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Water Ambulance Service Provision to Improve Healthcare Access for Community in Nusa Penida Island, Bali: A Qualitative Feasibility Study

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ABSTRACT

Background and purpose: An important component of healthcare access is transportation. Lack of transportation has been cited as an important barrier to healthcare access in remote islands region. Here we conduct a feasibility study on the implementation of water ambulance service to improve healthcare access in the region of Nusa Penida and its surrounding islands in Bali Province, Indonesia.

Methods: We employed a qualitative approach with interviews and focused group discussions with stakeholders. Data collection was conducted to assess the feasibility of operating water ambulance services, based on a framework that included technical, market, organizational, and financial feasibilities. Inductive coding was conducted and data was analyzed to evaluate the feasibility based on local capacity against pre-determined framework of assessment based in literature.

Results: Qualitative interviews revealed perceived urgency and need for water ambulance service among stakeholders. They also perceive the need of water ambulance service was not mutually exclusive to other alternatives, such as expanding healthcare capacity on the islands. There was also readiness and adequate capacity from stakeholders which include a dedicated health emergency services under the health office that coordinate ambulance service in the region, readiness to create dedicated medical team and boat crew to operate water ambulance services, and readiness to cover the cost of initial procurement followed by operational costs which may include public-private partnerships.

Conclusion: There was a strong perceived need for water ambulance service in Nusa Penida Islands. At the same time, local stakeholders revealed adequate basic capacity to feasibly operate water ambulance services according to benchmarks identified in literature review.

Keywords: healthcare access, water ambulance, islands region, rural health, Indonesia

INTRODUCTION

Improvement of healthcare access is part of the efforts to achieve equitable health development worldwide. It means improvement in various fronts, with the most basic being the reliable way to physically access healthcare facilities. In this regard, there are ongoing inequities between urban and rural areas. Various studies have showed rural areas have more barriers to physically access healthcare facilities.[1,2] A systematic review found that barriers to healthcare access are considerably higher in islands-based polities.[3]

Nusa Penida Islands is one such islands. It consists of three small islands organized as a single *kecamatan* (municipality), a third-tier sub-national division under Indonesian regional administrative system. Its permanent population consist of 45 thousand people who live in 16 village communities.[4] At the same time, no less than 250 thousand tourists visited the islands annually.[5] While the islands is located only around 25 km off the shore of Bali, a heavily urbanized tourism island, it remains an underdeveloped region with sub-optimal access to healthcare facility.

Access to tertiary healthcare facility is especially difficult. Although there are three public primary healthcare centers on the islands, there is only a single hospital with 42 beds to serve all 45 thousand permanent population and around 250 thousand annual tourists on the islands. The hospital also lacked specialty healthcare, with only 2 specialist physicians permanently stationed there.[4] There are 20 obstetric and gynecological cases and 5 abortus cases were referred to the regional hospital in Klungkung. However, during the process of transporting the patients, the medical staff in Nusa Penida faced a hard time due to the lack of reliable transportation system, especially because there is no water ambulance service available. Mostly the patients would be transferred by using a public boat which are only available during the day time, while in the evening there is no public boat available, therefore the referral mostly not possible to be carried out in the evening. As the results, sometimes the patients with critical condition could not be saved.

These conditions fit the factors affecting healthcare access in rural areas from previous studies. Other studies have stated transportation as a barrier to healthcare access, especially tertiary healthcare.[6] Availability of means to effectively and safely transport patients to more equipped healthcare facilities, measured by required transport time and the outcome of the referral is also an important measurement to healthcare access to rural areas.[7]

Shortening of transport time between primary and tertiary healthcare by improvement to the transport system and ambulance services is important for better health outcome to rural communities.[7,8] However, available studies are currently focused on regions with terrestrial terrain where improvement means road-building with automobile-based ambulances.[9]

Studies on improvement of transport time for tertiary care referral would be valuable to answer this gap in our knowledge. Thus, we conduct this study to evaluate the feasibility of improving tertiary healthcare access, especially pertaining to referral time, by running an effective boat-based water ambulance service in an island polity of Nusa Penida.

