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Abstract: East Java Province has an area consisting of eastern parts of the Java Island and small islands surrounding it. The connectivity of the main island and surrounding islands is still a pertinent problem. Seaplane can be an alternative to increase the connectivity of this area. This research aims to calculate the potential demand for ship passengers at the port of East Java for the N219A seaplane. The research was carried out by analyzing existing inter-island transport conditions and continued by identifying movement patterns. Based on the results, it was found that the potential trip demand between the North Coast of East Java and the surrounding islands is around 2,619 movements a day. The high level of movement per day provides an opportunity for the development of the N219A transportation mode as a paid transportation mode.

Keywords: amphibian; island; N219A; port; seaplane

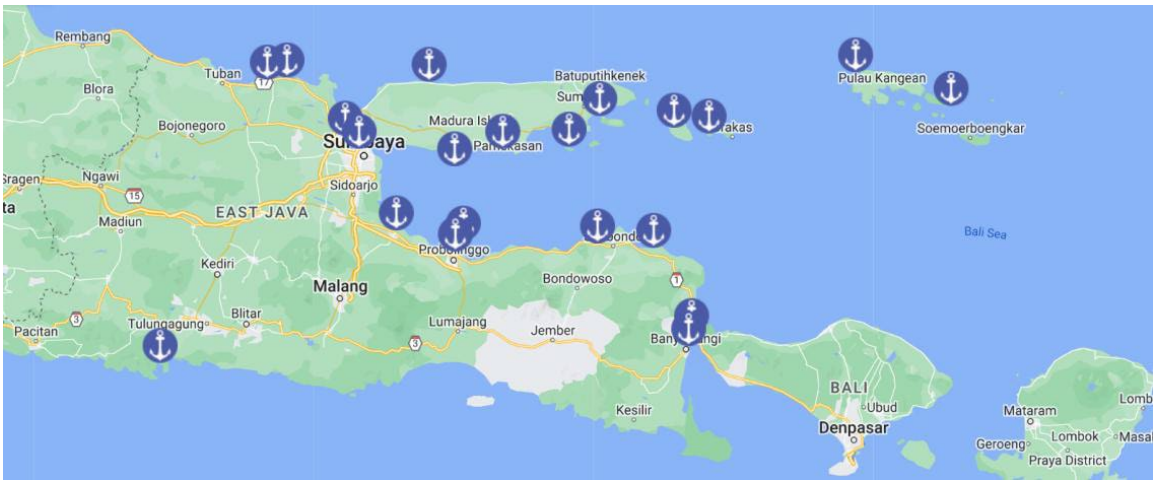
1. Introduction

Indonesia is known as an archipelago state as stated in chapter 46 and chapter 47 verse 1 of the 1982 United Nations Convention on Law of the Sea (UNCLOS)[1]. Indonesia is also known as the world's largest archipelago and the sixth most islands in the world. Hundreds of names of islands in Indonesia spread across various regions in Indonesia, including Java. Java is an Indonesian island located in the Greater Sunda archipelago and is also the 13th outermost island in the world. The island is administratively divided into six provinces, namely West Java, Central Java, East Java, and Banten, as well as two special regions, namely DKI Jakarta and DI Yogyakarta. Java Island had a population of 151.6 million people in 2020[2] with a density of 1,121 people/km^2. The archipelago that the world has pinned on Indonesia means that Indonesia has 16,771 islands, consisting of large islands and small islands. The island of Java consists of 757 islands, with a list of the number of islands as in Table 1[3] below.

Table 1 Number of Islands on The Island of Java

Province	Number of islands
Banten	81
DKI Jakarta	110
West Java	30
Central Java	72
DI Yogyakarta	33
East Java	431
Total	757

East Java, which has the largest number of islands in Java, also has several ports for crossing to the islands, as shown in Fig. 1[4]. Ports have a crucial role in facilitating movement and fostering economic growth in the archipelago of eastern Indonesia[5].



Source: http://bidanglaut.dishub.jatimprov.go.id/

Fig. 1 Distribution of ports in East Java

Indonesia has approximately 30 main ports, 200 collector ports, and 1,000 feeder ports[6]. The distribution of ports in East Java shows varying inter-island crossing potential. For most people, traveling is an opportunity to perform economic, cultural, social and political and other essential activities[7]. And to accelerate the economic development is to strengthen the connectivity of inter-island[8]. Demand for freight and passenger crossings also varies with the increased potential for inter-island crossings in the province[9]. In his research, Hope said that living cost influenced mode choice by passenger[10]. Indonesia's geographical condition in the form of an archipelago stretching along 81,000 km demands the development of fast transportation modes that can connect small islands effectively. One of the ideas for such transport was the development of aircraft. The number of aircraft manufacturers have contributed to the development of capable of adapting air transportation through introducing amphibious versions of their land-based models[11]. The Amphibious Aircraft Due to their distinct structural characteristics and flight patterns, amphibious aircraft provide numerous benefits over conventional aircraft as specialized surface transport vehicles[12]. It should be considered to assess the effects of scale effect on the wave planning performance of amphibious aircraft from both design and experimental viewpoints as suggested by Chen et al[13]. The Amphibious Aircraft offer an alternative transportation option for accessing destination situated on small islands with restricted land area, encompassed by water[14]. The Amphibious Aircraft Development Plan (N219)[15] is in line with the National Medium-Term Development Plan (RPJMN) 2015-2035 and the National Industrial Development Master Plan (RIPIN) 2015-2035. The aviation industry's operations directly impact the economy, but more significant expenditure and broader economic gains linked to better access to resources, markets, technology, and economic mass also have an indirect effect. In consequence, economic activity creates and sustains demand for air travel[16]. The Amphibious Aircraft due to their distinct structural characteristics and flight patterns, amphibious aircraft provide numerous benefits over conventional aircraft as specialized surface transport vehicles. Many industries, including maritime transportation, search and rescue, medical services, and combating forest fires, heavily rely on it[17].

Travel demand forecasting plays an important role in air transportation industry resource planning[18]. Travel demand directly affects flight scheduling, marketing revenue management and fleet planning. Determining the amount of investment required in transportation infrastructure or optimizing revenue from ridership demand[19]. Demand is an important element for airport operations to make the right operation plan[20].

Several studies have already been done to analyze the use of seaplane as alternative public transportation. Castelluccio, et al. analyze the comparison between seaplane and helicopter as passenger shuttle transport for tourist's remote destination areas. This research performed a modal split model to identify the passenger's quota based on these two air transport modes, identify the characteristics of helicopter and seaplane performances through technical analysis, identify the routes regarding the breakeven point, and the flight infrastructure cost influence. The research showed that the helicopter could capture around 5-20 percent, while the seaplane captured from 1-14 percent of tourist travel demand. The service was also profitable because of the strategic regional origin-destination pairs involving the two major airfields and the most UNESCO-visited locations. The study also showed that the helicopter has the best performance, while the seaplane has an advantage to take off/land from the sea[21].

A study performed by La Franca, et al. identify the demand and cost analysis of air transport (helicopter and seaplane) between Sicily and Eolie Islands, Italy. The generated data used for the analysis is from the historical tourist annual arrivals from 1999-2008. Based on the forecasting analysis using AREMA, the tourist annual arrivals are increasing by around 20-60 percent for the

next two years. The cost analysis shows that both helicopter and seaplane offer lower tourist transportation expenses than the existing transportation mode[22]. The main aspects that would motivate passengers to choose seaplanes would be the offered trip duration, the ticket price and the trip convenience. The analysis concludes that the potential of seaplanes as a transport mode lies in the enhancement of sustainable transport, the connectivity of isolated regions and their economic growth[23].

