Hospital Ship Design for Public Health Services in the Foremost, Outermost, and Remote (FOR) Areas in Indonesia

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Abstract. Indonesia National Health which is one of the achievement indicator of prosperity and prosperity of the people was still encountered many obstacles. Among many islands in Indonesia, there are only around 6,000 inhabited islands. Some of the islands, especially remote areas in the foremost, outmost and remote (FOR) areas, lack health services because the distribution of doctor or medical nurse rarely reaches these remote areas, and the difficulty of access to these areas also causes inequality in development, information flow, technology, education, and infrastructure compared to other regions. Health services are very important for the society, an alternative health service system needed to reaches FOR areas such as hospital ship concept. This concept not only offers health services but also access to education, training and other public facilities that can build up the prosperity.

1. Introduction
The Indonesian population has almost increased in size from 206.4 million in 2000 to 271 million in 2019. The rate of growth was 2.32% during 1980-1997, but it decreased to 1.31% during 2000-2019, this was the outcome of planned program propose by the government and also the result of development education in the family opportunities. The large Indonesian population is not equally distributed by the territory. Actually, 58.6% of the Indonesian people is concentrated in Java Island, even though Java Island only 7% of Indonesia’s total land territory [1]. Indonesia’s health level have shown in the poor level indicators of health among the society. The number of small islands in Indonesia has not been matched by health service facilities. These small uninhabited islands are far from development centers. The long distance and the lack of means of transportation, information and communication, makes this island left behind in many aspects. The lack of health, logistic, infrastructure and the difficulty of the community in accessing hospitals is a serious problem for the society.

The number of small islands in Indonesia has not been matched by the number of health service facilities. These uninhabited islands are far from city centers. The long distance, poor of public transportation, less of information and communication, makes this uninhabited island has a serious problem for health handling. The government itself has guaranteed funding for health services. However, it is not an easy for society in the small island to go to a referral hospital and covered the cos of living during the treatment process. Many victims were not saved because they could not reach the referral hospital in the city center. The presence of a floating hospital is expected to help the society to obtain the better medical services.
The presence of hospital ships with operating rooms and expert doctors as has been done by the Navy with KRI Dr. Soeharso, Doctorshare, Sailing Medical Service and RST. Ksatria Airlangga, can provide real support for the society in the uninhabited. The number of hospital ships is too small to covered the 6 thousand more inhabited islands in Indonesia, maritime health fleet services is needed to present comprehensive health services from Sabang to Merauke and from Miangas to Rote Island. The problem that shown in the hospital’s ship design before was not actually designed specifically for medical treatment activities. The existing hospital ship does not fully refer to the hospital building technical guidelines, operating rooms guidelines that publish by Ministry of Health in Indonesia. Hospital ship layout plan has to support the effectiveness and efficiency in the process of medical treatment.

2. Health Care in the Foremost, Outermost and Remote Areas in Indonesia: An Overview

The government provides primary health care centers called as puskesmas, this primary health care center provides in each subdistricts in Indonesia. Puskesmas has at least one medical doctor and nurses or other medical personnel who assisting the health services in this facility. Besides that the government provides a midwife as well to each village, but in fact this facility didn’t exists in the uninhabited island that far from city center. Secondary health care services are provided by 2820 hospital around Indonesia, 40% of them are government owned. Hospitals in Indonesia consist of public hospital and private hospital, growth of public hospitals for the past 6 years below the growth of private hospitals. Hospital growth rate public by 0.4%, because decrease the number of hospitals private non-profit, meanwhile private hospital is 15.3% [2]. The growth of hospital in Indonesia until April 2018 shown in Figure 1.

![Figure 1. Growth of Public Hospital and Private Hospital in Indonesia (2012 - April 2018) [2]](image)

The growth rate divided by province shown in Figure 2. The number of hospitals in regional 1 such as in East Java and West Java has increased more aggressively than other provinces with an average growth of 7% -8 %. Growth in the number of hospitals in regional 2 is not as aggressive as in regional 1, for regional 2, the average growth in the number of hospitals the highest in South Sumatra was 9% compared to the growth in the number of hospitals in other provinces. The highest number of hospitals in North Sumatra is in regional 3 with an average growth of 8%. while in South Sulawesi, although the number of hospitals is not as much as in North Sumatra, the average growth is also in the same value. The average growth in the number of hospitals in regional 4 is Kalimantan Island 2% - 9% [2].
The lack of hospital growth for the Indonesian archipelago, especially eastern Indonesia became the biggest problems. Concept of floating health service facilities a very feasible option, floating hospitals are needed, and smaller, more maneuverable ones. Because of that, the healthy budgetary surge doesn’t directly reflect the fulfillment of primary medical care. Indonesia possesses a glaring inability to provide equal distribution, productivity, and quality of health care throughout the archipelago to a population of approximately 260 million [3].

