

Management and Production Technology of The Traditional Dockyard in Bagan Siapiapi, Indonesia

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ABSTRACT

A series research activity was conducted on four traditional wooden dockyards in Bagan Siapiapi, Indonesia to be conscious production technology and management system of the traditional dockyard for producing wooden boat. Six respondents were interviewed from four traditional wooden dockyards, which as an owner of dock yard, foreman, and carpenter. The data of wooden boatbuilding skill, management of employee, material and tools for wooden boatbuilding, and quality assurance were collected and then those are described and analyzed. The results show that the productions of traditional wooden dockyards were decrease since 2007 to 2012 due to limited wooden material for boat's construction. Wooden boatbuilding technology is traditionally carried out by the simple equipment, i.e. 82.4% of tools used manually by hand and 17.6% mechanical equipment with electric power. Boatbuilding skill was obtained by them from generation to generation. Almost all of boat construction was made of wood, which they obtained around Rokan Hilir, Rokan Hulu and Bengkalis Regency. Wood processing for boat construction is conducted by sunlight drying, whichever after coated by kerosene or diesel oil. Even though, the boat production generated by the traditional wooden dockyard still gets quality assurance, such as boat performance and leak test. Further, production technology and management of the traditional wooden boat dockyard in Bagan siapiapi are discussed detail in this paper.

Keywords: *Bagan siapiapi, boat building, management, technology, traditional dockyard.*

INTRODUCTION

Technology can be viewed as the application of science in the work and produce something in human's life. As well as, technology can be understood as a way of doing things or tips in order to achieve a particular outcome or goal, which is based on science. In accordance with his origin from the Greek; "*Techne*" is "how to do something" and "*logos*" as a logically study, or the logical knowledge or rational (Ahmad, 1982). The purpose of technology is efficiency, and to enable people to do or produce something. Technology is the result of a human brain when faced with a situation that must be conducted or achieved in a specific way in order to its output is greater than the input (devices, materials, energy, time) used in generating the job.

Technology contains four main elements; the first, basic and scientific principles as it's. Second, the materials and neccesery tools. Thrith procedures or steps to use the tool, and the fourth how are working on materials and tools. Technology is a coherent system that connects all four elements it contains in producing output or outcome goals (goods or services) specific (Nofrizal and Ahmad 2012; Ahmad and Nofrizal 2014; Ahmad 2012; 2012a; 2012b). Based on the the above discussion, it is essentially in producing any and even at retarded communities, they still have technologies. Similarly, in a factory of wooden dockyard for producing fishing boat or cargo boat, when they are producing its there are used technologies.

This paper is the observation and understanding result of the technology that is used in traditional dockyard in Riau, especially in Bagan Siapiapi. Especially for the state of the technology presented briefly at traditional dockyard with his trademark emphasis with regard to technological knowledge, labor, technology, wood preservation and wood boatbuilding, production and quality of wooden boats issued.

MATERIALS AND METHODS

Four wooden traditional dockyards were elected as sampling for data collection by propulsive sampling methods, which based on the willingness of owners traditional dockyard for interviewing. The traditional dockyard location is at Bagan Hulu and Bagan Barat village, Bangko district, Rokan Hilir regency, Indonesia (Figure 1).

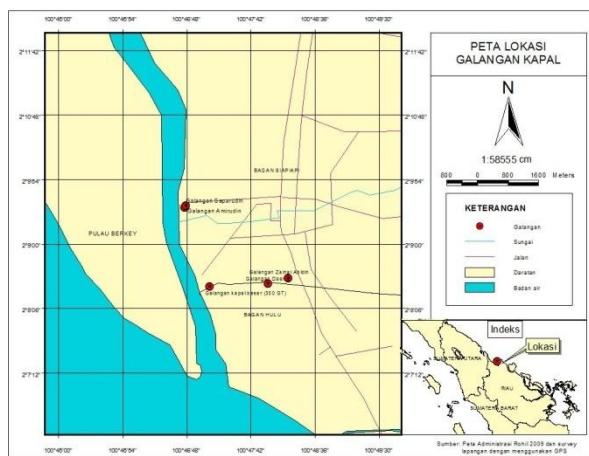


Figure1. Map of the wooden traditional dockyard location in Bagan Siapiapi, Rokan Hilir regency.