In Indonesia, research on the potential demand for seaplane passengers and goods used as a mode of public transportation for inter-island travel is still limited. Additionally, the potential demand for passengers and goods will affect the tourism sector because local communities need an active role in creating a tourist village, based on data from the Central Statistics Board there are 1734 tourist villages in all regions, and the majority of 857 are located in Java-Bali[24]. Previous research for inter-island travel focused on passenger and freight demand research using ships[25][26–30]. Meanwhile, other studies on inter-islands demand focus on potential shifting from ship to conventional airplane[31]. Study on potential demand for amphibious aircraft for inter-island travel is very limited. In this paper, the focus of our study was therefore to identify the potential demand for ship passengers in East Java for the N219A mode of transportation for existing shipping routes. With this research, the potential demand for N219A passengers in East Java will be known to what extent ship passengers will change modes of transportation to N219A thus providing an overview of the market potential of N219A for future planning.

Analysis of the potential demand for travel using amphibious aircraft and modeling the origin and destination of amphibious aircraft travel is needed to find out how big the travel potential of the N219 aircraft is. East Java Province shows the potential for inter-island crossings that vary based on the number of ports owned. The demand for freight and passenger crossings has also varied with the increase in the potential for inter-island crossings in the province.

The potential demand for passengers on the N219A aircraft will see the potential for the transfer of passengers from the ship to the N219A aircraft in case of fare adjustment and travel time between locations. In response to conform potential demand, it is better if the N219A aircraft is managed by a green company, which means a company that will provide services with renewable energy sources to support a more efficient resource program and minimize environmental impacts[32]. Furthermore, the production of N219A needs to be considered a green manufactured process, which means the production process remains based on environmentally friendly operations by utilizing used goods but still focuses on profitability[33].

It has been empirically recognized that transportation demand analysis is fundamental for planning, handling congestion, reducing accidents, and pollution, and developing a region. Modes of transport such as rail, road, air, and water are generally available, the importance of each mode varies[34]. However, Air mode has different attributes from other modes of transportation because it is congestion-free and capacity can be large. Air and train modes also provide travel convenience and faster travel time[35]. Good forecasting of air travel demand plays an important role in the aviation industry[36,37] and has increased in recent years[38]. For airlines, travel demand directly affects flight schedules, revenues, fleet needs, and network services. For operators, estimating travel demand is the basis for making airport master plans, and for policymakers is a benchmark in developing regions in the context of equitable development[39].

Air transport has grown rapidly due to rising income, population, and industrial structure[40]. Therefore, the analysis of demand for air transportation travel / N219 is a considerable concern in this study. This paper examines the travel potential of N219 aircraft passengers based on data from the origin of the travel destination.

2. Methodology

2.1 Data Collection

The data needed for this research consists of primary and secondary data. Primary data is obtained, taken, and collected directly from observation and survey results in the study location. Observations and surveys are located in the Port of Gresik, Port of Jangkar, Port of Kalbut, and Suramadu Road. Primary data in this study include Travel origin and destination in the harbor, Travel origin and destination in the road section, Traffic volume, and Port facilities and infrastructure condition

Secondary data are collected through study literature and transportation-related government agencies like the Harbor and Port Authority Office and Transportation Department. Secondary data in this study include Government national transportation planning documents, Number of passengers, and Ship routes and schedules

2.2 Determination of Sample Size

The total number of units or individuals within the scope to be studied is called the population. In research, there is a population within the scope that will be studied. Under certain conditions, there are limitations in conducting research on the entire population. Therefore, it is necessary to take an approach with sampling that can represent the population[41].

Data collection in this research carried out by origin-destination survey and road side interview survey. The origin-destination survey carried out at ports on the north coast of East Java Province, including Gresik Port, Jangkar Port, and Kalbut Port. Road side interview survey conducted on H. Moh. Noer street on Madura Island. The population of respondents in the origin-destination survey consisted of passengers traveling from Gresik Port, Jangkar Port, and Kalbut Port. Meanwhile, the population in road side interview survey included road users traveling

via the Suramadu Bridge from the Surabaya area to Madura Island and from Madura Island to Surabaya. The population in the road side interview survey obtained from the results of a traffic counting survey on H. Moh. Noer street. Traffic counting survey carried out to obtained volume of traffic passing from Surabaya-Madura and Madura-Surabaya.

The sample size was calculated using the Slovin formula[42)], with a confidence level of 94% and 'e' value (the desired percentage of sampling error) of 6%. **Table 2.** below explains about minimum sample requires to fulfill the rule of 94% confidence level criterion. In this research, total of 178 respondents were obtained during origin-destination survey, 280 respondents were obtained as samples of travelers from Madura Island to Surabaya in road side interview survey, and 284 respondents were obtained as samples of travelers from Surabaya to Madura Island. It means total respondents that have been obtained fulfill the minimum sample size requires for a 94% confidence level.

Table 2. Sample Calculation

Type of Survey	**Population (N)**	**e (%)**	**Minimum Sample (n)**
Origin - Destination Survey (Gresik Pelindo Port, Jangkar Port, Kalbut Port)	402	6%	164
Road Side Interview Survey (H.Moh.Noer street)	3009	6%	254

2.3 Survey Teams Organization

The survey team consists of a supervisor and surveyors. The supervisor is the coordinator in each location and is in charge of surveys and surveyors for each location. In contrast, the surveyors have a responsibility to collect the data or interview the drivers. In this research, there are three kinds of surveys conducted under the supervisor, which are the Origin-Destination Survey (O-D Survey), Roadside Interview Survey (RSI Survey), and Traffic Counting Survey (TC Survey) which were implemented by the surveyors as shown in Fig. 2

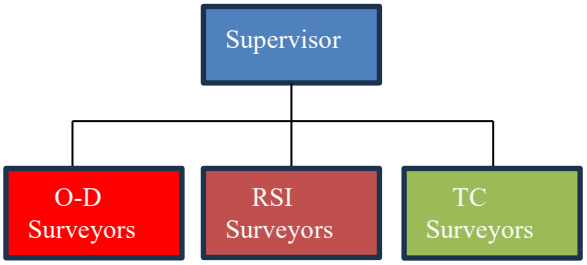


Fig. 1 Organization Chart

2.4 Potential Demand Surveys

The surveys conducted to obtain potential demand in this research include Origin-Destination (O-D) survey and Roadside Interview (RSI) survey. The O-D survey and RSI survey methods share similarities, as both involve interviewing respondents about their trip origin, destination, and travel/trip purpose. However, the target respondents and survey objectives have some differences, as shown in Table 2 below.