Indonesia has 2,820 hospitals with 1.21 beds per 1,000 population. The ratios of physicians and dentists per 100,000 populations are 16.06 and 4.57. Compared to the WHO recommendation of 1:600 doctor patient ratios, the condition of health care system in Indonesia is one of the lowest in Southeast Asia [4]. The majority of financial health sector is using insurance-based schemes, this schemes estimated that 70% payments constitute the total health care in Indonesia. The government also provides financing for puskesmas and hospitals. However, due to lack of funding, people still have to pay in certain period, it means the funds that the government provides may only subsidize the cost incurred in the health services [5].

3. Floating Hospital as a Health Service Facility
The desire of the government to increasing health service facilities in Indonesia, this issue has not been achieved due to slow and uneven development, especially in the eastern Indonesia. Floating health service facilities as a feasible option can provide medical services that can flexibly move from one island to another to reach populations living on the coast. Floating hospitals are a partial solution to provide better access in health aspect. The floating hospital have to complete and sustainable for the environment, for example the KRI Dr. Soeharso can’t dock at the thousands of small island [6]. Although the facilities are excellent, but the properties is not compatible for the environment.

The addition of the aforementioned Ministry of Health allocation opens opportunities and gives space for the government to take part in the provision of health services in remote islands in Indonesia through floating hospital solutions. The participation of local and private governments that have been actively involved in addressing the scarcity of access to health on small islands especially in Eastern Indonesia should be supported through the provision of operational grant funds to these vessels. Governments with a wide network can also attract local donors as well as from other international social institutions to help so that these efforts can be sustainable.
Floating hospital design concept is the availability of medical facilities that are complete as a support for medical treatment including administration room; waiting room; large operating room (OR type 1); Small operating room (OR type 2); clean operating room (OR type 3); clean operating room contaminated (OR type 4); laboratory; tool sterilization room; tool laundry room; radiology room; treatment room/recovery room; scrub up room; medicine warehouse; operating clothes storage warehouse; meeting room; medical/doctor’s room; crew room; toilet for patient; toilet for medical crew; CO₂ and O₂ space; food warehouse; the dining room; galley/kitchen; and laundry room.

The list of medical facilities then becomes the basis for designers to make floating hospital ship layouts. This layout is based on regulations regarding the flow of medical activities that have been established, the horizontal relationship system. Table 1 is an example of regulations related to the minimum area of a room determined by hospital type C hospitals, this type was chosen based on the approach that the hospital ship would be used as a referral hospital.

Table 1. Minimum space requirements for public hospital type C [7]

| No. | Item                              | Area (m²) / bed room |
|-----|-----------------------------------|----------------------|
| 1   | Administration                    | 3 ~ 3.5              |
| 2   | Emergency room                    | 1 ~ 1.5              |
| 3   | Polyclinic                        | 1 ~ 1.5              |
| 4   | Social service                    | 0.1                  |
| 5   | Registration                      | 0.2                  |
| 6   | Clinical laboratory/pathology     | 2.5 ~ 3              |
| 7   | Obstetrics and gynecology         | 1.2 ~ 1.5            |
| 8   | Diagnostics and radiology         | 3 ~ 4                |
| 9   | Kitchen                           | 2.5 ~ 3.0            |
| 10  | Officer facilities                | 0.5 ~ 0.8            |
| 11  | Meeting room, training            | 0.5 ~ 1              |
| 12  | Speech and hearing therapy        | 0.1                  |
| 13  | Housekeeping                      | 0.4 ~ 0.5            |
| 14  | Material management               | 0.4 ~ 0.5            |
| 15  | Central warehouse                 | 2.5 ~ 3.5            |
| 16  | Purchase                          | 0.2                  |
| 17  | Laundry                           | 1 ~ 1.5              |
| 18  | Medical records                   | 0.5 ~ 0.8            |
| 19  | Medical staff facilities          | 0.2 ~ 0.3            |
| 20  | Engineering and maintenance       | 5 ~ 6                |
| 21  | Nuclear medicine                  | 0.4 ~ 0.5            |
| 22  | Child room                        | 0.4 ~ 0.5            |
| 23  | Officer                           | 0.3 ~ 0.4            |
| 24  | Pharmacy                          | 0.4 ~ 0.6            |
| 25  | Public area                       | 1 ~ 1.5              |
| 26  | Skin treatment room               | 0.1 ~ 0.2            |
| 27  | Radiation therapy                 | 0.8 ~ 1              |
| 28  | Physical therapy                  | 1 ~ 1.2              |
| 29  | Occupational therapy              | 0.3 ~ 0.5            |
| 30  | Operation room                    | 3.5 ~ 5              |
| 31  | Circulation                       | 10 ~ 15              |
| 32  | Inpatient unit                    | 25 ~ 35              |

4. Design of Floating Hospital for FOR areas in Indonesia

Floating hospital ship design is based on health service needs to the society in the territory of Indonesia. In order to improve public health services, the government has also built more than 7500 health centers (called puskesmas) spread throughout the territory of Indonesia [8]. Not all medical treatment can be done at the puskesmas, therefore patients can be referred to the city/regency/provincial hospital that has
the capability in terms of facilities and equipment, but sometimes the location of the puskesmas and hospital is not on the same land. This has become a problem in the efforts to equalize health services as a result of the territory in the form of islands, so that a floating hospital can become a referral hospital and expand the reach of health services for people living in remote areas.

