

# Technological adaptation in traditional fisheries: way to survive

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**Abstract.** Traditional fisheries use traditional fishing gear and fishing boats at a scale of household and the small group of fishermen. Traditional fishing gear and boats which have been used since ancient times are still used in the era when more advanced technologies are available. What makes this simple technology able to survive today and how does it interact with new technologies? This question is tried to be answered through surveys conducted over the last few months (March-July 2017) in several fishing villages on the coast of the Celebes Sea and the Islands of Sangir in North Sulawesi. The level of mastery of local boat-making technology, the tendency of fishermen to maintain their technique known and mastered for generations and limited access to new technologies are among other factors that make traditional fisheries remain. On the other hand, the limitations of natural raw materials, the introduction of new technologies by governments or fishermen from other regions, as well as the needs of fishing communities encourage traditional fisheries to adapt technologies continually. This article also illustrates some examples of technological adaptations to the fishing boats.

## 1. Introduction

Boats for fishermen in everyday life are primarily economic means, yet at the same time are social symbols and cultural institutions in society. In addition to catching fish, boats serve as means of personal as well as public transportation, function as the main mean in various ceremonies of various maritime cultures throughout the archipelago. It is also a marker of particular social strata in fishing communities.

Salam and Osozawa [1] have observed the technological adaptation of all traditional boat forms in Indonesia which occurs since centuries ago, especially in the Spermonde Islands-South Sulawesi. The interaction between the original technology of the archipelago and the technology of foreign ships (Arabic, Indian, Chinese and European) since the era of trading began has led to the evolution of ship forms and their functions that are driven by the relentless adaptation of technology. The technological adaptation of boats and fishing gear can be understood as a fisherman's effort to improve the performance of their boats and fishing gear by taking advantage of the available technology while maintaining old forms and functions that are deemed usable.

Observing technological adaptations conducted independently by fishermen on boats and fishing gear gives a dynamic picture of the development of the shape and function of the boat and its gears. By understanding this dynamic, we can at least learn the patterns of acceptance and rejection, as well as modifications to a technology introduced to fishermen. Thus, it can be considered a model of technological adaptation that can easily be accepted by the community if a particular party, such as the



government, is about to introduce a new technology in the field of capture fisheries. In other words, technological adaptation is a transitional path that can bridge the development of traditional fisheries toward modern technology which is a necessity if it is to expect advanced and sustainable capture fisheries in Indonesia in the future.

Technological developments in various fields directly or indirectly related to fishing activities which are involved in traditional fishing communities influence boats and fishing gear development. The influence is pervasive, either through adoption and self-adaptation by fishermen or introduced by others such as government or fishing fleets from other regions with more advanced technology. However, the acquisition of technology by fishermen through adaptation looks so slow, secondary and partial on items that are not so significant on catch performance. Since the Indonesian fishermen recognize motorization for the first time in the era of the 1970s [2, 3], there is no technological progress that stands out for the betterment of their boats. The outrigger-boat, for instance, is still with the same outboard engine and until today the predicate “traditional” is still attached to our fishermen.

How the technological adaptation in fishing boats occurs? What kind of and at what extent technologies are adopted in the traditional fishing boat technology? These two questions are attempted to be answered to understand the development of traditional fishing boats from traditional fisher’s capabilities to maintain their existence.

## 2. Methods

This study examines the technological adaptation of boats used by the traditional fisherman along the north coasts of northern Sulawesi and in the Sangir Islands of North Sulawesi Province. This research is aimed to know the process of technological adaptation on fishing boat and adaptation of technology of traditional fishing boats.

Research on technology adaptation on traditional fishing boats and fishing gear needs to be done to obtain a knowledge base for a better understanding on how to develop boat and fishing gear for suitable for the traditional fishermen by introducing more advanced technologies in the future. The results of the research can be used as a reference to create a concept of applying advanced technology in traditional fishing boat design. If similar research is conducted in various locations with different geographical, oceanographic and fishermen’s characteristics, the concept of applying technology is appropriate to local characteristics in various regions in Indonesia. Furthermore, fishing vessels and fishing gear can be built with more advanced technology and best suited to the needs of traditional fishermen in their respective localities. This concept can be useful for governments to up-grade fishermen through empowerment and development programs.