The research activities were emphasis on observations of technology usage pattern in build process of the wooden boats in traditional dockyard, which is willing give information. Series survey activities were given the ideal business model for traditional boatbuilding businesses that use wood as raw material to produce boats and the possibility to replace the fiber reinforcement plastic (FRP) as new raw material. From various aspects and phases of this study were obtained informations on the state of traditional wooden dockyard especially its management; so it can be the difference with a Modern dockyard which uses manifold materials other than wood, such as fiberglass and steel, or a mixture of both. One hundred question of the questionnaire its relation to the naval technology was as tools in this research. The question was emphasized on management, technology, and strategies of dockyard owners in run their business. Furthermore, it can be shown the difference in both the dockyard industry, especially with regard to efficiency and productivity, including through the "gap analysis". These informations are very useful for decision makers how to shift technology of traditional dockyard that are able to master and use technology of the modern dockyard. In addition, this study also analyzes the opportunities and enriched with fiber reinforcement plastic vessel development.

RESULTS AND DISCUSSIONS

Labor in the traditional dockyard. Owner of the traditional wooden dockyard in Bagan Siapiapi is concurrently also as a foreman. They were directly in charge of the allocation of resources and skills election workers will be hired as a craftsman boat. Proficiency that, they gained from work experience. However, there is also derived from the Chinese people who had once as their employer. When feel they have adequate skills, they began to move the work to the family dockyard business. If the experience has felt enough, then they usually open their own wooden dockyard business on a small scale. Although small-scale enterprises because of the very limited availability of capital, they are the steadfastly undergo the effort. There is no specialization and a clear division of labor. A labor is not focused on a specific job (one job one man). A handyman is not too responsible for the results of his work, as the result of the installation of the particular construction. However, they are entirely the responsibility of the foreman.

Nevertheless, the foreman always supervises other craftsmen for maintaining the quality of the work, when they are installing an ingredient in certain parts of the boat building. The craftsmen get knowledges on boat construction, based on experience working boat conducted jointly with the foreman. There is no special training for the construction workers before the team was working on the development of a boat. So, the skill level of a boat builder is largely determined by their old work or the number of boats they have made and the skills of intelligence or talent.

The level of education and educational backgrounds of the craftsmen boat ever lived it is by no means a benchmark for making decisions foreman in the appointment of workforce. Recruitment was more based on kin or familial connection. Nevertheless, specific standards in the selection of the relatives or family who will be employed as a craftsman, the owners of dockyard remained performed dockyard, based on the relevant experience in boatbuilding.

Making process a boat by a team formed dockyard owners. While a number of teams make a boat only range up to four people labor that is including foreman. Certainly, the larger size of the boat to be made, the more precisely the labor required. Overview of the number of workers and boat builders in the level of education in the process of making a boat can be seen in Table 1. Educational level and educational background is not decisive in the acceptance or craftsmen in the traditional dockyards. Moreover, the traditional dockyard owner's education in Bagan Siapiapi is generally just graduated elementary school, or even has not finished primary school, but there are also among the graduated of junior high schools.

Table 1: Number of labor and formal educational background of traditional boat builders in Bagan Siapiapi

Dockyard name	The capacity of boat (GT)	Number of craftsmen	Educational level of craftsmen (person)				University/Aca demi
			Not graduated primary school	Premary school	Junior high school	Senior high school	
Zainal	1	1	1	-	-	-	-
Abidin	2	2	1	1	-	-	-
dockyards	3	3	2	1	-	-	-
Daeng	1	1	-	1	-	-	-
Budiman	2	1	-	1	-	-	-
dockyards	2,5	1	-	1	-	-	-
Saparuddin	1	2	1	-	1	-	-
dockyards	1,5	2	1	-	1	-	-
	2,5*)	2	1	-	1	-	-
Amiruddin	4	2-3	2	1	-	-	-

dockyards	3	2	1	1	-	-	-
	2	1	1	-	-	-	-
	10	4	1	1	2	-	-

*) Just maintenance and reparation the boat

Continuous supervision of the work carried out during the process of manufacture or installation of boat building parts. If there are errors or omissions made craftsmen were reprimanded and was followed by follow-up repairs are conducted directly together foreman.

Wage or salary system in the boat builders of traditional wooden dockyards consists of two kinds, namely contract and daily wage system. The amount of salary received is determined based on the position which is carried out by craftsmen. For a foreman earns Rp. 120.000,- / day up to Rp. 150.000,- / day. While other craftsmen only received Rp. 50.000,- / day. Craftsmen salaries are not much different than the local minimum wage. State salaries and wages of craftsmen in the dockyards in Bagan Siapiapi can be seen in Table 2. Table 2 shows the level of education is not at all decisive salaries paid by the craftsmen. Determination of salaries and wages was also not wearing a certain wage standard basic. Therefore, foreman salaries between one team with the other team are not the same.