METHODS

We conducted a qualitative study with an exploratory approach in two selected villages which already developed BSG in Badung District, namely Kekeran Village in Mengwi Sub-District, and Punggul Village in Abiansemal Sub-District. The BSG in Kekeran Village was strengthened by the Kekeran Village Perbekel

Decree Number 20 of 2019. Cadres and midwives from the satellite public health centers (*puskesmas pembantu/pustu*) facilitated the BSG in both villages.

Research design and setting

This feasibility study used a descriptive qualitative design where for primary data collection to describe perspective of various stakeholders on the issue of water ambulance service for Nusa Penida Islands. Stakeholders involved in data collection included the staff of Klungkung District Health Office, managing authorities of healthcare facilities on Nusa Penida Islands, local clinicians, and general population of the islands.

Qualitative data collection

Data collection was conducted by focused group discussions (FGDs) and in-depth interviews (IDIs) with informants representing stakeholders including local healthcare workers, healthcare workers from the Bali mainland, local government, and the community. Informants were selected and contacted in cooperation with local government and health office. In total 10 IDIs and 2 FGDs were conducted in November 2019.

Table 1. Analysis framework to assess feasibility of water ambulance in Nusa Penida, Bali, Indonesia[10]

Product (Technical) Feasibility
1. What is the required technical specification of equipment necessary to implement the innovation?
2. Are there regulations on the applicability of the innovation implementation?
3. Is it possible to comply to the regulation for implementation of the innovation?
4. How to source the required equipment to implement the innovation?
Market Feasibility
1. How much is demand for referral to the mainland from the local community?
2. Is it possible to have the private sector provide the necessary services?
3. Are there similar service providers in the area?
4. What is the benefit and/or risk of provision of water ambulance service by the local government?
Organization Feasibility
1. What is the capacity, human resources, and skills possessed by the local government?
2. Are there any non-material resources that can be mobilized to develop the innovation?
3. Are there potential human resources that can be utilized to manage the innovation?
4. Is it possible to implement the services cost-effectively?
5. Does the government have the support of local community to implement the innovation?
Financial Feasibility
1. How much funds would be required?
2. Does the government have enough funds to procure the innovation and its operational costs?
3. How to source the required funds?
4. How can the government ensure the sustainability of the funding?

All data collection activities were recorded and transcribed in Indonesian language. Coding was conducted based on deductive method. The theme was classified based on framework of Feasibility Analyses for New Venture Non-Profit Enterprise explained by Berry (2017). Based on this framework there are 4 components including: Product feasibility, Market feasibility, Organizational feasibility and Financial feasibility. The 4

components guided the thematic analyses in this feasibility study,[10] and the term of "Product Feasibility" is modified into "Technical Feasibility" in order to address the technical aspects which were assessed in this study. The framework used in analysis can be seen in Table 1.

RESULT

Demographic characteristics of informants

We recruited 20 informants from various stakeholder groups with details visible in Table 2. Demographically, it included 7 (35%) females and 13 (65%) males. Mean age of informants was 38.25 (±8.70) years. Healthcare worker representatives from the islands included 7 representatives from public health centers and 3 representatives from Emergency Department of the local Pratama Gema Santhi Hospital. Meanwhile, government representatives included the regional secretary (highest ranking non-elected public servant), 2 representatives from Health Office, and 1 from Transportation Department. There was also 1 representative from Social Security Administrative Body (*Badan Penyelenggara Jaminan Sosial*/BPJS), government agency responsible for health coverage under public insurance scheme. Local community was represented by 1 local village leader and 1 local boat operator.

Table 2. Detailed list of informants, their affiliation, data collection method.