Table 3. Potential Demand Surveys Method

Parameter	Origin-Destination (O-D) Surveys	Roadside Interview (RSI) Survey
Purpose	To collect detailed information on travel patterns, including trip origins, destinations, purposes, and frequencies.	To gather immediate data on vehicle movements and travel characteristics directly from travelers on the road.
Method	Typically conducted through questionnaires, interviews, or travel diaries completed by respondents.	Conducted at specific roadside locations where interviewers stop vehicles and ask drivers about their trip origins, destinations, routes, and purposes.
Scope	Provides comprehensive data on travel behavior over a period of time, often capturing a wide range of trips made by individuals.	Focuses on real-time data collection at specific points in the transportation network, providing a snapshot of travel patterns.
Data Use	Used for transportation planning, modeling, and analysis to understand overall travel demand and to design transportation networks and policies.	Used for traffic management, monitoring road usage, and understanding travel behavior on specific road segments or corridors.

The Origin-Destination survey is one method to obtain O-D demand matrix that used to denote average number of trips going from an origin to destination[43].The method of this survey is doing interviews with ship passengers which are collected as samples at the port. This survey was done in the Port of Gresik, Port of Jangkar, and Port of Kalbut as shown in the **Fig. 3**. Further, the questionnaire's materials include characteristics and vehicle types used to the harbor, number of passengers, travel origin and destination, and travel purpose.

Roadside Interview (RSI) survey method is done by interviewing the drivers or passengers as samples on the roadside at the survey posts that have been determined. In this interview, the material of the questionnaire includes characteristics and vehicle types, number of passengers, travel origin and destination, and travel purpose. Selection of the location is done with several criteria, such as:

- Surveys are located in each direction and nearby,
- Survey locations are on the 300 meters – 500 meters straight road, thus will be visible for the drivers,
- Survey locations are not in the uphill and downhill,
- Survey locations are on a wide road that can be used to stop the vehicles,
- Survey locations are marked before the survey begins.
- Surveys are done on weekdays according to local conditions. While the duration of the survey is 6-9 am for the morning session and 3-6 pm for the evening session.

The roadside interview survey was carried out on 1 day in 2 sessions, namely session 1 o'clock 10.30 – 12.00 WIB and Session 2 at 15.00 – 17.00 WIB. Roadside interview survey was conducted at the intersection of Jalan Moh. Noer – Jalan Raya Suramadu where the location point is shown on the Fig. 9. Sampling was carried out on Vehicle Drivers Passenger cars passing through this section of road, both vehicles from the direction of Surabaya as well as those towards Surabaya. The survey location point was chosen at a signalized intersection because it makes it easier for surveyors to conduct interviews when drivers are stopped waiting at a red light

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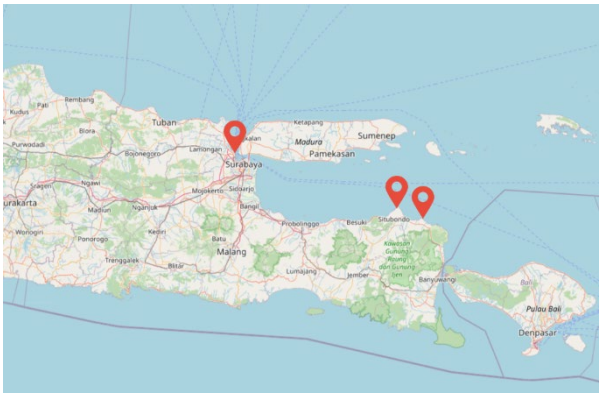


Fig. 3. Survey Location

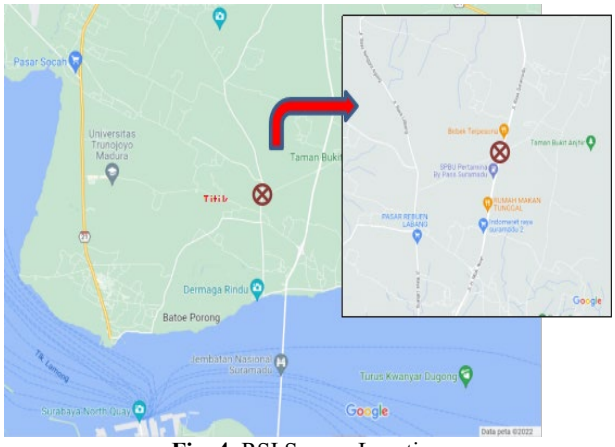


Fig. 4. RSI Survey Location

2.5 Traffic Counting (TC)

Traffic counting is used to determine the volume of vehicles traveling through certain roads. In addition to describing the traffic conditions on each road section, the results of the traffic count survey will be used as the population for the expansion process data from the interview survey (RSI - OD Survey).

2.6 Existing Condition Analysis

This analysis is important to find out the condition of the area in the study location. Several aspects that are included in this analysis are population, economics, land usage, natural resources distribution, transportation systems, and development projection. Furthermore, **Figure 5** shows the flowchart that explains the process of this research. Starting with the literature study and data collection through the primary and secondary data. The data then processed and the trip pattern's overview and characteristics will be recognized. The research then continued with O-D zoning determination, trip generation simulation, potential trip numbers in east java, and the implications obtained.

