Trip Planning Support Ship Mockup Design: A Case Study of Pioneer Ship Services in the Maluku Islands

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Abstract. The process of mobilizing passengers and goods on more than five hundred islands in Maluku Province uses pioneer shipping where the route is regulated by the government to serve areas that are not reached by modern commercial ships, including: outermost, remote, border, and disadvantaged areas. The condition in which one port serves ten islands makes the impact of information availability very large, it was known in previous research by Kelwulan, 2019 [5]. Explain that the impact of information uncertainty causes additional costs that are 2-3 times the cost of transportation itself. This research was conducted to analyze and design support for the planning of pioneering ships. ITS Architecture or also known as Telematics Architecture is an intelligent transportation system where one of its basic objectives is information management by utilizing information and communication technology as a tool for making transportation systems that can manage data from pioneering shipping.

1. Introduction.
Maluku Province is an archipelago in the eastern region of Indonesia which is included in the criteria for pioneer shipping services. The total archipelago in Maluku Province is 993 islands consisting of 10 large islands and 983 small islands [9] and there are 559 inhabited islands. Maluku province also has 55 ports which are divided into 3 types of ports, namely public ports, collectors, and local ports. Thus, one port serves 10 islands or 10.16 islands / ports [5]. The impact of uncertain information causes service users to travel long before the ship arrives. Due to the relatively long distance, such as: inter-island trips to the port and having to wait at the port because there is no certainty of information about the arrival of ships.
There are four factors that have a significant impact on improving the performance of marine transportation in the Maluku region, namely the availability of port infrastructure, ship services, the availability of information and communication infrastructure, and the availability of other modes of infrastructure. The factor index of the availability of information and communication infrastructure has a higher impact on transportation performance than the other three factors, namely 58.4%, while other supporting factors are: port infrastructure by 34.3%, ship services by 16.3%, and other modes of 24.1% [9].
In today's world, the development of information and communication technology (ICT) is getting wider so that it includes the land, sea and air transportation sector. In the development of ICT for the transportation sector, it is inseparable with the term Intelligent Transport System (ITS) which is also referred to as transport telematic systems where an Intelligent Transportation System. Recently, the mode of water transportation (sea / river / lake), especially sea transportation, has received special attention from ITS, related to the development of a maritime intelligent transport system, where the main focus will be marine navigation with a telematics approach.

2. Literature Review.
ITS first appeared in the late 1960s as a computerized traffic signal control system with the aim of making urban traffic flow smooth, the ITS concept was developed again in the 1980s, to be precise in 1988, OECD (Organization for Economic Corporation and Development) in Paris. Development continued in 1996 in America, namely National ITS Architecture, in 2000 in Europe with the KAREN Project. Recently, water transportation modes (sea, river, and lake), especially sea transportation, have received special attention from ITS, related to the development of a maritime
intelligent transport system in the future. The main focus is marine navigation with a telematics approach. Although ITS is often seen in the context of road traffic, because travelers and other modes of transportation share goods, ITS also includes rail, water and air transportation systems (Williams, 2008).

ITS service types, according to ISO 14813-1 include several domains. Among them:

- Traveler information.
- Traffic management and operations.
- Vehicle services.
- Freight transport.
- Public transport.
- Emergency.
- Electronic payments related to transportation, etc.

According to a group of organizations that are responsible for the maintenance and development of the European ITS Framework Architecture (FRAME Architecture) methodology to create an ITS Architecture from the FRAME Architecture which is illustrated in Figure 2.1. This is important for two reasons: firstly an ITS architecture created using a methodology will not become obsolete through technological advances or the development of certain products, and the second opens up the possibility for the development of new technologies to allow certain functionality to be provided.

![Flow chart of ITS design using FRAME](image)

**Figure 1.** Flow chart of ITS design using FRAME [3].

3. Methodology.

3.1 Research Location

This research was conducted in the Maluku archipelago and several ports on the R-49 with the KM Belt Nusantara 103 ship as a pioneer ship serving the R-49 route.

3.2 Data collection methods

The data collection process is carried out by three methods, including:

- Study literature to identify stakeholders by studying documents related to pilot ship activities. Literature studies are also carried out at the completion of the observation process to maintain what possibilities if unidentified stakeholders.
- Field observations to find out directly the obstacles faced by stakeholders and observe the process of data and information flow to and from the pilot ship.
4. Result and Discussion.