## 3. Results and Discussion

### 3.1. Boat evolution: the survival of the fittest

The evolution boat, as proved by [1], is a phenomenon that does occur. As the evolution that occurs in the living things the evolution of boats also occurs relatively slow, of course with a shorter timescale. With the passage of time, the boats used by humans are developing. The shape changes with function, capacity demands, interconnection and even subject to the human aesthetic.

Thus, the types of boats have increased and then developed into hundreds of ship types used by humans in this era. With such a rapid rate of development, countless types of extinct boats that have been found were no longer sail on the waters. In Indonesia the types of boats, especially in South Sulawesi, legendary boats that had been the backbone of the maritime axis of the archipelago such as the *phinisi* and *padewakang* now only become a symbol of the past maritime glory [4].

Boats in Indonesia have been the part of livelihood since early humans, the Australo-Melanesians who migrated from Sunda land to the Wallacea, inhabited the caves. Many prehistoric boat paintings are evident to this [5, 6]. There is a report of a boat painting in caves of the Little Kei Island in Eastern Indonesia. Reproduction of the cave imprint presented by [5] shows the boat as a dugout with additional structure and projecting bows. This painting resembles the boat painting with pictures of

men, animals and the sun along with pictures of long boats called *kora-kora* found in East Timor reported by [7]. All those boats were single-bodied dugout canoes without outriggers, although some of them show the additional construction for poles and sails or other strengthening structures (figure 1) [5].



**Figure 1.** The boat painting on a cave wall in Ohoidertavun Village in Lesser Kei Island.

Outrigger canoes are absent from cave paintings. The outrigger boat technology is associated with the second wave of migration of the Austronesians from Taiwan to Indonesia circa 2,000 BC with more advanced technology. They might have started life in pillared houses above sea level or on their outrigger boats that roamed the waters of Nusantara.

The oldest evidence of outrigger boats is preserved on the impressive reliefs of the eighth-century Borobudur Temple [8]. However, the earliest written description is found in the fifteenth-century La Galigo cycle [9]. The boats are described as aristocratic boats used in adventures and wars to conquer neighboring states. A story in the La Galigo that narrates the creation process of the mythical boat indicates that the boat's body consisted only of a large tree that is hollowed out, a dugout boat. Further details on the manuscript describe the boats as ocean-going outrigger boats with a deckhouse structure, tripod mast, squared sails and lateral rudder. A description which very much resembles the Borobudur oceangoing outrigger ship. Outrigger boats are still in use today by small-scale fishermen across the archipelago but of course with their present appearance different from their ancestors. Hundreds of local names are used all over the country with variations in their appearance and parts.

Likewise, with the boats in the northern part of Sulawesi, some types of boats to flourish and there are also types that lead to extinction.

### 3.2. Traditional fishing boats on Northern Sulawesi

The north coast of Sulawesi and also Sangihe-Talaud Islands inhabited by several ethnics namely Gorontalo, Bolangitan, Minahasa and Sangir. Ethnically there is no striking difference between the boats they use in the fishery. The small boats they usually use are boats with outriggers and outboard engines mounted in the stern. There are only a few variations on how to bind the floats (*ateq*) to the transverse beam in the outrigger structures (*bahateng*) and various forms of bow and stern.

The outrigger boat used is commonly referred to as a *pelang* boat. Traditionally this type of outrigger boat is a semi dugout boat. Boat bodies are made by adding boards on the sides of the *mahera* (the base keel made from a whole piece of hollowed wood). This kind of boatbuilding technique is accepted throughout Indonesia because it is a legacy of the Austronesian boatbuilding technology.

However, there are several naming variations on boats based on size, style and place. A simple dug-out canoe with an outrigger is called *buloto*, a name that is also used for a paddle boat without an outrigger. The *pelang* boat was originally a term for a *mahera*-based boat, but with the influx of Filipino technology on Sangir fishermen, then a boat made of waterproof plywood can also be referred to as a *pelang* boat if it is made to follow the model of the outrigger boat common in this area. On the

northern coast of Gorontalo, the slightly larger sized boats are called *pamo* boats that can be used to operate larger fishing gear such as gill net, and if the size is bigger, it will be called *pajeko* with larger fishing gear such as mini purse seine.

