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Innovation Through AI Integration: A Study of AI Technology Adoption for the Maritime Inspection and Consulting Sector using Soft System Methodology

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ABSTRACT

The maritime industry, a global powerhouse for trade and transportation, is on the cusp of a transformative era driven by Artificial Intelligence (AI). This paper explores the potential of AI to revolutionize various aspects of the maritime sector, from navigation and route optimization to predictive maintenance and enhanced safety. This paper will study AI implementation in the inspection and consulting industry. This AI will help speed up the maritime industry's regulatory compliance process and maintenance services. The study showed four main stakeholders in AI implementation: Operational experts, managers, clients, and the AI team. Each stakeholder has a crucial role in successfully implementing AI in this industry. This study will map out each stakeholder's interest using SSM, giving a clear picture of what each stakeholder wants and their apprehensions. The result of this study is some conditions that need to be met by each stakeholder for the implementation of AI in this sector to be successful.

Keywords: Artificial Intelligence, SSM, Technology Implementation, Maritime.

I. Introduction

The digital era is characterized by rapid technological advancements, with artificial intelligence (AI) emerging as a transformative force across various industries (Brynjolfsson & McAfee, 2017). AI boasts impressive capabilities in data analysis, pattern recognition, and generating insightful recommendations, offering significant advantages for streamlining processes and improving decision-making (Varian, 2018). The maritime inspection and consultancy sector presents a prime example of where AI can potentially revolutionize workflows. Traditionally, ensuring shipping safety, environmental protection, and efficient trade relies on standardized procedures established by the International Maritime Organization (IMO) (e.g., MARPOL Annex VI). However, individual member state interpretations and implementation of these policies can lead to legal and operational discrepancies (Stopford, 2009).

This study focuses on the potential of AI to address these challenges within the Indonesian maritime inspection and consultancy sector. With its burgeoning economy and widespread technology adoption, Indonesia presents a compelling case study for exploring AI integration in this domain. While companies

increasingly recognize AI's potential, a deeper understanding is required to overcome the barriers associated with its adoption and fully leverage its benefits.

This research explores the challenges and opportunities of integrating AI in the Indonesian maritime inspection and consulting sector. By understanding these factors comprehensively, we hope to empower companies to make more informed decisions regarding their AI strategy. Ultimately, the goal is to unlock the full potential of AI for sustainable growth and enhanced efficiency within this crucial sector.

II.   Literature Review and Hypothesis Development

The transformative potential of artificial intelligence (AI) extends across various industries, presenting both opportunities and challenges (Brynjolfsson & McAfee, 2017). In the food supply chain (FSC), AI adoption holds promise for addressing food safety, quality, and waste reduction by enhancing transparency and traceability (Dora et al., 2021). This finding underscores AI's critical role in tackling complex supply chain management issues. However, the integration of AI in the educational sector faces ethical concerns and implementation hurdles (Tahiru, 2021). This highlights the importance of considering sector-specific ethical and practical challenges when deploying AI technologies. Beyond its benefits in supply chain management, AI demonstrates potential in the healthcare sector. Research by Simon et al. (2018) suggests AI's ability to address knowledge gaps in cancer care, paving the way for improved diagnostics and treatment. Similarly, AI and machine learning applications offer promising solutions in environmental challenges like biodiversity conservation and forest management (Shivaprakash et al., 2022). These findings suggest that AI adoption within the maritime inspection and consultation sector could contribute to environmental and sustainability goals. Osamy et al. (2022) also showcase how AI techniques can address data collection, aggregation, and dissemination challenges in wireless sensor networks. This emphasizes AI's potential to streamline data management in complex operational environments, potentially benefiting maritime operations. While AI adoption offers promising maritime inspection and consultation advantages, several knowledge gaps and challenges remain. A critical area for future research is exploring AI implementation's specific challenges and opportunities within the maritime industry, considering its unique operational environment and regulatory landscape. Understanding the potential ethical implications and challenges associated with AI use in maritime inspection and consultation is also crucial. Investigating the barriers and facilitators of AI adoption in this sector is necessary, considering the complexities of maritime operations and regulatory compliance requirements. Furthermore, integrating AI with digital feedback systems could support the implementation of measurement-based care in the maritime industry (Lyon et al., 2019). This approach can improve operational processes and decision-making in maritime inspection and consultation. Learning from AI tool penetration in other sectors, like banking, can also benefit AI adoption in maritime operations. Studies by Marinakis et al. (2021) and Schlögl et al. (2019) offer valuable insights into best practices and potential challenges that can inform the maritime sector.

III.   Research Method

This research employs Soft Systems Methodology (SSM) (Challender, 2000) to explore the complexities surrounding the implementation of AI in the maritime inspection and consultation context. SSM offers a structured approach for tackling ill-defined problems often encountered in social and managerial situations, particularly those with multiple stakeholders and conflicting viewpoints (Vidal, 2005). This methodology prioritizes understanding the problem space from diverse perspectives rather than focusing solely on finding the optimal solution. Here is how SSM will be applied in this study:

1. Rich Picture Development
    A comprehensive "rich picture" will be constructed to visualize the situation's complexities. This diagram will depict the relevant actors (individuals, groups, organizations), their activities and

interrelationships, and the influences that shape the situation. Stakeholder workshops and in-depth interviews will be conducted to gather data to construct a rich picture that reflects the various perspectives involved.