4.1 Stakeholders

Identified stakeholders:

- **Main Port Authority Office.** Main Port Authority Office is a government institution at the port as the authority that carries out regulatory, controlling and supervisory functions of port activities that are commercialized.
- **Main Harbormaster Office.** Main Harbormaster Office is a government official who is appointed by the minister and has the highest authority to carry out and supervise compliance with the provisions of laws and regulations to ensure the safety and security of shipping.
- **Port Authority and Harbormaster Office.** The Harbormaster and Port Authority Office is the Technical Implementation Unit within the Ministry of Transportation under and responsible to the Director General of Sea Transportation.
- **Port Health Office.** Port Health Office is a technical implementation unit within the Ministry of Health which is responsible technically and administratively to the Director General of Disease Prevention and Health.
- **Agricultural Quarantine Office.** The Agricultural Quarantine Office is to carry out the operational activities of animal and plant quarantine, as well as supervision of biosafety, animal and vegetable.
- **Fish Quarantine and Fish Quality Control Office.** Who carry out operational activities in the context of preventing the entry and spread of quarantine fish pests and diseases from one area to another in the country as well as controlling the quality and safety of fishery products.
- **Port Business Entity.** Business entities whose business activities are specifically in the field of operating terminals and port facilities.
- **National Sea Transportation Company.** National Sea Transportation Company is a sea transportation company with an Indonesian legal entity that carries out sea transportation activities in Indonesian territorial waters and / or to foreign ports. The Sea Transportation Company also functions as a pioneer ship operator.
- **Loading and Unloading Companies.** Companies that contribute to smooth port operations in the form of loading and unloading goods from and to ships.
- **Service User.** Prospective passengers or passengers who use Pioneer Ship services as a mode of transportation for the mobilization of people and goods.
- **The captain Crew of Pioneer Ship.** The captain is the crew of the ship who is the supreme leader on the ship and has certain powers and responsibilities in accordance with the provisions of laws and regulations. The crew includes Chief Commander I, Chief Second Officer, Chief of the Engine Room who has the authority to transfer information and data.

4.2 Identification of Stakeholder Aspirations.

The process of identifying the aspirations of stakeholders is carried out by means of interviews with stakeholders. The aspirations of stakeholders are divided into two parts, where the first is the aspirations of pioneer ship operators as well as related agencies and service users.

4.2.1 Ship operators and related agencies.

The interview process was carried out to PT. Pelni as the operator of the domestic ship, the captain and the ship's crew as well as related agencies related to data transfer activities and ship information.

| No | Description                                      |
|----|--------------------------------------------------|
| 1  | Information needs, data reporting is not properly monitored |
| 2  | Reports relating to easily lost and damaged documents |
| 3  | Data recapitulation is still manual               |
4 The customer database could not be fully known
5 ships of difficulty sending information and data in Real time
6 Information provided is often late
7 The arrival of the ship cannot be properly monitored
8 The departure of the ship cannot be properly monitored
9 Cargo loading is not well integrated
10 SOP not working properly
11 Poor telephone and internet networks in remote areas

Source: Results of Data Processing.

4.2.2 Pioneer ship service users.
The interview process is carried out to users of pioneer ship services either using pioneer ship services to send goods or as prospective passengers.

| No | Description |
|----|-------------|
| 1  | Passengers have difficulty obtaining information on special goods delivery procedures. |
| 2  | Gaps in ship delay information |
| 3  | Gap in port schedule information |
| 4  | The cost of seeking information is relatively high |
| 5  | Port waiting fees are expensive |
| 6  | The cost of living on board is expensive |
| 7  | Alternative boats are expensive |
| 8  | There are no alternative ships in some ports |
| 9  | Information gaps related to the mechanism of delivery of goods |
| 10 | Passengers want to get information easily |
| 11 | Leave the goods at ABK Deck for the delivery process |
| 12 | Not knowing the delivery mechanism |
| 13 | Want to know the position of the ship in real time |
| 14 | Want to know the position of the goods (can track the shipment) |
| 15 | More security in shipping goods |
| 16 | There was a queue at the manual ticket reception |

Source: Results of Data Processing.