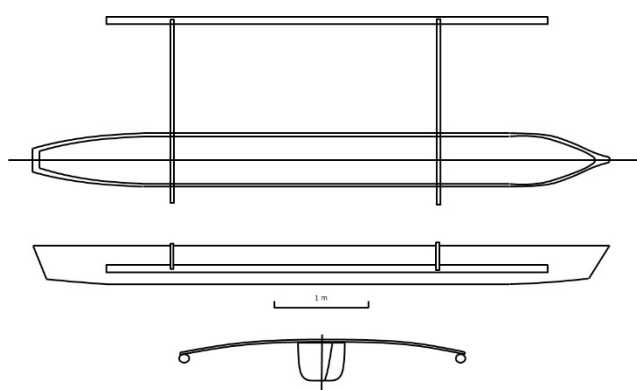
The boats used by the Sangir ethnic in the Sangihe-Talaud Islands seem to have more types. In addition to the *pelang* and *londe* boats, they use various types of boats the same kind of boats used by fishermen in the southern part of the Philippines, such as the *pambut*, *fuso* and *banka*. Large types such as the *fuso* and the *banka* are made in the Philippines territory and then purchased by Sangir fishermen. Smaller types such as the *pambut* can be made by Sangir boat builders who acquire these skills in the Philippines.

Among the types of boats is a boat *londe* is the type of boat whose numbers are already rare. This type has its own uniqueness. The current size of the *londe* boats is only about 5 m long, generally driven by oars and sometimes with a screen and operated by one fisherman. Its uniqueness mainly lies in its bow and stern. There is a kind of horn that pokes out from the bottom of the bow protruding forward and curling upwards like an elephant tusk. At the stern the horn is not so prominent but can be seen a little form backward. There is a strong supposition that this type of boat is the remnants of the ancient Sangir boat called *bininta* which is now enshrined in the symbol of the region of Sangir Islands District. Boats of the 'ancient times' *bininta* is a boat with the bow and stern both have a horn that pokes toward the front and back.

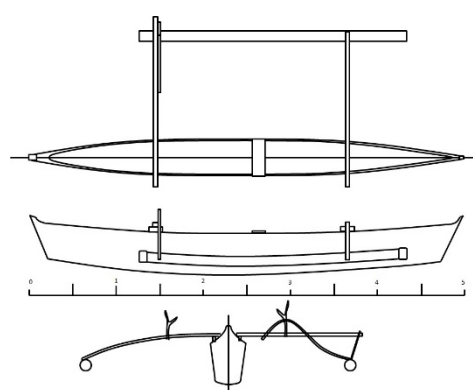
### 3.3. Development of traditional boat through technological adaptation

**3.3.1. Simultaneous development.** In this research, a development occurring on the boats used by traditional fishermen along the northern coast of Sulawesi as well as in the Sangihe Islands was observed. These developments occur simultaneously on several different levels of development. Underdeveloped types of boat are still in use according to its capacity and function along with new types of boats that have been developed with some or more changes. Thus, the previous type of boat does not necessarily become extinct. Possible changes on boats that go through technological adaptation are include changes in size, propulsion, materials and manufacturing technology, fishing gear, fishing auxiliaries and of course bringing change to the capacity and function as well as the aesthetics of the new boat.

The *buloto* used as a means to do fishing activities by using fishing rods in waters very close to the beach is a simple boat driven by oars. This type of boat is made of intact wood dredged in the interior and then formed into a boat. The outrigger float can be made of bamboo or light wood that has a buoyancy that is connected with two logs across the front and rear of the boat (figure 2).



