Initial Study of Autonomous Shipping in Indonesia

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# Introduction to Presenter

<table>
<thead>
<tr>
<th>Bachelor</th>
<th>Master</th>
<th>Doctor</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Civil and Environmental Engineering, Universitas Gadjah Mada (S.T.)</td>
<td>- Master in Transportation, Infrastructure, and Logistics, Technische Universiteit Delft (M.Sc.)</td>
<td>- <em>Maritime Studies at School of Civil and Environmental Engineering, Nanyang Technological University</em> (Ph.D. student)</td>
</tr>
<tr>
<td>- <em>International Civil Engineering Management</em>, Hanzehogeschool Groningen (Ing.)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Working Experiences

- Expert Staff of Maritime Transportation, Authority of Indonesia New Capital City (2024-present)
- Port and Logistics Expert, *STC Next*, Rotterdam (2021-present)
Content of Presentation

- Introduction of the Study
- Autonomous Shipping Technology in the Context of Indonesia
- Opportunities
- Suggested Road Map for National Authority
Introduction of the Study
This study extends the autonomous shipping understanding in Indonesia

• The study aims to complete the international consultant understanding of MASS adoption in Indonesia
• Interviews and desk studies have been conducted with various stakeholders to understand different perspectives of maritime autonomous surface ship (MASS): regulator, port operator, business players, academics, associations
• Four main questions related to autonomous shipping are asked to guide the interviews and desk research

• Due to the very limited MASS concept adoption, we do not seek extensive lists of stakeholders

<table>
<thead>
<tr>
<th>Sector</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulation</td>
<td>Desk study, interview</td>
</tr>
<tr>
<td>Business Players</td>
<td>Desk study, interview</td>
</tr>
<tr>
<td>Related Association</td>
<td>Desk study</td>
</tr>
<tr>
<td>Academia</td>
<td>Desk study, interview</td>
</tr>
</tbody>
</table>

Table 1: List of method and related stakeholders in this study

Figure 1: Main questions asked regarding the study
Introduction of the Study
Different degree level of MASS

- The International Maritime Organization (IMO) has defined a Maritime Autonomous Surface Ship (MASS) as a vessel capable of operating independently of human input to varying degrees. This autonomy is categorized into four different levels, from 1 to 4.

<table>
<thead>
<tr>
<th>Degree type</th>
<th>Definition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree 1</td>
<td>Ship with automated processes and decision support</td>
<td>Seafarers are on board to operate and control shipboard systems and functions. Some operations may be automated and at times be unsupervised but with seafarers on board ready to take control.</td>
</tr>
<tr>
<td>Degree 2</td>
<td>Remotely controlled ship with seafarers on board</td>
<td>The ship is controlled and operated from another location. Seafarers are available on board to take control and to operate the shipboard systems and functions.</td>
</tr>
<tr>
<td>Degree 3</td>
<td>Remotely controlled ship without seafarers on board</td>
<td>The ship is controlled and operated from another location. There are no seafarers on board.</td>
</tr>
<tr>
<td>Degree 4</td>
<td>Fully autonomous ship</td>
<td>The operating system of the ship is able to make decisions and determine actions by itself.</td>
</tr>
</tbody>
</table>

Figure 2: Autonomous container vessel, Yara Birkeland. Source: Norway Embassy (2023)
Autonomous Shipping Technology in the Context of Indonesia
Domination of small feeder vessels in Indonesia

- In 2021, 72,313 seagoing vessels operated in Indonesia. This number increased by 14% y-o-y compared to 2020
- The share of foreign agent vessels has risen from only 28% in 2017 to 48% in 2021

![Figure 3: Number of seagoing fleets in Indonesia.](source: Ministry of Transportation, 2022)

- Due to the dominant shallow draft in commercial ports in Indonesia, there are more small vessels than large ones
- The vessel composition in the country is dominated by small feeder vessels and feeder vessels (74%)

![Figure 4: Share of domestic vessels to the capacity](source: STC International (2022))
Indonesia had 3,672 ports in the port system by 2022:
- 2012 public ports
  - 111 commercial ports managed by SOE
  - 1846 ports managed by MoT
  - 55 managed by private entity

Ports in Indonesia are dominated by small ports with drafts that are not too deep (4-8 m).
This range of depth only can handle the small feeder (<1,000 Units, TEUs) and feeder vessels (1,000-2,000 TEUs).
Autonomous Shipping Technology in the Context of Indonesia
To uphold its infrastructure and technology in MASS, Indonesia is still far from the current global shipyard competition

Infrastructure and Technology
• **Globally, the shipbuilding capacity has reduced** from 57.7 million CGT in 2013 to 39.5 CGT.
• The capacity has reduced greatly caused of the financial crisis of 2008 and the weakening of vessel prices. Indonesia has significant gap to catch up in the shipyard industry compared to other maritime giants (China, South Korea, and Japan).
• In Indonesia, the shipbuilding industry has experienced hard time due to the lack of spare part and capacity causing the lack of appetite of ship orders from other and inside the country.
• Indonesia has 250 shipyard companies. The **production capacity is 1 million DWT annually for new ship construction and 12 million DWT for ship maintenance and reparation**
• The shipyard industry constructs passenger ships, cargo ships, and special needs vessels. The largest capacity of the graving dock in the country is 150,000 DWT.
• PT PAL in Surabaya is the largest shipyard in the country. Most of the products are tanker vessels with sizes of 30,000 DWT and 17,500 DWT.
Autonomous Shipping Technology in the Context of Indonesia

Indonesia is the third largest seafarer producer globally.