Table 2. List of workers and craftsmen salery in the traditional dockyard in Bagan Siapiapi

Dockyard name	Job title	Educational background	Salery/wage (Rp)
Zainal Abidin dockyards	Foreman	Not graduated primary school	Rp150.000,-/day
	Craftsmen	Primary school and Junior high school	Rp50.000,-/ day
Daeng Budiman dockyards	Foreman	Not graduated primary school	Contract system
	Craftsmen	-	Contract system
Saparuddin dockyards	Foreman	Primary school	Rp150.000,-/ day
	Craftsmen	Junior high school	Rp50.000,-/ day
Amiruddin dockyards	Foreman	Junior high school	Rp120.000,-/ day
	Craftsmen	-	Rp50.000,-/ day

In the boat building contract system for example, the payment of wages based on the results of operations performed. Profits of operations are divided evenly between the foreman and craftsman boat, because the craftsmen came from a large family relationship or even in one household in this contract system.

Technology of the wooden boatbuilding in the traditional dockyard

Tools for construct wooden boat. Craftsman tools used mostly carpenter tools; such as axes, hammers, saws, electric planers, tape measure, ruler elbow, marker thread, electric drill, big and small braces, etc (Figure 2). There among the tools those are functionally equivalent however different size or same type, and different functions such as longitudinal and transverse saws.

Table 3. The list of type and price of tool for contructing the wooden boat

No.	Tool type	The number of required	Price of tools (Rp.)
1	Axe	1	45.000,- - 60.000,-
2	Small hammer	1	25.000,- - 35.000,-
3	Big hammer	1	40.000,-
4	Transverse saw	1	26.000,- - 35.000,-
5	Longitudinal saw	1	26.000,- - 35.000,-
6	Hand planers	1	20.000,-
7	Electric planers	1	280.000,- - 380.000,-
8	Meter	1	20.000,-
9	Flexible elbow ruler	1	10.000,- - 15.000,-
10	Static elbow ruler	1	15.000,- - 20.000,-
11	Marker yarn	1	25.000,-
12	Electric drill	1	380.000,- - 500.000,-
13	Big brace	1	40.000,- ^{*)} - 450.000,-
14	Small brace	1	25.000,- ^{*)} - 75.000,-
15	Big chisel	1	15.000,-
16	Small chisel	1	10.000,-
17	Handspike	1	25.000,-

*) Secondhand price



Figure 2. Craftsman tools are used in traditional dockyard.

Source : Nofrizal and Ahmad (2012)

This tool prices ranging is from Rp. 10.000, - to Rp. 450.000, - per-unit. The type and number of tools require for making a wooden boat in the traditional dockyards show in Table 3.

Boatbuilding tools were purchased by the owner of the dockyard is nothing newone, however in general the former tooling. The craftsmen tools can be purchased at a hardware store in the Bagan Siapiapi city. So, there are no tools to be ordered out of the Bagan Siapiapi city. In the traditional wooden dockyard, nothing at all that using a functional facilities, such as a slip way or rail slide to raise and lower the boat into the water, cranes for lifting equipment and materials that are large and heavy, and the winch etc. In terms of determining the boat design does not require a plan and line of special drawing at traditional dockyard. Determination of the design and shape of the boat is just based on sheer experience of foreman. To determine the capacity of the boat is based on the size of keel, amount of casco and the amount hull board. Keel size was 6 inches in thick. The more of the hull board is used as a result the greater capacity of the boat (GT) to be produced. Boatbuilding knowledge is gained based on experience gained from the production number of boats that have been produced over the traditional dockyat it self.

Wood as raw materials and processing for boat's construction. Wood as raw materials for boatbuilding in the traditional dockyard was obtained from existing forests along of the Rokan river. Several types of the materials were logged from the forest around Bagan Siapiapi. Materials were obtained through an order which ordered the encroachers of forest or to the loggers who have known foreman and owner of a dockyard. They relate trade in the range that has been a long time. Fishing vessel owners or entrepreneurs with a regular subscription are related dockyard owners.

Ordering of materials was usually conducted only when there was an order from the owner of the boat. Wood materials for boat's construction are usually ordered with a certain size in accordance with the boat's owner to dockyard owner. Then, the owner of dockyards ordered to loggers.