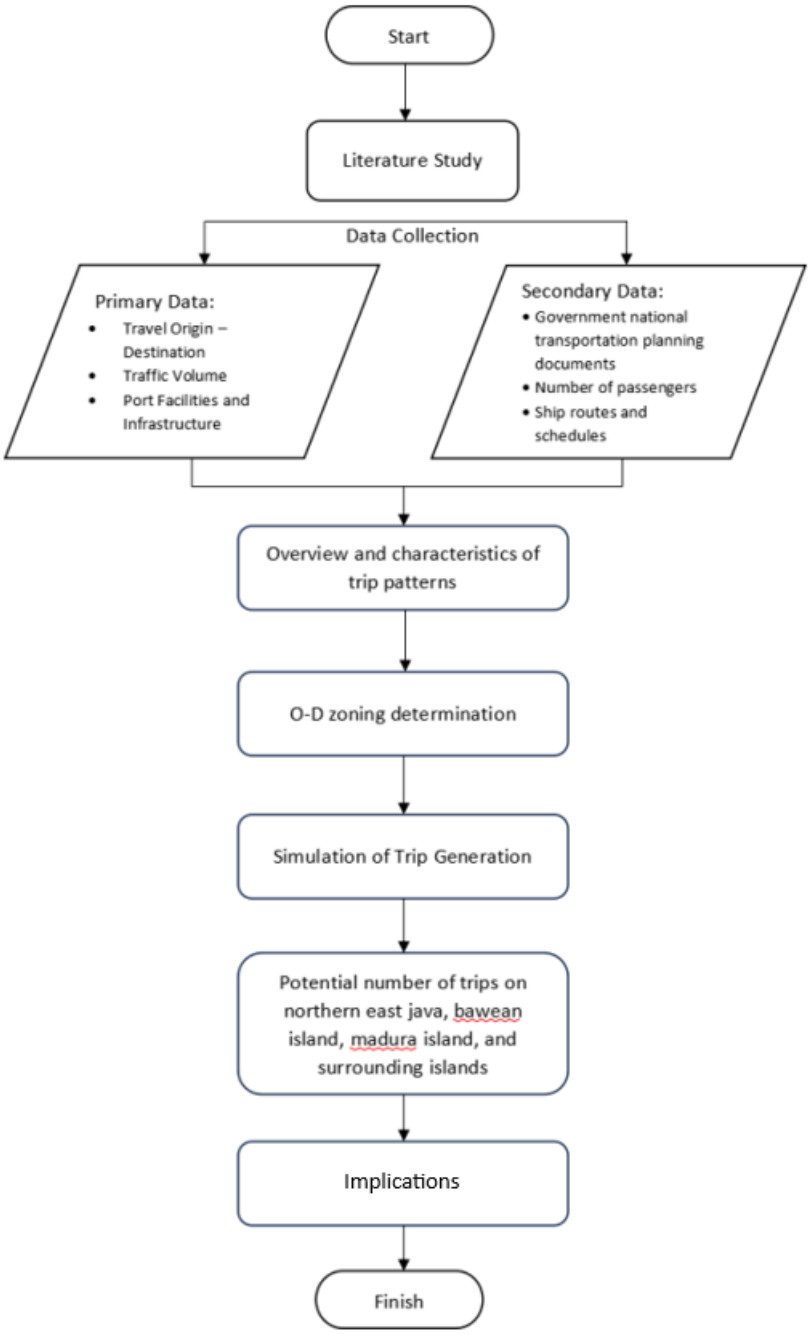


Fig.5 Research Flow

3. Result

3.1 Characteristics of Traveller at Jangkar Port

Jangkar port are serving round-trip routes by subsidizes ferries, Jangkar - Sapudi - Kalianget, Jangkar - Kangean, and Jangkar - Ra'as - Kalianget. The Ship capacity is 180 passengers and they not only carry passengers but also vehicles with the average passenger is 90 people. Origin-destination survey carried with random sampling method in the waiting room, with 40 people as respondents. As much as 80% of respondents are men and 20% are women, even more 68,29% of respondents depart from home, such as family's home, boarding house or their own home as shown on the **Fig. 6**. and their destination 92,7% said that they are going home as shown on **Fig. 7**. the majority of respondents travel for visiting family. The access mode used to reach the port, 65,6% respondents ride their own motorbike and ship it to the destination with the same ship. And the egress mode used by the respondents 73,17% are motorbike.

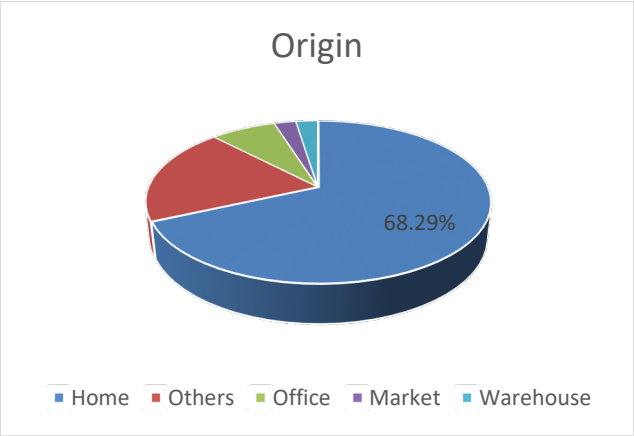


Fig. 6 Jangkar Port Passenger Origin Base

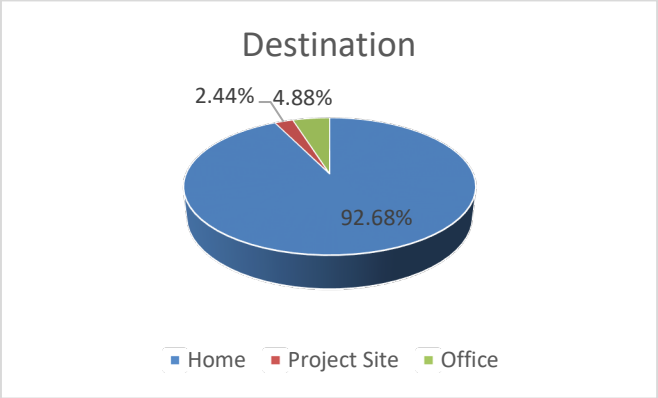


Fig. 7 Jangkar Port Passenger Travel Destination

Based on the origin - destination survey result, most of the respondents depart from Situbondo and Bali, then followed by Jember and Banyuwangi. Most of the passengers are local residents of Sapudi Island or Sumenep.

3.2 Characteristics of Traveller at Kalbut Port

Kalbut port is served by a traditional wooden ship that served Kalbut - Sapudi round trip route, with the departure schedule every Monday, Wednesday and Saturday. The capacity varied from 40, 60 and 100 passengers and the ship only carried passengers with no space for vehicles.

A total of 25 respondents interviewed in this origin-destination survey with a random sampling method. The respondents are passengers that arrived from Sapudi with 52% of the respondents are men and 48% are women. Meanwhile their origin is home base with the destination 68% are home, as shown on Fig. 6. The majority of the respondents make a trip for visiting family purposes and trade.

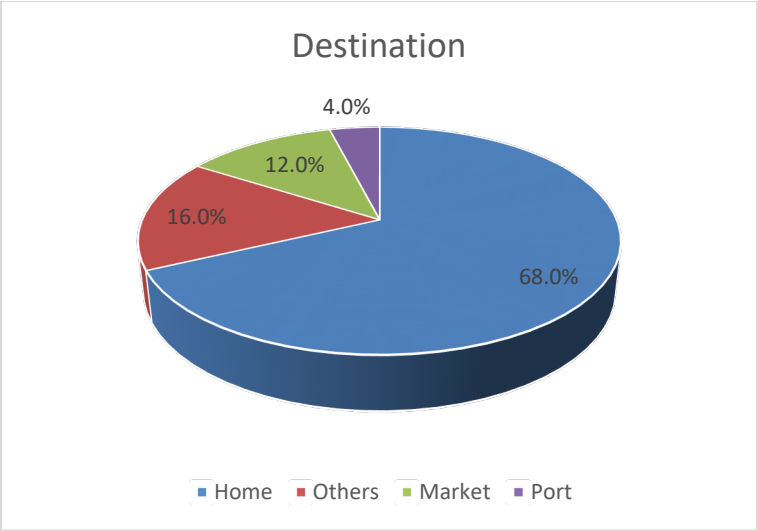


Fig. 8 Travel Destination for Kalbut Port Passenger

The respondents, 80% of them use their motorbike and the rest is using car, pick-up, and also pedicab. Meanwhile, the egress mode from Kalbut port to their destination 48% of respondent used motorbike and 32% used car or pick-up.

Based on mapping from the survey result, all the respondents departed from Sapudi Island, Sumenep District. And most of the respondents are heading to Situbondo District, and there is no respondent that is heading to another district. To get an understanding of the whole movements, the data from the survey is expanded by calculating the expansion factor based on the number of respondents and also ship passengers.

3.3 Characteristics of Traveller at Pelindo Gresik Port

Pelindo Gresik general port served the shipping route Gresik - Bawean round trip and Gresik - Gili Iyang round trip with motorboat. the capacity of the ship around 250-390 passenger. The ship is intended for passengers, and for the Gresik - Bawean route are scheduled every day except Friday.