**Figure 2.** Buloto, the simple paddling boat with outrigger used for line fishing.

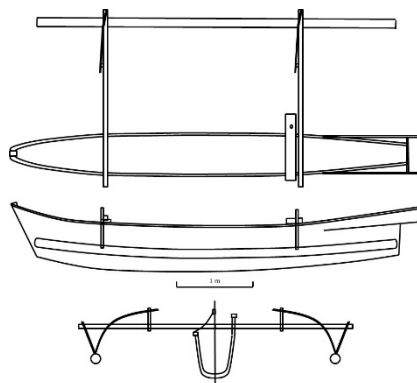


**Figure 3.** The small *pelang* with marine plywood for its side planks.

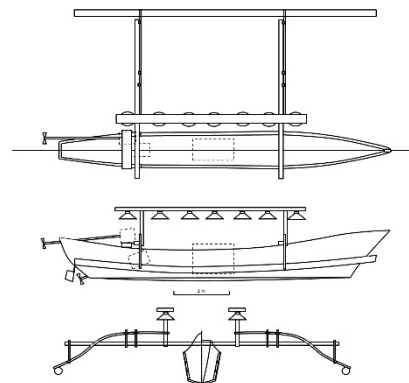
This outrigger paddle boat type is then developed into a small *pelang* boat of approximately the same size that is also only driven by using a paddle; its function is still the same that is for fishing with the hand line in the waters near the beach. However, this boat is made by using a *mahera* from a small tree trunk. The *Mahera* obtained from small wood does not have enough height to be used as a boat. Thus, the *mahera* is in the form of the flat keel of wood with a slight curvature. The side planks are made of marine plywood with some frame construction and side beams as reinforcement. This construction produces an outrigger paddle boat that is much lighter than the *buloto* to give comfort to the fishermen who operate it (figure 3).

The change in wooden boat making the material into plywood is a common phenomenon in northern Sulawesi. The diminishing source of wood for boatbuilding and the availability of marine plywood imported from the Philippines is a factor that allows this to happen. The reduced supply of timber is allegedly caused by the control of industrial timber plantations (HTI) by the company at locations that were traditionally the source of boat-building materials.

The *pelang* boat in figure 4 is a boat made of wood. The underside is made of a whole wooden *mahera* which is then raised with wooden planks. This boat uses an outboard engine (*katinting*) as a driving force to perform fishing operations using gill nets and line fishing in more distant waters. This type of boat is evenly distributed throughout the research sites visited. The outrigger boat that used to use sail as the main propulsion then adopted the use of the engine that could be regarded as the leap in technological adaptation by traditional boats in Indonesia in the 1970s.



**Figure 4.** The *pelang* with outboard engine as its main propulsion.

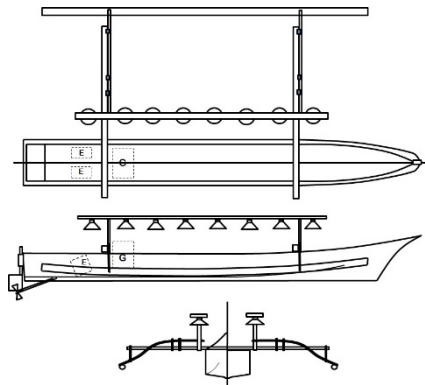


**Figure 5.** The *pelang* boat that turns to a lamp boat.

One of the developments of the function of the outrigger *pelang* type with an engine is to make the boat as a light boat. The boat is equipped with lights used to attract fish to gather around the boat. The boat depicted in figure 5 below is documented in Likupang at the tip of Sulawesi about half an hour from Manado City. The boat has an electric generator to turn on the lights and is equipped with an outboard engine as propulsion. The raw material is marine plywood with a length of about 7 m.

The boat operates independently collecting fish in the fishing grounds. Fishermen with purse seine who come to harvest the fish around the light boat will share the revenue of the catch to the owner of the light boat.

A very progressive development is also observed in the same village. Another light boat with larger size and capacity of lights (figure 6). This boat is made of fiberglass by local boat craftsmen who have been trained by the local government to make fiber boats. Although the design follows a modern ship design with a wide hull with good stability, it still retains the outrigger on both sides that is intended to obtain a good stability guarantee. This boat uses two internal engines mounted side by side on the stern of the ship and equipped with an electric generator.



**Figure 6.** A bigger lamp boat made of fiberglass.

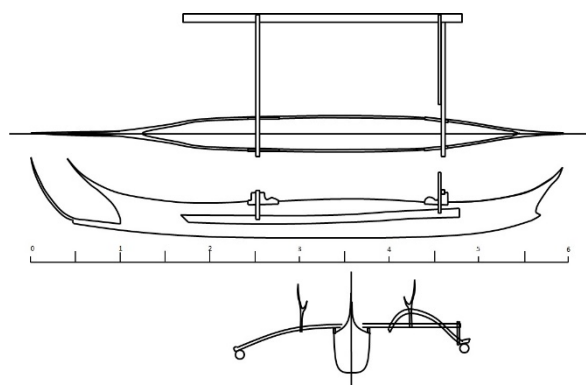
Development towards the use of fiberglass material generally occurs throughout Indonesia. Governments often provide aid in the form of fiberglass fishing boats to groups of fishermen. Even training has been done to local boat makers to make a boat from fiberglass. This has more or less helped solve the problem of scarcity of wood raw materials for boat making.