Stakeholders	Data collection methods	Numbers
Head of Klungkung District Health Office	IDI	1
Head of Healthcare Affairs Section, Klungkung Health Office	IDI	1
Heads and program managers of public health centers on Nusa Penida Islands	FGD	7
Director of Klungkung General Hospital, Semarapura	IDI	1
Director of Pratama Gema Santhi General Hospital, Nusa Penida	IDI	1
Managers and clinicians in Pratama Gema Santhi General Hospital, Nusa Penida	FGDs	3
Regency Secretary	IDI	1
Village community representative	IDI	1
Transportation Department representative	IDI	1
Public Safety Center (KRIS) operator representative	IDI	1
Social Security Administrative Body (BPJS) representative	IDI	1
Private boat operator representative	IDI	1
Total		20

Qualitative interview results

Technical feasibility

Informants showed lack of knowledge on boat dimension and design that they perceive to be ideal for water ambulance operation, citing lack of exposure to a real-life operating water ambulance as the reason. They only cite the boat has to be adequately sized to be stable on the water as to not impede any medical procedure or cause the patient discomfort. However, stakeholders from health office and healthcare facilities have a picture of medical equipment that would be required in a water ambulance based on their knowledge of regulations on ambulance services. They perceived minimum healthcare capacity in a water ambulance should include basic life support tools such as patient beds, oxygen, intravenous equipment, minor surgery kits, emergency delivery kits, rescue kits in case of apnea, and medical emergency medicines.

"The most important thing is, perhaps, adequate room inside the boat, meaning that the comfort of the patient who is referred to and the officer in the room on the ship, must be maintained, so maybe there should be minimum standard for the size of the boat.

The comfort of the patient and the officer in taking medical procedure or escorting the patient maintained. So that the possibilities that occur during this trip can be well anticipated."
IDI 003

One informant who was a local private boat operator revealed it is possible to procure standard-sized boats that would be appropriate for water ambulance use from local supplier. Local supplier could also provide routine maintenance that would be required. As for medical equipment, informants revealed local ambulance services in Bali, Indonesia has long been able to source their equipment through local distributors.

Market feasibility

Informants revealed the demand for referring patients to healthcare facilities on the mainland and difficulties in conducting it. Stakeholders from healthcare facilities on Nusa Penida Islands revealed they usually refer 3 to 4 patients daily due to emergency causes. The most frequent causes were traffic accidents while high risk obstetric cases also feature prominently. Moreover, they also revealed around 10 daily referrals for non-emergency causes.

"For hospital, Klungkung General Hospital, that I know. ... around one to three people per day. For outpatient care, it could be between 5 to 10."
IDI 003

"...yes, there are fractures, then there is also childbirth, then there are also cases such as high-grade dengue fever that required advanced care. yes, you have to be able to handle follow-up. If only grade 1 grade 2 can still be in Pratama Hospital. Moreover, we now have an internist there, it can be resolved here. But if, for example, you need more advanced care, you can probably refer to it later. Then labor is also often later, for example, a high risk, for example and so on. Then general surgical cases also exist."
IDI 002

Currently, referral to the mainland was conducted by using public ferry services or, if condition required it, to charter a boat on demand. The boats used for the travel was not equipped with required tools and equipment to provide emergency medical care on the sea. There was a disconnection between healthcare facilities who refer the patients from the islands and healthcare system who accepted them on the mainland. Healthcare personnel from healthcare facility of origin would usually only accompany the patient up until their departure from Nusa Penida docks. Meanwhile, KRIS, emergency service operator based on the mainland, would only start accompanying the patients upon their arrival on the mainland piers. As such, for a period of 30 to 90 minutes of sea travel with general passenger boat, there would be no professional healthcare who accompany the patients.

This arrangement also poses financial and operational problems. As the boats were operated by private boat operator, not healthcare providers, they cannot claim the expenses from the BPJS that acts as public health insurance, thus patient would have to pay out of pocket. As private boat operators, their operation was also regulated by local transportation department which prohibit crossing by boat after nightfall due to lack of equipment for such operation. Accordingly, the current referral system can only refer patient during the boat operational hours of 7 a.m. to 4 p.m.

"The boats in Nusa Penida used to have cooperation. Then, if in the past the BPJS [i.e., Social Security Administrative Body] patient was covered [for boat transportation costs], now it is not covered because if, for example, it is not in the form of an ambulance boat, the BPJS won't want to pay so they now have to cover the boat by themselves. So, from the hospital to the port, it

is the responsibility of the public health center as well as the responsibility of the referring hospital. … So, when the patient got off at Padang Bai and dropped off at Tri Buana, KRIS picked them up."