A total of 113 respondents were interviewed in the origin-destination survey at Jangkar Port. Sampling was carried-out using a random sampling method on the prospective passenger in the waiting room. A total of 61.95% of respondents were men and 38.05% were women. Meanwhile, if grouped by base of origin, as many as 84.82% of passengers surveyed leaving from home, whether a relative's house, a boarding house, or your own house. as well as with the base destination, as many as 88.29% of passengers will go home. The majority of respondents travel for home purposes or to visit family as well as holidays and work, as shown on the **Fig. 8** and **Fig. 9.**

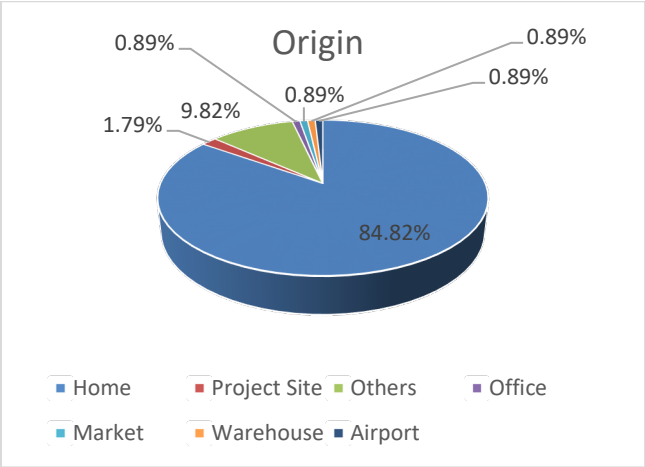


Fig. 9 Gresik Port Passenger Travel Origin Base

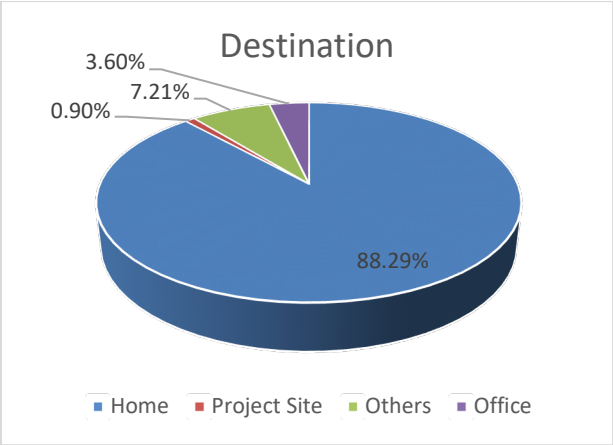


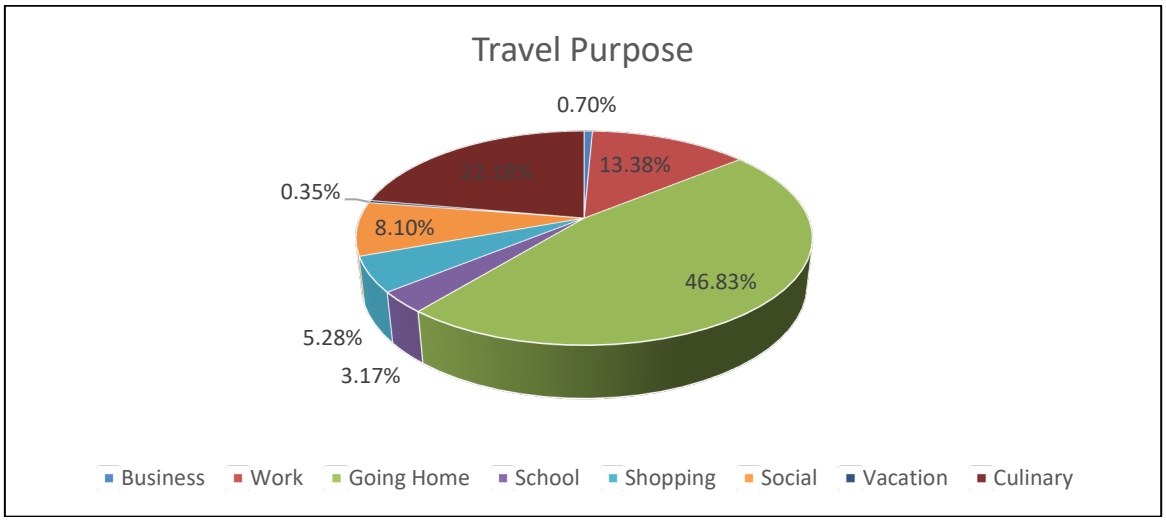
Fig. 10 Gresik Port Passenger Travel Destination Base

In reaching Gresik Harbor, the journey is dominated by cars and motorbikes were 44.64% and 32.14% respectively. There are also passengers who use buses and trains followed by motorbikes or public transportation to get to Gresik Port, especially for passengers who come from areas outside Gresik City. Meanwhile, for the egress mode, most passengers continue to travel by car and motorbike after arriving at Bawean Harbor. The origin-destination survey also maps the origin - destination of travel from Gresik Port. The results show that most of the passengers interviewed departed from mainland Gresik and Surabaya with the destination Bawean Island which is also still in the Gresik administrative area. Most of the passengers are residents from Bawean Island who have migrated or finished their activities in these areas as well as residents around Gresik and Surabaya who have relatives on Bawean Island. Apart from that, there are also passengers from Malaysia and Central Java, with the intention of traveling for vacation or visiting relatives.

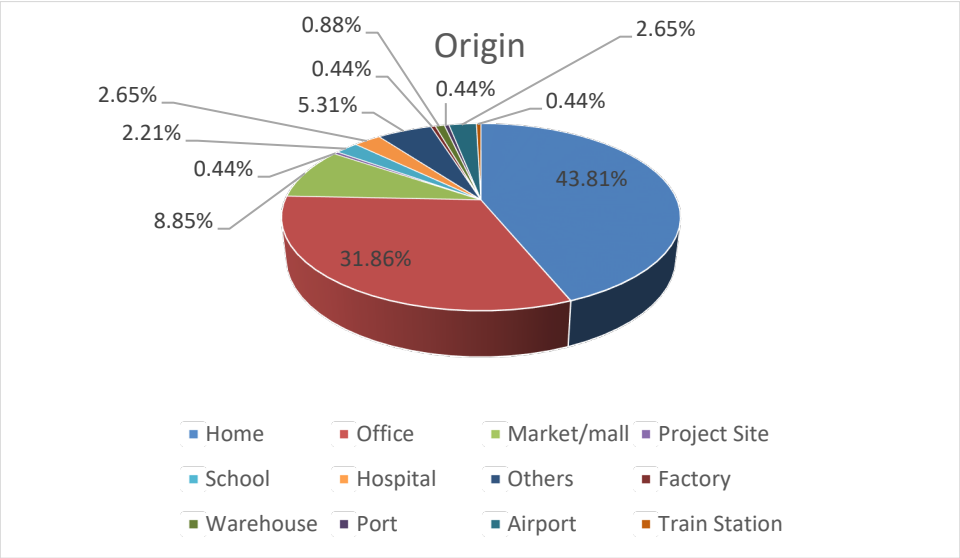
3.4 Characteristics of Traveller on The Suramadu Road (Surabaya – Madura Direction)

The total number of respondents obtained for the direction to Surabaya was 280 vehicles The survey results indicate that respondents mostly travel to pick-up their children or going on culinary journey. Most of their origin are home and their destination are also going home. Their origin zone mostly from Surabaya City. The key takeaway points from the survey are respondents mostly travel home (46,83%), followed by culinary purpose and pick-up/drop-off children to Islamic boarding school (25%) and working purpose (13,38%). The original base is dominated by home (42,81%), after that office (31,86%), and market/mall (8,85%). The destination is dominated by home (61,97%), after that other (15,14%) and office (8,45%). Destination zone being dominate by Bangkalan District (56,03%), and then Sampang District (18,44%), after that Pamekasan District (8,51%).