Almost all traditional dockyards were used same type of wood for boat's construction in Bagan Siapiapi. There is no significant difference between the wood used on one another dockyards. The types of wood are usually ordered to the logers such as *Parastenon* sp, *Vitex pubercens* Vahl, *Shorea platiclados*, *Tetramerista glabra* Miq, *Agathis dammara* (Lamb.) Rich, and *Dysoxylum densiflorum* (Bl.) Miq used in certain parts of boatbuilding. The wood type for material of boat smaller than 10 GT present in Table 4.

Table 4. The wood type as material for boat's construction in Bagan Siapiapi.

No.	Type of materials	Class		Part of boat's construction	The number of required	Price per rod (Rp)	Total price (Rp)
		Durability	strength				
1	Malas (<i>Parastenon</i> sp)	II-III	I	Keel	1 rod	800.000,-	800.000,-
2	Loban (<i>Vitex pubercens</i> Vahl)	I	I-II	Rip	34-50 rod	50.000,-	2.500.000,-
3	Pasak lingga (<i>Dysoxylum densiflorum</i> (Bl.) Miq)	II-III	II-IV	Tramson	6-8 rod	150.000,-	1.200.000,-
4	Pasak lingga (<i>Dysoxylum densiflorum</i> (Bl.) Miq)	II-III	II-IV	Stringer	1 ton	1.000.000,-	1.000.000,-
5	Meranti (<i>Shorea platiclados</i>)	II-III	II-IV	hull	2 ton	3.500.000,-	7.000.000,-
Total							12.500.000,-

Note: Total price based on the maximum amount of material

The main obstacle in the procurement of raw materials was difficulty to get the material in the forest around Rokan Hilir regency. It happened due to the increasing scarcity of wood species, other than those in the woods, also increasing the demand for wood by increasing wooden dockyard since several years ago. Raw material procurement of the wooden boat was also increasingly difficult after the issuance of a law that prohibits harvesting and utilization of forest products, especially those that will be traded in the form of wooden logs. However, the rules also apply for constructing a wooden boat.

Each a reservation wood for boatbuilding usually takes 20 to 30 days arrives to doackyard. Sometimes, the hard times of materials wood boat the orders can not be fulfilled at all, because of the type of wood that is intended is not available in the forest. Wood type material that is very difficult to obtain vessels usually is *Vitex pubercens* Vahl. *Vitex pubercens* Vahl commonly was used as rip of the boat, and *Parastenon* sp was used as a keel. For part of the boat that are not directly bear the burden or indirectly in the water can still be held, but it takes a long time to look for in the forest.

Overcoming the difficulty of obtaining wood as a boat material, the strategies used by the owner or the dockyard foreman is first, to provide a higher bid price on the wood material of their message to the seller and loggers. Second, the cannibalism method, i.e. taking and buying materials on wooden boat that have been damaged, some of the wood in the building is still possible to use a certain boat then take it. Rip and keel are part of the boatbuilding, which usually was purchased. Wood material for rip and keel were usually purchased at a price as Rp800.000,- to Rp1.000.000,- per cubic, its according to the material conditions. Third, if the main ingredient is not available, it can also be used substitutes. Desired wood was replaced with other types of wood; but its magnitude and relatively similar grade durable, such as *Shorea platiclados* as hull of boat. It can be replaced as *pemulai*, as well as *Parastenon* sp can be replaced *Dysoxylum densiflorum* (Bl.) Miq. However, the use of these material remains of course will reduce the quality and durability of boats made by the traditional dockyard.

Table 2. Number of wood required for shipbuilding

No.	Type of Boat	Capacity (GT)	Required wood			Total
			Board	Beam	Rip	
1.	Fishing boat	a). 1,5	0,4 M ³	0,15 M ³	0,1 M ³	0,65 M ³
		b). 3,5	0,85 M ³	0,35 M ³	0,25 M ³	1,45 M ³
		a). 5	1,5 M ³	0,5 M ³	0,3 M ³	2 M ³
		b). 10	2,4 M ³	1 M ³	0,6 M ³	4 M ³
2.	Cargo boat	c). 20	4,8 M ³	2 M ³	1,2 M ³	8 M ³
		d). 50	12 M ³	5 M ³	3 M ³	20 M ³
		e). 100	24 M ³	10 M ³	6 M ³	40 M ³
		f). 500	120 M ³	50 M ³	30 M ³	200 M ³

Source: Ahmad et al., (2004)

Step of the wooden boatbuilding. Processing of wood materil for boatbuilding was relatively more difficult than the process several types of other boat materials. Therefore, the necessary knowledge, skills and techniques or tips specific processing such as in the case of indentation or arch form in certain parts of the boatbuilding. The owner dockyard or foreman gain knowledge of this wood processing techniques from his parents for generations, which was used generally also a b boat builder.