4.3 Data and Information Identification.
Field observations of the pioneer ship serving route R-49. Following are the ship and route specifications for the R-49.

**ship specifications:**
Name of Ship: KM Sabuk Nusantara 103

| Specification | Value |
|---------------|-------|
| LOA           | 62.80 M |
| LPP           | 57.36 M |
| B             | 12.00 M |
| H             | 4.00 M  |
| T             | 2.70 M  |
| V             | 12 Knot |

Engine Power: 2 x 1000 HP
Capacity:
ABK : 36 people
Class I Passengers : 8 People
Class II Passengers : 18 People
Economy Passengers : 372 People

R-49 Voyage Route 17,2019:
Ambon – Marsela – Kroing – Dawelor – Seira – Adaut – Saumlaki – Tutukembong – Romean – Larat – Molu – Elat – Tual – Ambon.
Rute R-49 Voyage 18.2019: Ambon – Tual – Elat – Molu – Larat – Romané – Tutukembong – Saumlaki – Tutukembong – Romané – Larat – Molu – Elat – Tual – Ambon.

4.3.1 Data and information to and from the ship.
Identification of data and information from and to the ship is carried out by studying the documents relating to the ship's activities at the port of origin, while sailing, and the ship arriving at the port of destination. Data and information can be seen in table 3.

4.3.2 Data and information on service users.
There are 3 data and information for service users where:
- Information Search Process for Ticket Purchases.
- Goods Delivery Mechanism.
- Search for Ship Arrival Information and Ship Schedule

Table 3. Identified data and information to and from the ship

| Data and Information Services | Types of Data and Information | Description |
|-------------------------------|-------------------------------|-------------|
| Pioneer Ship Routes Network   | Emplooi                       | Emplooi Trip report |
|                               | Employee's Correction         | Proposed Change of Schedule |
|                               | Omission                      | Omission Report |
|                               | Deviation                     | Emplooi Correction for Omission |
| Service Standards             | Eating of the Crew            | Submitting for the ABK Food Fee |
| Fuel and Lubricants           | BBM                           | Giving Meal Costs for ABK |
|                               | Lubricant                     | Request for filling fuel |
|                               | Lubricating Oil Demand        | Approval Letter for BBM Request |
|                               | Lubricant Request Approval Letter | |
|                               | Oil Supply and use reports   | |
| Ship Maintenance              | Emergency Docking             | Breakdown News Event (emergency docking) |
|                               | Maintenance of the Ship When Operated | Submission of SPB (Ship Request Letter) |
|                               | Updating of Ship Documents and Certificates | SPB / FPP approval letter |
|                               | Insurance                     | Endorsement Approval Letter |
|                               | Procurement                   | Incident Minutes |
|                               | Financial Management on Pioneer Ships | |
|                               | Ticket Management             | |
|                               | Use of Boat Tickets           | Minutes of Use of Boat Tickets |
|                               | Use of Partner Tickets        | Partner Ticket Usage Report |
|                               | Ticket Distribution           | Receipt of tickets on board |
|                               | The ship entered              | |
|                               | PKK (Notification of Entry Vessels) | |
|                               | RPK / PKKA / PFKM / PK        | Ship Health Documents |
|                               | Manifest                      | Manfest List of Dangerous Payments |
|                               | Quarantine Documents          | Quarantine Documents |
|                               | SPM (Ship Entry Approval Letter) | |
|                               | Issuance and Receipt of Goods | |
|                               | Unloading and Loading         | Goods Transportation Report (LAB) |
| Ship Out Service              | Ship Out                      | Request for Ship Out |
|                               | Issuance of Sailing Health Certificate | |
|                               | SPB (Sailing Approval Letter) | |
Extend Mooring Period
SPOG (Movement Order)
Application for Extension of Mooring Period

Moving Ship Services
PPK issuance
Request for moving ships / shifting

Cancellation of Services
Publishing
Request Cancellation of Service
Issuance of Ship Service Determination (PPK) for Service Cancellation

Source: Results of Data Processing.

4.4 Interpreted Ship Data and Information.
Integrated data and information is data and information that has been developed in the form of apps or web, both from ship operators and related agencies related to pioneer ship information transfer activities.