IDI 002

"The only problem is that this fast boat has a schedule. The operating hours now start from 7 a.m. to 4 p.m. But now, thankfully, there have been crossings almost every hour. After 5 o'clock it is usually because the passengers are also reduced because also in terms of safety, the boat is not equipped with search light for sailing at night."

IDI 006

On the alternative plan of expanding healthcare capacity on the islands, informants believed these courses of action should not be mutually exclusive. While expanding advanced care capacity on hospitals located on the islands would be necessary, it would not eliminate the need for emergency referrals. Arguably, as more basic conditions can be managed on local healthcare facilities, referred cases would be more severe and required more advanced care which necessitate dedicated water ambulance services.

"In fact, this supports the development of Pratama Hospital because with the development of the Pratama Hospital, of course it will handle more complex cases, so it was not referred to here from the start, he will handle it first there so that when this treatment fails, it requires more treatment continue now, usually this patient has an ee level, usually it would be higher, right, to have been treated, yet it failed, right? Usually, the emergency rate would be higher."

IDI 003

Organizational feasibility

Organizational feasibility of operating water ambulance service in Nusa Penida Islands was evaluated based on human resource and management required for such operation. There was consensus on the need of dedicated human resource to crew and maintain the seaworthiness of the boat and its associated medical equipment. A two-men crew was deemed necessary for each shift of water ambulance operation, one to captain the ship and another to assist with launching, docking, engine, and other operational requirement as necessary. These crewmen could be recruited from experienced boat or ferry sailors with additional training on emergency medical procedures.

There was also consensus on the necessity of dedicated paramedics to staff the water ambulance services. Healthcare facilities on Nusa Penida Islands voiced their objection to provide paramedics for the operation of the water ambulance claiming their human resources was already stretched thin under current condition. A dedicated paramedic team was viewed as more ideal for the operation of water ambulance services.

"There should be at least 2 at least, 1 at the helm, and the captain. There should be 4. There are those who handle the engine, there are those who help the helmsman to launch and dock… seaworthiness must be checked annually."

IDI 006

"Not yet, the Pratama Hospital has 109 employees if I'm not mistaken, with 109 of and as a Type D hospital, er, which will soon become a Type D hospital. The operation theater team, the operation team they only have one team, which they shouldn't, they should have more than one team. So currently they stand by 24 hours every day to do operations, you know, that's one example of a lack of resources."

IDI 001

Healthcare facilities on the islands also voiced objection to manage the water ambulance services for similar reason. Instead, there was a consensus for the service to be managed by KRIS, which is based on the mainland. This option was complicated by organizational chart of KRIS under the health office. Currently, KRIS operates as a non-autonomous operational unit under Health Services Affair in Klungkung District Health

Office, with no dedicated management team and non-flexible bureaucracy. To accommodate expansion of its services to include water ambulance, it was perceived to be necessary to upgrade its status to autonomous technical service unit, similar to how public health center was organized. In this capacity, KRIS would be able to manage their resources and to deploy them more strategically with less bureaucratical constraint.

"If not in the form of UPT [i.e., technical service unit], then we are not ready, because the water ambulance is a service delivery. There are a lot of health services delivery in the Health Service Affair, itself has a lot to manage, it has a lot of activities. What's more, there is a lot of activity ... if we add staff, staff who may have special qualification, maybe, in this field, maybe at least nurses, maybe doctors, maybe, yes, we would be ready. But now, not yet."

IDI 001

There was also concern on the legal and administrative requirement to operate a boat as water ambulance. Representative of Transportation Department revealed there was administrative requirement for boat operation which may apply for water ambulance. Water ambulance should also follow general standard operating procedures for boat launching and docking by port authorities. Under current procedure, ports which serve Nusa Penida Islands, both on the island and on the mainland, are closed after nightfall. Modification to their work procedures would be necessary to accommodate operation of water ambulance as a 24 hours emergency service.

"If it's at sea, the ship's document is from the harbormaster who will publish it later. Then if for departure there are special rules. It needs to at least be communicated. If from Nusa Penida, at least the harbormaster should be contacted with when the boat would depart and where. ... But that is until the service hours close. At night, no one is on duty. Maybe later we can make a separate SOP, if that's how we would do it. At least there should be information, because safety is the responsibility of the harbormaster."