Figure 11a and 11b shows the composition of the purpose of the trip and the origin of the trip from RSI survey on Surabaya – Madura direction



(a)



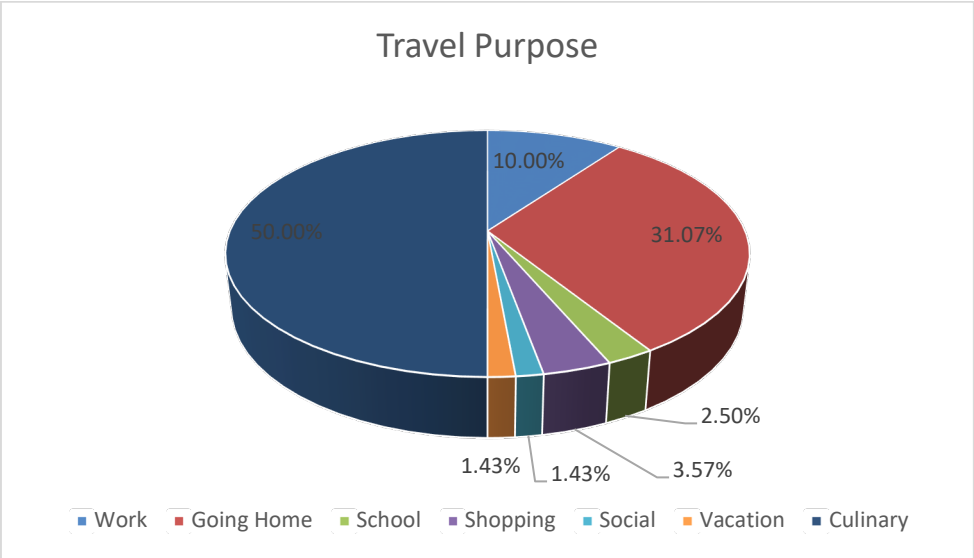
(b)

Fig. 11 The composition of the (a) the purpose of the trip and (b) the origin of the trip (from RSI survey data Surabaya – Madura direction)

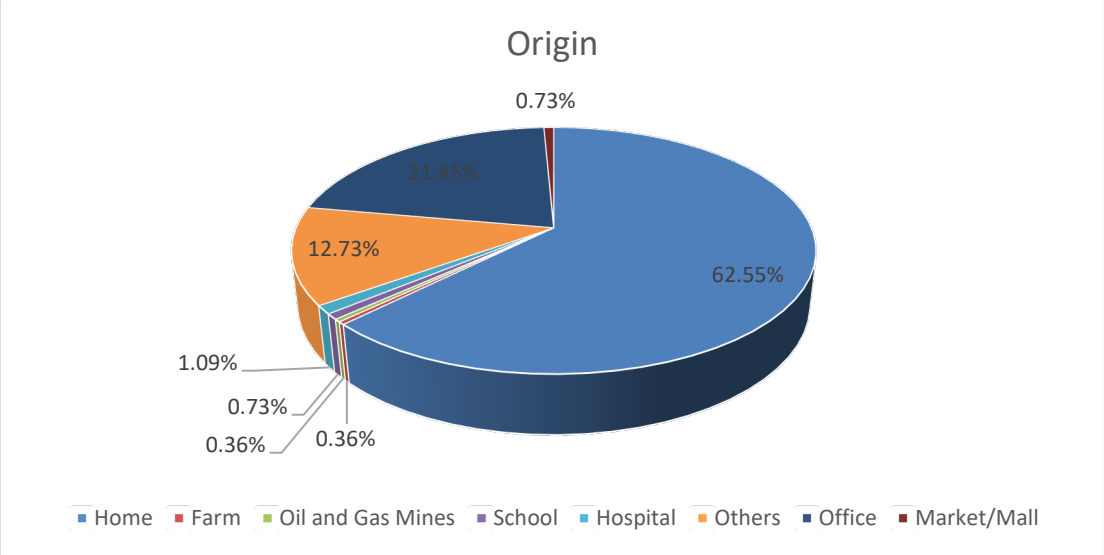
3.5 Characteristics of Traveller on The Suramadu Road (Madura –Selatan Direction)

The total number of respondents obtained for the direction from Surabaya was 284 vehicles The respondents mostly travel to ho home. Most of their origin are home and their destination is also going home. Their origin zone mostly from Bangkalan District. The key takeaway points are most of the journey's purpose is culinary journey and pick-up or drop-off children to Islamic boarding school (51,07%), after that going home (31,07%) and working (10%).The original base is dominated by home (62,55%), and then office (21,45%), and others (12,73%). The destination is dominated by home (57,14%), after that other (18,57%) and office (10,36%). Destination zone being dominate by Surabaya City (75,09%) and Sidoarjo District (7%)

Figure 12a and **12b** shows the composition of travel destination base and destination zone for Madura – Surabaya direction.



(a)



(b)

Fig. 22 Composition of (a) the trip purpose and (b) the trip origin zone (from RSI survey data Madura - Surabaya direction)

4. Potential Demand for Passenger N219 Amphibious Aircraft

Analysis results from origin-destination survey conducted in the North Coast region of East Java (Gresik Port, Kalbut Port, and Jangkar Port) and the road side interview survey on H. Moh. Noer street (Suramadu Bridge) reveal the origin-destination pattern of respondents spread across the North and South Coastal areas of East Java and the Madura Island region. The northern coastal areas of East Java include Gresik Regency, Pasuruan Regency, Sidoarjo Regency, Bojonegoro Regency, Lamongan Regency, Tuban Regency, Jombang Regency, Mojokerto Regency, Ngawi Regency, and Surabaya City. Total trips from respondents from the northern coastal region of East Java, who traveled to Madura Island, the coastal region of East Java, and its surroundings, amounted to 1222 trips, with the total trips for each region shown in **Fig. 13**. According to the figure below, the total trips made from respondents from Surabaya, who traveled to Madura Island, the coastal region of East Java, and its surroundings, reached the highest trips at 964 trips. The figure also shows that trips from Gresik, Pasuruan, Sidoarjo, Bojonegoro, Lamongan, Tuban, Jombang, Mojokerto, and Ngawi were each below 200 trips for their respective origins.

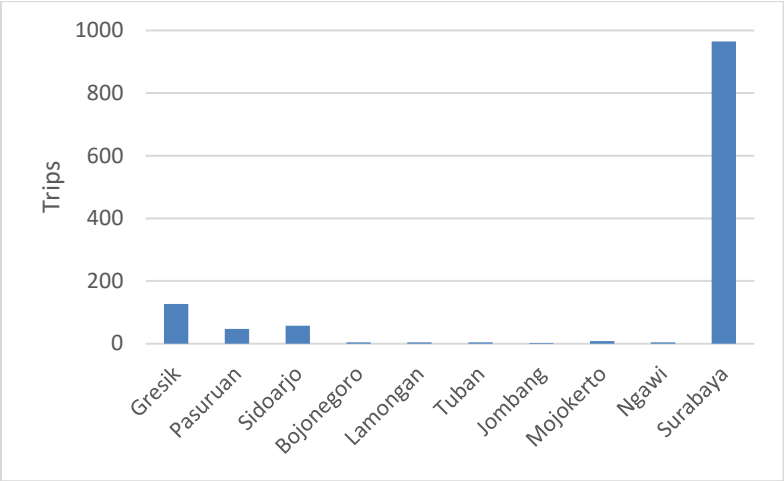


Fig. 33 Total Trips of Northern Coastal area of East Java

Details of total trips with originating from Surabaya City, can be seen in **Table 4.** The results indicate that the majority of respondents traveling from Surabaya with destination to Bangkalan and Sampang. These results indicate the presence of a potentially high demand with travel origin from Surabaya to destinations in Madura Island. Travel patterns of respondents originating from Surabaya can be seen in **Fig. 14.** According to the figure below, it can be seen that the desire line with a thicker line indicates a higher generated total trips compared to the others. Bangkalan and Sampang have potentially high demand.