Design of floating hospital has principle dimension LOA 42 m; LPP 36 m; B 12 m; H 4 m; T 2 m; Vs 15 knot. Principle dimension of the ship consider where the operational area, therefore it starts with the feasibility study stage. This consideration to justify the optimal size of the main ship's operational. The determination of operational areas is focused on the FOR (foremost, outermost and remote) islands area because this region needs attention especially in the health sector. Design of floating hospital shown in the Figure 3.

Figure 3. Design of floating hospital for FOR areas in Indonesia

The existence of floating health services does not replace existing health services, but instead serves as a referral place that has facilities such as operating rooms. Operating room is not provided at puskesmas, apart from being a public health service ship, this floating hospital also serves as an educational interface for developing and enhancing research activities in the field of public health sciences. This facility carries out integrated social service in various fields of science for the advancement of health services and public welfare.

This hospital ship is classified into the class I category, based on the operation area. The hospital ship that have a size more than 41 meters belong to the class I category [9]. Considering the inter-island shipping area with quite extreme geographical conditions such as the Madura Islands which have shallow water so they need a ship that has a draft low enough to be able to move closer to the mainland and the Maluku Islands which have high waves so need a ship that can covered the geographical conditions in the operational area, then a ship with a catamaran hull was chosen as an option.

Floating health services for the society are divided into IV classes with reference to the size of the ship, function of the ship, and the area of operation. Shipping area, type of ship material, minimum medical needs that must be provided above when sailing contained in the regulations. So the ship to be planned by the researcher refers to this regulation including determination the number of ship crew, medical crew and also patients that can be handled on board as shown in Table 2 related to the general classification of ship classification.
Table 2. General classification of floating hospital ship [9]

| No. | Class | Material | L (m) | B (m) | GT (ton) | Operation Area | Time (hour) | Stock of Medicine (kg) | Crew | Medical crew | Patient | Function                  |
|-----|-------|----------|-------|-------|----------|----------------|-------------|------------------------|------|---------------|---------|----------------------------|
| 1   | V     | *        | 6-10  | 2-3   | ~-20     | *             | 6           | 200                    | 2    | 4             | -       | Medical transport          |
|     |       | *        | 10-18 | 3-4   | 21-40    | *             | 12          | 300                    | 4    | 6             | 2       | Medical transport          |
| 2   | IV    | *        | 19-28 | 4-5   | 41-80    | *             | 24          | 500                    | 6    | 6             | 6       | Medical transport          |
|     |       | *        | 29-40 | 5-8   | 81-200   | *             | 36          | 500                    | 12   | 6             | 10      | Medical transport          |
| 3   | III   | *        | 41-~  | 9-~   | 201-~    | *             | 120         | >500                   | 20   | 10            | 20      | Medical transport          |
| 4   | II    | *        | 41-~  | 9-~   | 201-~    | *             | 120         | >500                   | 20   | 10            | 20      | Medical transport          |
| 5   | I     | *        | 41-~  | 9-~   | 201-~    | *             | 120         | >500                   | 20   | 10            | 20      | Medical transport          |

Notes:
i : Polyethylene
ii : Fiberglass
iii : Aluminium
iv : S (river); P (coastal); L (sea)
Based on the ship principle dimension, it is known that this ship is classified as a class I, with an alternative choice of steel or aluminum for hull material. Operation areas can be at sea with a maximum cruise of 120 hours. This ship is used for the floating hospital, equipped with medical equipment, examinations, medication and is required to be able to carry out small to heavy surgery aboard the ship. Facilities that need to be provided also include a recovery room or postoperative care, carried more than 500 kg of medical supplies and minimum of 10 medical crew. Design of heavy surgery room shown in Figure 4.

![Design of heavy surgery room in the floating hospital ship](image)

**Figure 4.** Design of heavy surgery room in the floating hospital ship

The flow of medical activities on hospital ships also referring to the flow of medical activity on shore hospitals, that is not allowed to have access to the same entry and exit points, so the flow of medical activities is designed to have access with different entrances and exits to keep the sterility of the room. Layout of the floating hospital ship can be seen in Figure 6. The existence of a floating health service is expected to be able to occupy the needs of health facilities, especially society who are in the FOR area which poor health facilities.

![Layout/general arrangement of floating hospital ship](image)

**Figure 5.** Layout/general arrangement of floating hospital ship (a)
5. Conclusion

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