IDI 006

Financial feasibility

Financial feasibility was evaluated by informants' perception on availability of funds to procure the necessary equipment and to budget for maintenance. Health office representatives have stated readiness to push for substantial funds for initial procurement of the required equipment to the tune of IDR 1.5 to 2.5 billion. That would be comparable to required funds for two conventional ambulance cars. However, they also voiced concerns on the boat's longevity and efficiency, stating it serves multiple purposes if possible, such as patrol duty, to improve efficiency, reduce idle time, and overall maintain the boat's seaworthiness.

"If it's still around 2 [billion rupiah] we can afford it. The only thing I worry about is how sustainable it is, is the maintenance. It's not every day, not even every week, there's an incident like that. It can be used, for example, if I think, maybe as a marine ambulance it can also function as disaster response, it can also function as an ambulance, it also functions as a patrol boat, so that for example. If it is idle, it can get broken quickly."

IDI 004

Informants have also floated idea for mixed public-private funding scheme for the program in the long run. Informants revealed there has been initiatives by private companies operating in Klungkung District to donate ambulance as part of their corporate social responsibility (CSR) scheme, a mandatory charity spending by large private enterprises under Indonesian law. Directing some CSR funds for boat procurement and maintenance

may lighten the burden on public budget.

> *"Well, as it engaged in the humanitarian service, private sectors who have CSR, it can also be directed to operations related to equipment or even helping with procurement. More and more banks are donating ambulances even though ambulances are for hospitals."*
>
> *IDI 003*

DISCUSSION

Qualitative interviews revealed a sense of urgency and demand for improved ambulance services to facilitate patient referral and transport from the islands to tertiary care on the mainland. This demand persists despite recent development of the on-island hospital which was viewed should go hand-in-hand with development of the water ambulance service. This perceived transportation-related lack of healthcare access was also reported in islands communities around the world.[11] This perception was founded considering travel time required to reach quality healthcare from rural island communities.[12]

This perception is not misplaced as improvement of ambulance service in rural area has been found to be associated with improved health outcome, especially pertaining to maternal and neonatal health.[13,14] Although those studies reported outcome of improved ambulance service in terrestrial setting, this is also true for rural area with islands setting. Our literature review also found perceived improvement of healthcare access from implementation of water ambulance service in an island community.[15]

However, the interviews also revealed lack of knowledge on specification of boats required to operate water ambulance services among stakeholders. Stakeholders revealed reluctance to operate smaller boats due to perceived lack of stability on the waters while larger boats were perceived to be too expensive. Ideal boat size of 10 to 30 m in length with 1 to 1.5 draft obtained from literature review would fit mid-size boat stakeholders have in mind for water ambulance services.

This perception is in line with literature where the minimum specification of water ambulance was a boat with a length of 10-30 m, width of 2.5-3.5 m, and 1-1.5 m draft.[16–19] The material was also of consideration which is preferrable to be fire retardant as to prevent fire when on the seas. Its engineering should also prepare for the risk of capsizing and should be functional in such event.[20] Water ambulance services with boats of similar specification has been reported in Raja Ampat Island, Papua, and Riau Islands, Sumatera.[17,19] The condition in Raja Ampat Island is especially comparable, considering it is also a tourism heavy island.

Currently water ambulance service has not been regulated in Indonesia. Ambulance service as a whole has been regulated by Minister of Health under the regulation number 143 of 2001 which only defines cars as ambulance vehicle. However, perceived technical requirement for water ambulance revealed by stakeholders did not far differ from reports on similar services in other settings. Ambulance boat did not need to be large, it only required to have enough room for the patient and paramedics to give required medical procedure. However, there is no doubt that the water ambulance is an exceptional unit with the rescue team who have to be trained specifically based on the requirement to simultaneously sailor and provide medical rescue. This team may serve as the link between the seafaring rescue units, such as MSARs, as well as carry out independent rescue operations in the coastal zone.[18]