Pattern of wooden shipbuilding enterprises and traditional boatbuilding system is very possible for them to lower their knowledge to a child or close family, because recruitment system or handyman based family and kinship relationship. However, there are also some boat builders who gain knowledge of techniques to make it boat directly from the experience gained from creating another boat in the

dockyard. However, the experience gained makes the ship was not the one in a short time. At least it took more than eight years.

Knowledge and skills to process the wood boat material not only form a specific part of a wooden for boat building, but also make the material preservation. The goal is that the material is resistant to pests and weathering, shrinkage does not occur during use and easy to process as well as the shape of the building work on the installation of certain boat. Therefore, before the wooden boat materials used or mounted on the boat building, wooden to be preserved first and subsequently processed in accordance with the shape of the building materials where the paired boat. So the process of using an ingredient in the manufacture of wooden boats is through the process; namely: forest wood roughly shaped and then dried and molded detail and smooth as the processing activities. Then conducted preservation and finally the installation of the boat building are according to the following workflow.

Wood as a raw materials → Formed (roughly) → dried → Formed (detailed/refined) → Preserved → Installation

Preservation is carried on wooden boat material especially with activity drying to reduce the moisture content of wooden to be used. Wood drying conducted with the wooden sunning under the scorching sun for at least more than 20 days. Drying is to avoid or minimize the possibility of a gap in the wall connection board of boat body (Figure 3). Wet wood will experience shrinkage when dry or worn for a long time and exposure to sunlight. If the boards are wet that the hull mounted as a wall, then in the opening under the sun light will experience drying, which resulted in a gap between the boards to each other (Nofrizal 2008; Nofrizal et al., 2014). The longer it the gap will be enlarged and cause boat to leak.



Source: Nofrizal and Ahmad (2012)
Figure 3. Drying wooden boat material in traditional wooden shipbuilding.

Order to improve the durability of wooden boat material and prevent the natural weathering process and wooden pests such as animal sticker / tacks and poker, then used preservatives (Ahmad, 2012; 2012a; 2012b). So in creating wooden boats preservatives are also required to ensure the resilience of the body or the wooden boat building. Preservative commonly used among other things, solar, black holes, the toxic chemicals and waste oils. For the size of boat 2 GT normally requires 30 liters of solar or waste oils. This type of preservative easily obtained at a hardware store around Bagan Siapiapi town.

The traditional dockyard owner and foreman generally have no other knowledge about alternative materials for making boat, such as fiber reinforcement plastic (FRP), steel, and other materials. Therefore, if the wood is not available, then the boatbuilding activities at its dockyard stopped. Then they usually look for alternative jobs such as making fishing gear, as a house constructor and as a fisherman. Thus, the threat of being unemployed for a very large boat builder, especially if the wood is no longer available for boat building.

Meanwhile, the desire for alternative materials or wooden substitute materials is not owned by owner of the dockyard. It is, because they do not have the knowledge and techniques of processing alternatives, or the replacement. Nevertheless, the desire to learn alternative or substitute materials is quite large among foreman and owner of the traditional dockyards. Unfortunately they do not know what to learn or get information about where it is not available in the environment they attempt.

Production of the wooden dockyard. Traditional wooden shipbuilding production depends on the availability of wood as raw material (Ahmad *et al.*, 2004; Nofrizal *et al.*, 2014). So the traditional dockyard owners are expecting the ease of the forester to get wood as raw material, because of their sustainability depends only on the material. Availability of raw materials is crucial kept his boat submission time specified by the buyer. Without the raw materials available it is difficult for them to be punctual submission boat on order. In fact it is not uncommon to wait for the raw materials that have been ordered to come over the business they do or do other work. In addition, the resulting production of wooden boats they are also determined by the equipment they have. Most of the equipment that they have comes from stuff used or when there is a new but low quality. So some times it takes care of the equipment again. Although with this condition the traditional wooden dockyard still produces wooden boats. However the production of wooden boats in the traditional shipyard as disturbed or even stopped as seen in Figure 4.