4.4.1 Pioneer Ship Application.
The function of the pioneer ship application is management of marketing and ticket sales of pioneer ships and this application has been implemented in 45 pioneer ships and 38 branches / terminal points (until the end of 2018).

Table 4. Pioneer Ship Application Module.

| No | Module Application | Description | User |
|----|---------------------|-------------|------|
| 1  | Central Administration Module | This application module is inside the PELNI Portal application that serves for managing data master such as ship, port, route, schedule / emplooi, and tariff. | Head Office: •Passenger Transportation Marketing Division of Passenger & Perintis Ships.. •Passenger & Perintis Ship Operations Division. |
| 2  | Ships Administration Module | This application module is installed on the ship server that serves for managing the upload data of revenues / passenger, download master data, and reporting passenger list and ship income. | Ships |
| 3  | Mobile Module | This application module is mobile and installed on android smartphone. This module serves for conducingt sales and check-in / checking passenger tickets. | Ships |

Source: PT. Pelni [7].

4.4.2 Inaportnet.
Inaportnet is an internet / web-based electronic single service system to integrate a standard port information system in serving ships and goods physically from all agencies and stakeholders at the port.

4.4.3 SPS Online.
Online Syahbandar Approval Letter (SPS Online) is a mail service system harbormaster approval or syahbandar approval letter service system or licensing in the field of harbormaster at the online office of the technical unit of the Directorate General of Sea Transportation. SPS Online has been
implemented in several ports of the Technical Implementation Unit of the Directorate General of Sea Transportation which includes the Ambon Class I Port Authority and Harbormaster Office.

Table 5. Integrated ship data and information mapping.

| Identified data and information from and to the ship | Types of Data and Information | Description | Ship Application Pioneer | Reported | Sps Online |
|-----------------------------------------------------|-------------------------------|-------------|--------------------------|----------|------------|
| Pioneer Ship Routes Network                         | Emplooi                       | Trip report |                         | •        |            |
|                                                    |                               | Ship Travel Monitor | Submission of endorsemets |         |            |
| Updates                                            | Updating of Ship Documents    | Endorsement Approval Letter | | * | |
|                                                    | and Certificates               |                          | | | |
|                                                    | Use of Boat Tickets            | Minutes of Use of Boat Tickets | | * | |
| Ticket Management                                  | Use of Partner Tickets        | Partner Ticket Usage Report | | * | |
|                                                    | Ticket Distribution            | Receipt of tickets on board | | * | |
| The ship entered                                   | Incoming Ship                 | PKK (Notification of Entry Vessels) | | * | * |
|                                                    |                               | RPK/PKKA/PPKM/PK | | * | * |
|                                                    |                               | Ship Health Documents | | * | * |
|                                                    |                               | Manifest | | * | |
|                                                    |                               | List of Dangerous Payments | | * | |
|                                                    |                               | Quarantine Documents | | * | * |
|                                                    |                               | SPM (Ship Entry Approval Letter) | | * | * |
| Issuance and Receipt of Goods                      | Unloading and Loading          | Freight Report (LAB) | | * | |
| Ship Out Service                                   | Ship Out                      | Outboard Ship Application | | * | * |
|                                                    |                               | Issuance of Sailing Health Letters | | * | * |
|                                                    |                               | SPB (Sailing Approval Letter) | | * | * |
|                                                    |                               | SPOG (Letter of Exercise Order) | | * | |
| Extend Mooring Period                              |                                | Application for Extension of Time Off | | * | |
| Moving Ship Services                               |                                | Publication of PPK | | * | |
|                                                    | Ship / Shifting Application   | | | | |
|                                                    | Publication                   | | | | |
|                                                    | Service Cancellation Application | | | | |
| Cancellation of Services                           | Issuance of Ship Service Determination (PPK) for Service Cancellation | | | * | |

Source: Results of Data Processing.