Table 4 Total Trips Origin from Surabaya

Origin	Destination	Total Trips
Surabaya	Bangkalan	548
Surabaya	Gresik	42
Surabaya	Madura	62
Surabaya	Malang	4
Surabaya	Pamekasan	66
Surabaya	Sampang	162
Surabaya	Sidoarjo	4
Surabaya	Sumenep	50
Surabaya	Surabaya	21
Surabaya	Tuban	4
Total		964

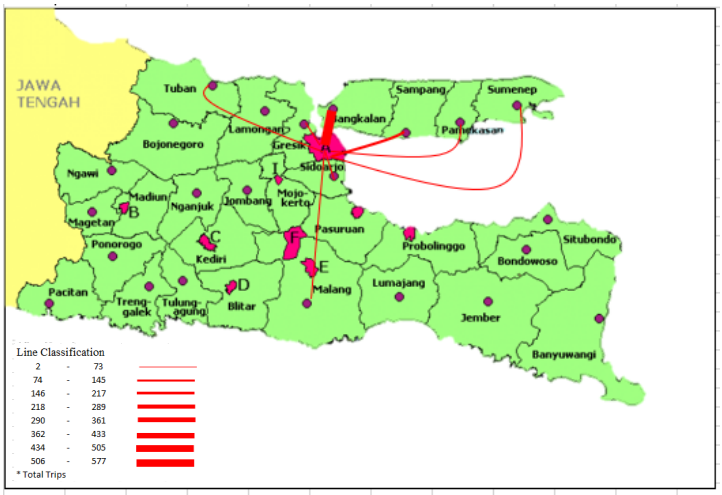


Fig. 14 Desire Line Movement Map from Surabaya

Moreover, the second larger total trips from Northern Coastal region of East Java come from Gresik Regency. The travel pattern of respondents originating from Gresik Regency is shown in **Fig. 14**. According to figure below, respondents from Gresik Regency have movement patterns with destination to Lamongan, Malang, Jember, Bangkalan, Sampang, Sumenep, Surabaya, and Central Java. Generated trips from Gresik Regency have relatively similar trips amount, indicating a consistent pattern in trip initiation from this region.

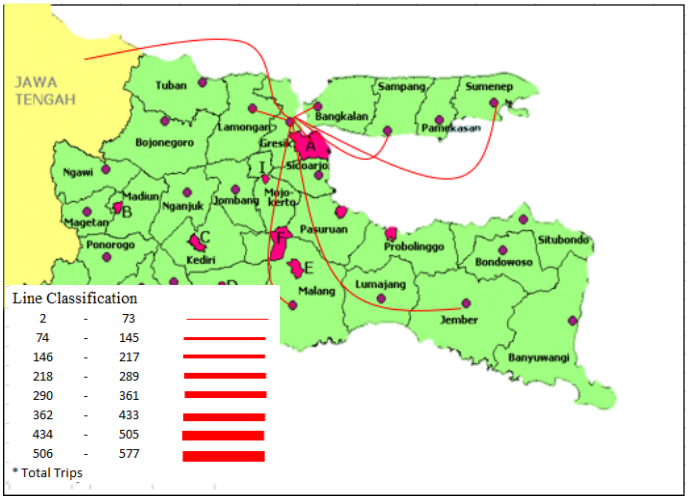


Fig. 45 Desire Line Movement Map from Gresik Regency

Meanwhile, total trips from respondents from Southern Coastal Region of East Java, who traveled to Madura Island, the coastal region of East Java, and its surroundings, amount to 271 trips, with total trips and pattern of trips as shown in **Fig. 15**. The Southern Coastal Region of East Java includes Situbondo, Banyuwangi, Bondowoso, Probolinggo, Lumajang, Blitar, Pacitan, Tulungagung, Kediri, Madiun, Nganjuk, Jember, and Malang.

According to the **Figure 16**, the total trips made from respondents from Sitobondo, who traveled to Madura Island and its surroundings, reached the highest trips at 144 trips. The figure also shows that trips from Banyuwangi, Bondowoso, Probolinggo, Lumajang, Blitar, Pacitan, Tulungagung, Kediri, Madiun, Nganjuk, Jember, and Malang were each below 40 trips for their respective origins.

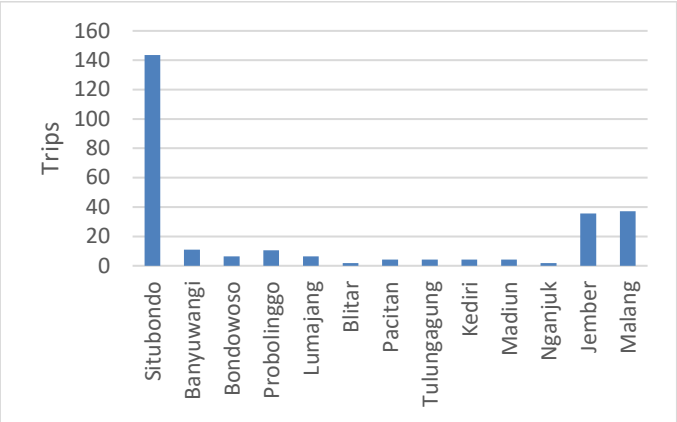


Fig. 56 Total Trips of Southern coastal area of East Java

Travel patterns of respondents originating from the Southern Coastal Region of East Java are illustrated in **Fig. 17**. According to the figure, the desire line originating from Situbondo to Sumenep has a thicker line, indicating a higher generated total trips compared to the others. Trips from Situbondo to Sumenep have potentially high demand.

Meanwhile, generated trips from other regions in Sourthern Coastal Area in East Java, such as Banyuwangi, Bondowoso, Probolinggo, Lumajang, Blitar, Pacitan, Tulungagung, Kediri, Madiun, Nganjuk, Jember, and Malang, have relatively similar trips amount.

