot.com/>

[18] <http://maritime.bernama.com/news.php?id=553302&lang=en&cat=ex>