- Indonesia is the **world's third-largest country of seafarers**
- The agenda of MASS still needs to be prioritized within the ministry
- Adopting autonomous shipping would significantly impact countries that heavily rely on the maritime industry and have a large population of seafarers.
- The maritime industry contributed 11% of Indonesia’s GDP.
- **Indonesia needs more training for the seafarers** in adopting MASS technology by adding specific courses to adopt the MASS concept: Autonomous system, data analytics and AI, cybersecurity, human-AI interaction, and regulatory and legal frameworks
- Elevate and expand the quality of **seafarer supply** for the country who has a crisis in seafarer numbers, such as Greece, Italy, Netherlands, and Japan

Figure 8: Share of seafarer number in the world
Source: UNCTAD, 2021
Autonomous Shipping Technology in the Context of Indonesia
How IMO and Indonesia attract women for jobs in maritime

• Globally, women have only 1.2% share of global seafarers
• The IMO has established the Women in Maritime Program
  • scholarships specifically designed for women
  • advanced technical training in the maritime sector in developing nations and
  • fosters an environment that encourages the recognition of women and provides them with opportunities

• Indonesia had 18,572 women in maritime across diverse roles, educational backgrounds, and sailing statuses
• Women in Maritime Association Indonesia (WIMA) has become a renowned organization. However, it is not specifically only for women who work in shipping; it also covers women's work in maritime law, consultancy, etc.,
• Interestingly, the Indonesia National Shipowner Association (INSA) and Indonesia Association of Offshore and Ship Buildings (IPERINDO) are led by women
Autonomous Shipping Technology in the Context of Indonesia

DGST and DGLT are responsible on introducing MASS in Indonesia

- The current regulator is the Ministry of Transport, especially **the Directorate General of Sea Transport** (DGST)
- Directorate General Land Transport (DGLT) is also in charge of this issue because the RoRo vessel (commonly used for ferry transport) is under DGLT.
- It regulates the different areas of transport and traffic, port, ship and sailor, navigation, and offshore safety
- Currently, **there are no laws, regulations, or guidelines mentioning the adoption of autonomous shipping** in the Indonesia context
- Currently, no law mentions the adoption of MASS

Figure 9: List of related regulators in Indonesia
• **Light Rail Transit (LRT)** is the only transport mode in Indonesia that operates autonomously.
• It operates in the Greater Area of Jabodebek (Jakarta-Bogor-Depok-Bekasi).
• The train system has **three Grades of Automation (GoA)**. LRT Jabodebek has the highest GoA, meaning it is fully automated.
• The system uses the Communication-Based Train Control (CBTC).
• The CBTC system operates trains based on communication, allowing for automatic train operation and schedule projections, which are also automatically supervised by the Operation Control Center (OCC).

Figure 10: LRT Jabodebek. Source: Tye Wong, 2023
Status of Autonomous Shipping Technology Research and Development
ITS has explored several technologies in MASS

2020: I-Boat
identify potential dangers and prevent collisions with objects at sea

2022: ROV W-101
streamline the process of monitoring underwater cables and pipelines and conducting marine exploration in Indonesia

2023: Aksanawa
an autonomous surface ship, to do Search and Rescue (SAR)

Current: research on ship size vessel for outer island logistics
Opportunities and Challenges
Challenges-high capital expenditure depends on the level of automation

- High capital costs in **upfront investment** to develop, integrate, and deploy autonomous technologies:
  - Retrofitting existing vessels or constructing new autonomous vessels
  - Advanced systems, sensors,
  - Communication infrastructure
- **The higher the automation level, the higher the capital cost required**

### Table 3: Investment in the MASS concept and its related automation level.

<table>
<thead>
<tr>
<th>Component</th>
<th>Type</th>
<th>Automation Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shore control center for remotely controlled vessels</td>
<td>System</td>
<td>2, 3, and 4</td>
</tr>
<tr>
<td>Data integration to support Vessel Traffic services</td>
<td>System</td>
<td>1, 2, 3, 4</td>
</tr>
<tr>
<td>Auto-mooring facilities for complete unmanned sailing to the terminals</td>
<td>Infrastructure</td>
<td>3 and 4</td>
</tr>
<tr>
<td>Training for new process in automation</td>
<td>Human resource related</td>
<td>1, 2, 3, and 4</td>
</tr>
<tr>
<td>Adjustment of berthing infrastructure for small ports</td>
<td>Infrastructure</td>
<td>3 and 4</td>
</tr>
</tbody>
</table>

Source: Fiedler, Bösse, Gehlken, Brümmerstedt, & Burmeister (2019)
Opportunities and Challenges
Challenges—The economy of scale of MASS is still in question