The adaptation of technology by fishermen and boat makers has shown that changes in the boat are in order to fit the boats to the needs of fishermen so that traditional fishermen can continue to maintain their existence in their efforts for livelihoods at sea.

**3.3.2. Extinction.** The logical consequence of technological adaptation on some types of boats which then gives better performance is that the types of boats that have been developed will be more widely used and the old types of boats will slowly be abandoned, no longer used and not made again. As a result, the old types of boats will be extinct.

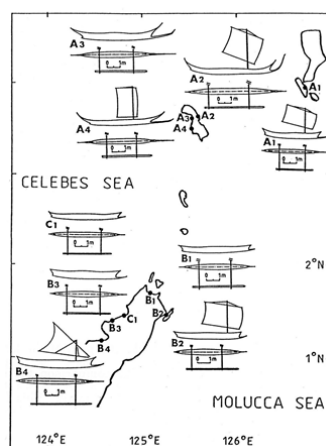
In Indonesia there are many types of extinct boats either permanently or still exist in the form of a replica. *Phinisi*, *palari*, *padewakang* and *pajala* boats are some types of boats from South Sulawesi that are already extinct. *Pakur* and *sandeq* are examples of boats from ethnic Mandar in West Sulawesi that suffered a similar fate. In North Sulawesi which is the location of this study there is a type of boat that has been extinct, the *bininta* boat which already mentioned above. Meanwhile, the type of traditional boats that have been on the verge of extinction is the boat called *londe*. It has a unique shape that gives a beautiful aesthetic impression. A slim transverse profile heralds a high hydrodynamics and streamlined curvature of hull lines. At the bow there is a horn that resembles an elephant tusk arch that protrudes from the bottom of the bow towards the front and curves upward. At the stern the horn is not so prominent but can be seen a small projection backward. This boat is made of wood with side planks on its *mahera*. The outrigger beam (*bahateng*) is different on the front and back. At the front, the outrigger beam is a piece of wood that is bent at the bottom end to hold the *atiq* (bamboo float) without a *tadiq* (the linking piece between *bahateng* and *atiq*). While the back is a straight piece of wood linked to the *atiq* with a curved rattan (figure 7).



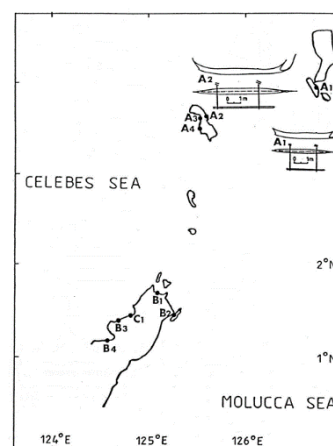


**Figure 7.** The *londe* type of Sangir Island.

In decades of 80s *londe* boats are still widely found along the coast through Manado City from Ranayapo, Poopo, Sario (Manado), Likupang to Batulubang near Bitung City [10]. Also found in Barangka, Tahuna, Naha and Lirung in the Sangihe Islands. The *londe* boat at that time was a sailboat used extensively in Sangir fisherman settlements (figure 8) [10]. In 2012, on Miangas Island, the outermost island on the border with the Philippines, there are still many *londe* boats [11]. However, in the same year, on the island of Marore in the Talaud Islands *londe* is no longer found which according to local residents once there are many on the island (figure 9) [11, 12].



**Figure 8.** The existence of *londe* in North Sulawesi in the decade of 1980s.



**Figure 9.** The existence of *londe* in North Sulawesi in the decade of 2010s.

The extinction of a *londe* boat with its horn characteristics is not because fishermen no longer need boats of the same size and functionality. The *londe* type began to become extinct because fishermen now no longer need the function of the horns, so they no longer order such boats. Horns were used as a place to hold to rest or to look into the sea at the time of collecting or capturing seafood by diving [10].

#### 4. Conclusion

Changes in boat features and types in order for fishermen to maintain the existence of their fishing activities are related to the process of or the absence of technological adaptation such as: (1) boat builders adapt to new material and technology for boat building, (2) fishermen adopt types of foreign boat and technology and (3) the extinction of boat(s) as a result of lack of technological adaptation. These are the proof that technological adaptation provides a way for the traditional fishery to survive.

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