Regarding specification of medical equipment, stakeholders reached a consensus that water ambulance services should have equipment to provide emergency and life-supporting treatment while transporting the patient. This is in line with medical equipment requirement regulated in Minister of Health Regulation no. 143

of 2001 as it would not much differ between land-based or water-based ambulance services. For emergency ambulances, it mandated availability of oxygen, resuscitation kits for neonates, pediatric, and adult patients, vital sign monitors, defibrillators, minor surgery kits, emergency medicine kits, intravenous solution kits, and personal protection equipment for paramedics on duty. Similar standard specification was also mandated in the National Health System of the UK. It further adds intensive care equipment, such as intubation kit, ventilator, and syringe pump, for specific types of ambulances designated as mobile intensive care unit.

Organizational system proposed by stakeholders also did not differ from what is conducted by similar water ambulance operations reported in literature. Stakeholders perceived a need for a dedicated water ambulance team which include boat crew and medical crew, operating under an autonomous health emergency service that would coordinate patient transport. Other case study also report a dedicated water ambulance team with similar composition.[17] Meanwhile, putting organization of the team under health emergency service would improve upon the decentralized system used some other part in Indonesia which may cause delay to patients.[16]

Meanwhile, financial readiness revealed by stakeholders exceed the benchmark obtained in literature review which estimated procurement costs of PHP 1.7 million, which translates to around IDR 500 million.[22] Stakeholders also accounted for operational and maintenance costs with plan for public-private partnership to assist with funding the program. However, stakeholders did not seem to account for the need for personnel cost in operating water ambulance service although there was a consensus in the need for a dedicated team for such service. Of course, the need for personnel cost could be averted if there were human resources available to be diverted to water ambulance service from existing pool of personnel in health emergency service provided, they are trained for water ambulance operation.

Another concern from stakeholders would be the cost-effectiveness and idle time. To answer this concern, water ambulance can also be utilized to deliver primary healthcare to harder to reach regions. Water ambulance has been cited to be able to deliver essential health services, such as maternal health services, immunizations, and general medical care to communities with inadequate land transport infrastructures. These services give tangible benefits in improved maternal health and increased healthcare utilization.[23,24] Another study reported the use of medically equipped boats to evacuate patients to and from healthcare facilities in time of flooding.[25]

Overall, this study provides a point of reference for other island communities in limited resource setting planning to expand their healthcare access capacity by operating water ambulance services. There are similarly remote islands in Indonesia and elsewhere around the world who may benefit from the data provided here.

However, this study come with several caveat. First, generalization of this data to other communities should consider specific situation of said community as geography and other factors may affect cost-benefit of implementing water ambulance service compared to other alternatives. Moreover, as this study provide data on feasibility planning, further investigation should be conducted to provide insights on the effectiveness of this plan in practice.

CONCLUSION

Our study revealed a potential improvement of healthcare access, especially pertaining referral time, with operation of water ambulance service in Nusa Penida Islands, a small chain of islands off the coast of a larger and more economically developed mainland of Bali, Indonesia. Health emergency services under the auspices of local health office could feasibly operate a mid-sized 10 to 30 m boat to operate referral and patient transport from the island chain to the mainland. To improve cost-effectiveness, the boat could also operate primary healthcare delivery to communities on the more remote coastal areas of the islands and provide emergency response services as necessary. Effectiveness of this service in reducing excess morbidity and mortality should

be further studied.

ETHICAL CONSIDERATION

The study protocol has been reviewed and approved by the Ethical Commission of the Faculty of Medicine, Udayana University/Sanglah Hospital with the ethical approval number 2020.02.1.0846. All informants have given their oral and written consent to participate in this study.

CONFLICT OF INTEREST

The authors have no conflict of interest to declare related to materials presented in this paper.

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AUTHOR CONTRIBUTION

Conceptualization, PA; methodology, PA; formal analysis, PA, GBSW; interpretation, PA, PPJ; investigation, PA, NPAH, NMAS, KGSW; data curation, PA; writing—original draft preparation, PA; writing—review and editing, PA, GBSW, NPAH, NMAS, KGSW, PPJ; project administration, PA; funding acquisition, PA. All authors have read and agreed to the published version of the manuscript.

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