4.5 Impact of non-availability of information.
In this research, the reason is that the unavailability of information related to cargo and passengers at the port of destination has resulted in ships still visiting the port. In table 6 it can be seen that the
unavailability of information on goods and passengers at Romean Port, Tutukembong, and returning to Romean.

| Port Name          | Cargo Loading M³ | Cargo Unloading M³ | Passengers Loading On Board | Passengers Off Board |
|--------------------|------------------|-------------------|-----------------------------|----------------------|
| Ambon              | 97               | 66                |                             |                      |
| Tual               | 4                | 22                | 73                          | 3                    |
| Elat               | 4                | 3                 |                             |                      |
| Molu               | 9                | 15                |                             |                      |
| Larat              | 14               | 21                | 30                          |                      |
| Romean             |                  |                   |                             |                      |
| Tutukembong        |                  |                   |                             |                      |
| Saumlaki           | 4                | 52                | 14                          | 109                  |
| Tutukembong        |                  |                   |                             |                      |
| Rumean             |                  |                   |                             |                      |
| Larat              | 2                | 21                | 2                           |                      |
| Molu               |                  |                   | 31                          | 9                    |
| Elat               |                  |                   |                             |                      |
| Tual               |                  |                   |                             |                      |
| Ambon              | 2                | 18                |                             |                      |
| Total              | 105              | 105               | 228                         | 228                  |

Source: PT. Pelni.

In this session, researchers will calculate the cost of ship fuel or marine fuel oil (MFO) on Voyage 17.2019 to see the big impact on the 3 port visits.

| Port Name          | LENGTH OF JOURNEY (hour) | MFO (Ton) |
|--------------------|--------------------------|-----------|
| Ambon              |                          |           |
| Ambon              | Tual                     | 36.54     | 35,000    |
| Tual               | Elat                     | 03.12     | 26,533    |
| Elat               | Molu                     | 12.30     | 25,878    |
| Molu               | Larat                    | 04.36     | 22,706    |
| Larat              | Rumean                   | 01.30     | 21,858    |
| Rumean             | Tutukembong              | 05.36     | 19,561    |
| Tutukembong        | Saumlaki                 | 06.18     | 17,028    |
| Saumlaki           | Tutukembong              | 07.12     | 17,028    |
| Tutukembong        | Rumean                   | 03.42     | 15,234    |
| Rumean             | Larat                    | 01.48     | 14,174    |
| Larat              | Molu                     | 04.00     | 13,226    |
| Molu               | Elat                     | 12.54     | 12,378    |
| Elat               | Tual                     | 03.12     | 9,462     |
| Tual               | Ambon Finish             | 34.42     | 8,826     |
| Ambon              | Finish                   | 0.50      | 0.600     |

Source: PT. Pelni.

In table 7 it is known that the total distance covered by the ship following the initial route is 1,199.8 ml, the fuel used is 34,400 tonnes, and the fuel consumption per ml is 0.029 tonnes with an average speed of 8.6 knots. If the ship has information about the unavailability of cargo at the three ports, the distance for the ship becomes 1,129.9 ml and the fuel used is 32,394 tons, then there is a difference in fuel of 2,006 tons with the MFO base price at PT. Pertamina for region 4 (Maluku, NTT, Papua), the ship can save budget for fuel as much as Rp 19,308,993.10.
4.6 Recommendations for the Implementation of ITS Architecture.

Based on the constraints faced, the aspirations of stakeholders and the conditions of existing applications, the authors propose an ITS Architecture design and involve technology related to data management and information on pioneer ship services so that they can process and send data when needed. The ITS Architecture design process includes:

- Needs and Aspirations Analysis.
  Analysis of needs and aspirations to determine priority needs and aspirations of users.

- Functional Architecture.
  The functional architectural design or implementation package is in accordance with the aspirations and needs of the current stakeholders and impactors.

- Physical Architecture.
  Physical Architecture Design is in accordance with the functional architecture that was designed earlier.

- Communication Architecture.
  This architecture describes the way of transferring information at each stage with certain conditions of the information.

- Mockup Design.
  The purpose of the mockup design is to be able to see the visual appearance of the previous design.

- Performance evaluation.
  This process is carried out using the method of cost benefit analysis and investment analysis.

5. Conclusion

1. The implementation of ITS in the marine transportation system, especially in the Maluku islands, is one of the recommendations to improve pioneer ship services to be more productive.

2. Availability of good information can save ship operating costs.

3. The availability of good information can reduce the waiting time for pioneer ship service users.

4. The availability of easily accessible information can reduce the cost of searching for information related to ship routes and schedules.

5. Users of pioneer ship services find it easier to make decisions to mobilize people and goods.

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