- The high capital of MASS adoption creates a question on the economies of scale of this operation.
- Some notable research shows the potential for cost savings in the long term of MASS operation.
  - Akbar, et.al., 2020
    - Reduced fuel consumption by 9.75%
    - Reduced crewing costs → reduced weekly charter cost by 36%,
    - Reduced construction cost by removing the deckhouse, by 5-10%
  - Nguyen, Ruzaeva, Góez, & Guajardo, 2022
    - Optimize routes, improve fuel efficiency, and enhance overall operational efficiency → reduction of 7% of operating cost
- Different ship size has a different percentage of reduced cost

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ship size</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity (TEU)</td>
<td></td>
<td>1,000</td>
<td>1,350</td>
<td>2,000</td>
<td>2,550</td>
<td>3,500</td>
</tr>
<tr>
<td>Conventional ship</td>
<td>Fuel usage (ton/hr)</td>
<td>0.61</td>
<td>0.69</td>
<td>0.75</td>
<td>0.80</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>Weekly time charter cost (kUSD)</td>
<td>53</td>
<td>54</td>
<td>56</td>
<td>58</td>
<td>64</td>
</tr>
<tr>
<td>Autonomous ship</td>
<td>Fuel usage (ton/hr)</td>
<td>0.55</td>
<td>0.62</td>
<td>0.68</td>
<td>0.72</td>
<td>0.77</td>
</tr>
<tr>
<td></td>
<td>Weekly time charter cost (kUSD)</td>
<td>32.5</td>
<td>33.5</td>
<td>35.6</td>
<td>37.7</td>
<td>44.0</td>
</tr>
</tbody>
</table>

Table 2: Different potential reduction of long-term cost operation in MASS
Source: Akbar, et.al., 2020
Opportunities and Challenges for MASS
Opportunities - developing human resources in MASS

- Indonesia can maximize its human resources to be a global HR supply for experts in autonomous shipping operations.
- Understanding autonomous shipping operations at different levels must be introduced to bring positive economic value.
- The seafarer community can be trained further as the controller of MASS operation in the shore center
- Potential courses can be added in academy to adopt with MASS technology

Figure 11: Potential additional courses regarding MASS adoption
Opportunities and Challenges for MASS

Opportunities – Continuous adoption can lower MASS operational cost

<table>
<thead>
<tr>
<th>Component</th>
<th>Sub-components</th>
<th>Autonomous container ship</th>
<th>Autonomous bulk carrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voyage costs</td>
<td>Bunker fuel</td>
<td>The fuel consumption is reduced by 13-15%(^a)</td>
<td>the fuel consumption is reduced by 6-15%(^a)</td>
</tr>
<tr>
<td></td>
<td>Port charges</td>
<td>Boarding crew cost is not estimated</td>
<td>Boarding crew cost +20%</td>
</tr>
<tr>
<td>Operating costs</td>
<td>Crew wages</td>
<td>-30 – 35% due to removal of crew cost; cost of shore control center +250k USD</td>
<td>-945,000 USD cost of wages; additional cost of shore control center +149k USD</td>
</tr>
<tr>
<td></td>
<td>Stores</td>
<td>Removal of stores concerning crew is not estimated</td>
<td>-67k USD</td>
</tr>
<tr>
<td>Maintenance and Repairs</td>
<td>Maintenance of autonomous systems carried in ports - the scale of increase unknown</td>
<td>Maintenance of autonomous systems carried in ports: -135k USD</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component</th>
<th>Sub-components</th>
<th>Autonomous container ship</th>
<th>Autonomous bulk carrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Cost</td>
<td>Purchase cost</td>
<td>Additional cost of redundancies, removed deckhouse, and hotel system – not estimated</td>
<td>Additional cost of redundancies (+10%), removed deckhouse (+5%), and hotel system (1-10%)</td>
</tr>
</tbody>
</table>

Table 3: Increase and Decrease Cost during the Ship Operation
Source: Ziajka-Poznanska & Montewka, 2021

- The cost decrease in fuel consumption, crew cost, removal of stores, maintenance, and repairs
- The cost increase in boarding crew costs, procurement of shore control center, redundancy in capital costs, removal of deckhouse
- The economy of scale in MASS operations is contingent on various factors, including the scale of operations, the nature of the shipping routes, the cargo volume, and the regulatory framework in place

\(^a\) = autonomous, c = conventional
Suggested Road Map for National Authority
The road map is divided into short, mid, and long terms

- **Short-term (1-3 years)**
  - introduce the concept aligning with IMO’s progress on setting guidelines
  - initiating pilot projects to test autonomous vessels’ performance, safety, and efficiency in Indonesian maritime conditions. The test will provide data on navigational challenges, vessel interactions, and environmental impact to inform the development of national guidelines and regulations

- **Mid-term (4-7 years)**
  - It concern the operation of autonomous vessels in Indonesia, considering the IMO's Interim Guidelines on Maritime Autonomous Surface Ships.
  - Focusing on what upgrade should country hard and soft infrastructure has

- **Long-term (8+ years)**
  - Specify shipping corridor and continue to develop the suitable regulation

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Figure 6: Suggested Road Map for National Authority