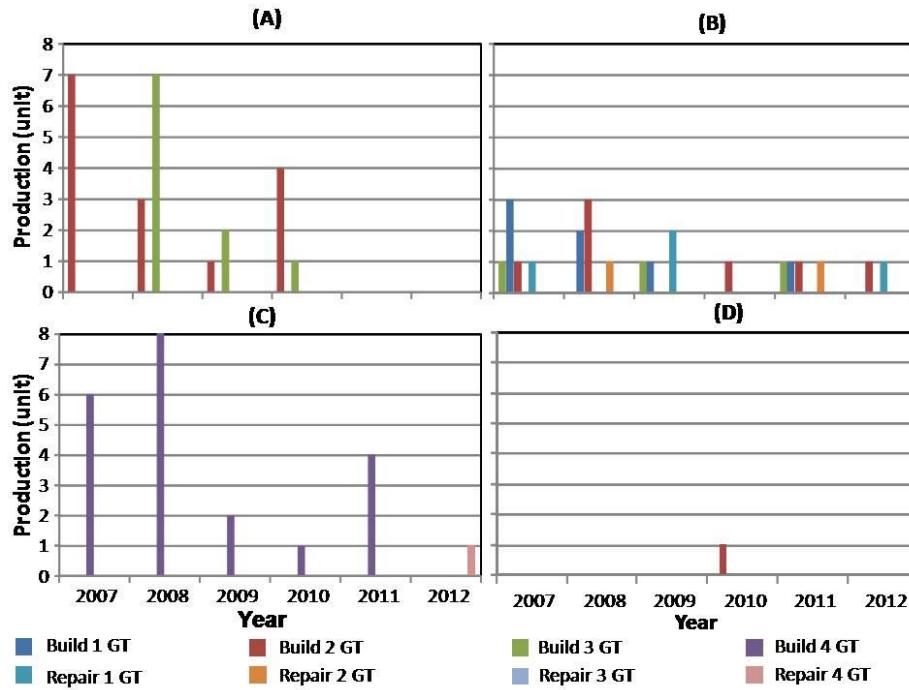


Figure 4. Production of traditional wooden dockyard last six years in Bagan Siapiapi; (A) The Zainal Abidin dockyard; (B) Saparudin dockyard; (C) Amiruddin dockyard; and (D) Daeng Budiman dockyard.

Source: Nofrizal dan Ahmad (2012)

Figure 4 shows that the production of wooden boatbuilding and boat repair were decreased in four traditional dockyards. Even the dockyard was not working in 2011 and 2012, because there are no getting job orders. Then they also stop the ship repair activities. This is mainly due to the difficulty also get wood, so that the shipyard owners can not give assurance to the customer about how long the ship can be prepared. Thus, the change of the ship's main material has a strong durable class I-II and replaced with durable and strong class II-IV. This replacement can reduce the quality of wooden boat, which was produced by this traditional dockyard. Fourth traditional dockyard owner was claimed that the problems in boat production is the difficulty of getting good wood materials and appropriate for boat's construction. Therefore, they expect any concessions to get permission obtain a wooden boat materials from the forestry agency. Although it is almost impossible to be granted, however they still pinned their hopes.

Quality production of the wooden boat. Efforts of the owners of traditional a wooden dockyards to improve the quality of artificial boat them by using qualified a wooden material. Nevertheless they never give warranty to the buyer after boat handover. To satisfy the buyer desires on the quality of the boat, the owner of the shipyard traditional boats performance testing it. The boat performance test, such as 1) Testing of boat performance in waters. Testing the look of this boat performed to determine the stability of boat in the waters or when sailing; and 2) the leakage test. If there is a leak in the boat, then immediately the owner of dockyard will be repaired by conducting re-plug and re-putty before the handover conducted.

The dockyard owners also do not have a policy of ensuring the quality of the resulting vessel. There has been no attempt to provide a guarantee to the customer on their boat product. There is also no agreement with the company's risk guarantor such as insurance companies, both public and private for the newly created boat. Nevertheless, the traditional owners of the dockyard were satisfied with the results of their homemade boat. If there is no "complaints" from the buyer after the ship was handed over, it is both an indicator for the owners of dockyards that they make qualified or competitive enough.

The owners of traditional dockyard expectations to government, especially local and central government in order to give special attention to the business of making wooden boats in the traditional dockyard in Bagan Siapiapi. It is expected that traditional wooden boat building business is still guaranteed maintained its existence and sustainability. So that, in the future not only live a longer story only. According to them the worst risks they may encounter and occurs in traditional dockyard business is going to close due to scarcity of raw materials that they need not be obtained.

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