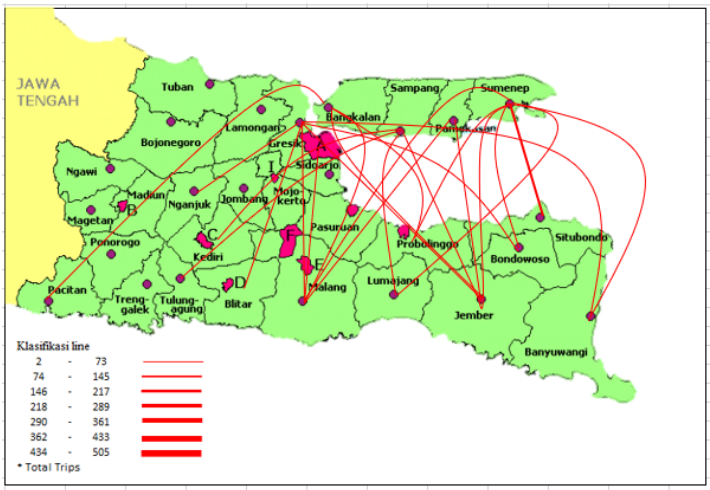


Fig. 67 Desire Line Movement Map From Southern Coastal Area of East Java

In the other hand, total trips from respondents from Madura Island, who travel within the internal regions of Madura Island and towards the coastal region of East Java, amount to 981 trips, with the total trips for each district in the Madura Island area as shown in **Fig. 18**. According to the figure below, Bangkalan has generated the highest potentially demand, compared to the other region in Madura Island (such as Pamengkasan, Sampang, and Sumenep)

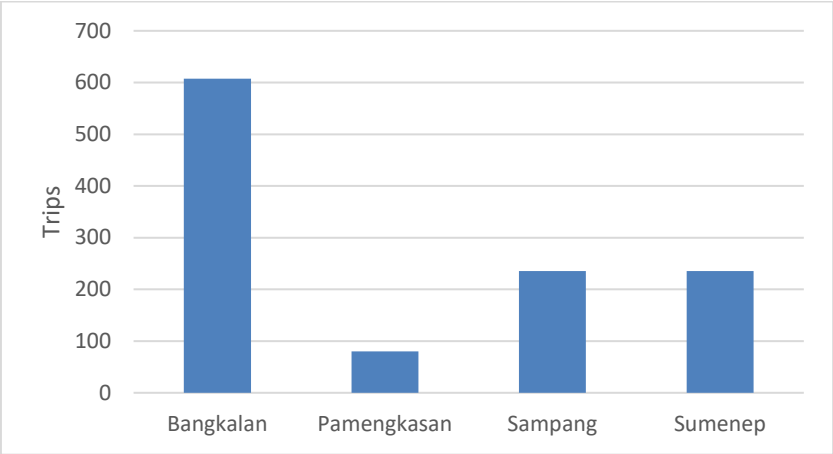


Fig. 7 Total Trips of Madura Island

Bangkalan Regency as the highest potentially travel origin area in the Madura Island, has total demand of 607 trips. According to the **Table 5**, trips from Bangkalan to Surabaya city have the highest number. Total trips from Bangkalan to Surabaya city were 451 trips.

Table 5 Total Trips Origins from Bangkalan (Madura Island)

Origin	Destination	Total Trips
Bangkalan	Bangkalan	20
Bangkalan	Banyumas	4
Bangkalan	Gresik	20
Bangkalan	Jakarta Barat	4
Bangkalan	Jember	8
Bangkalan	Malang	12
Bangkalan	Mojokerto	12
Bangkalan	Pasuruan	24
Bangkalan	Probolinggo	4
Bangkalan	Semarang	4
Bangkalan	Sidoarjo	40
Bangkalan	Sumenep	4
Bangkalan	Surabaya	451
Total		607

Travel patterns of respondents originating from Bangkalan are illustrated in **Fig. 19**. According to the figure, the desire line originating from Bangkalan to Surabaya has a thicker line, indicating a higher generated total trips compared to the others. Trips from Bangkalan to Surabaya have potentially high demand. Meanwhile, generated trips from Bangkalan to other regions in Java Island and Madura Island have trips amount below 40 trips.

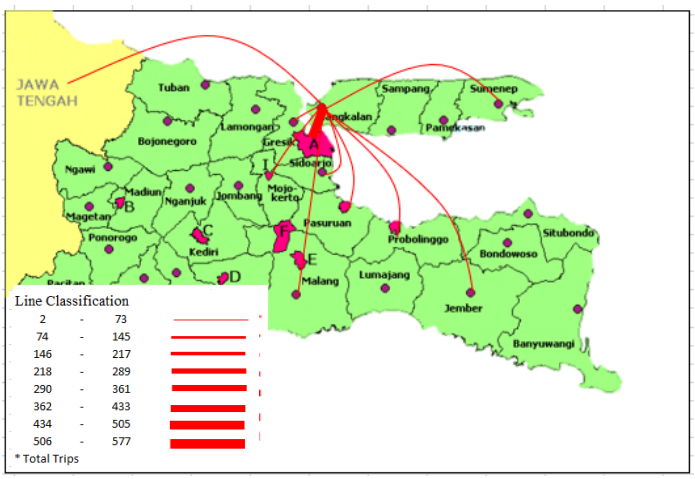


Fig. 89 Desire Line Movement Map from Bangkalan (Madura Island)

The total number of trips from travelers originating from Southern and Northern Coasts of East Java and also from Madura Island is 2619 trips per day, with a breakdown of 402 trips using sea transportation and 2,217 trips using road transportation via the Suramadu Bridge. The number of trips represents the potential number of travel demand from the coastal areas of East Java Province to Madura Island and from Madura Island to the coastal areas of East Java Province that could be served by N219 Amphibious Aircraft. The highest number of travel demand occurs between Surabaya and Bangkalan with a total of 548 trips (from Surabaya to Bangkalan) and 451 trips (from Bangkalan to Surabaya).

5. Conclusion

Passenger mobility in East Java Province includes passenger movements between the mainland East Java and the small islands around it, including Madura Island. Currently, the inter-island travel was mainly served by ship, ranging from small traditional boat to ferry. Amphibian plane can be an alternative to serve the inter-island passenger mobility between mainland East Java and the surrounding islands. Demand analysis was done to understand the potential passenger demand of the inter-island mobility. Origin – destination survey was done to obtained data on the travel pattern between mainland East Java and the surrounding island. The data shows that the total inter-island by ship is about 402 trips/day. Most of the trips were between Gresik – Bawean and Situbondo – Sapudi. Aside from ship, the inter-island movements also pass through Suramadu Bridge, specifically passenger movements between the mainland East Java and Madura Island. The estimated daily trip that pass through Suramadu Bridge is about 2,217 trips/day, with most of the trips is between Surabaya and Bangkalan.

The results serve to give an initial idea of the potential passenger t rips between the mainland East Java and the islands surrounding it, which can be a potential market for amphibian plane in the future. Amphibian plane may offer faster travel time, especially if we compared it to ship.These findings are in line with research into the feasibility and trends of the seaplane aviation business in Thailand, supported by the level of expectations for attractive seaplane routes and the convenience of traveling[44]. However, this study has not covered the potential shifting from current mode to amphibian mode. Therefore, the shifting probability from ship and land transport is unknown. Future study can look into a detailed market research, including stated preference survey, to obtain the estimated shifting probability and travel demand of amphibian plane, as well as factors that can influence mode shift to amphibian plane. From there, the feasibility of amphibian plane implementation for East Java inter-island transport can be analyzed. The implication of these research findings is that having an initial understanding of the current state of inter-island mobility in East Java can provide significant insights about the potential market for seaplanes service and the benefits that seaplanes could provide in enhancing the inter-island connectivity. Improved inter-island connectivity can stimulate economic activities, tourism, and trade within the region.

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Nomenclature

n	Sample size
N	Population
e2	Desired percentage of sampling error

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