2. Root Definition Formulation

Key elements of the situation will be defined using the CATWOE framework (Wheeler et al., 2000). This framework clarifies the:

- Customers: Who are the beneficiaries of a potential solution?
- Actors: Who is involved in the situation, and how do they interact?
- Transformation: What is the current process or situation being investigated?
- Weltanschauung (Owner's Worldview): What are the underlying assumptions and values guiding the current system?
- Owners: Who has the authority to implement changes?
- Environment: What are the external factors impacting the situation?

3. Generating and Comparing Conceptual Models

Building upon the rich picture and root definition, different perspectives on improving the situation will be explored. This stage involves brainstorming and developing conceptual models that represent potential solutions. These models will consider different stakeholder viewpoints and address the root causes identified earlier. Doing so will help the researcher to paint a complete picture, including the complex motivational web that hinders or pushes the problem forward. The findings from this conceptual model will be used to inform recommendations for practical action steps. This may involve proposing changes to existing policies, procedures, or organizational structures based on the insights gleaned through SSM.

4. Justification for Using SSM

The choice of SSM is justified due to the "complex and multifaceted nature of AI implementation in the maritime inspection and consultancy." This methodology allows for a deeper understanding of the issue's various viewpoints and challenges, leading to more comprehensive and well-rounded solutions (Bradbury, 2015). SSM is an iterative process requiring ongoing participant involvement. Additionally, the quality of the outcomes depends on the facilitator's skills and participant engagement. While limitations exist, SSM provides a valuable framework for exploring complex maritime inspection and consultation situations.

IV. Results and Discussion

4.1. Step 1: Rich Picture Development

While artificial intelligence is widely accepted for its uses, some challenges have arisen in its implementation in the maritime inspection sector. The challenges start from the very root of daily operations up to the complexity of decision-making at management and top management levels. AI implementation needs a dedicated team and expertise, which is in high demand worldwide. Of course, the need for the team can be delegated to an external third party, but that carries its own risk related to breach of trust, as data in the inspection industry often contains internal client data. Therefore, implementing artificial intelligence is a process that needs agreement between multiple stakeholders.
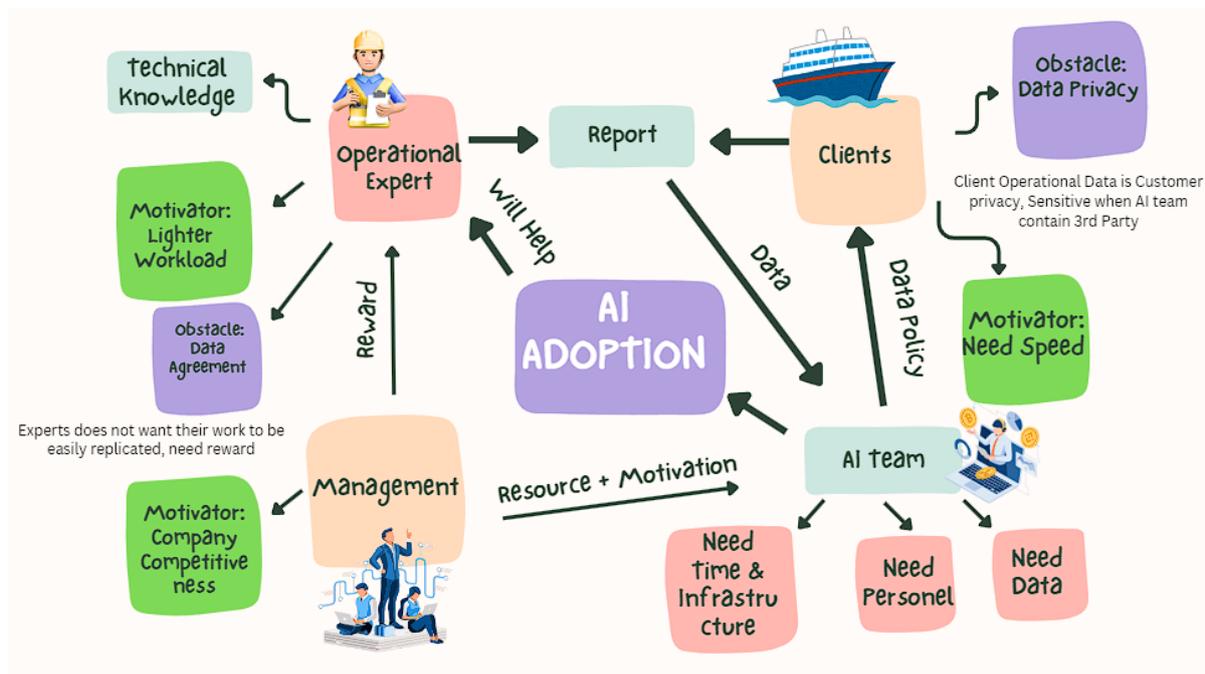
Figure 1. Rich Picture
Source: Author, 2024

4.2. Step 2: Root Definition Formulation

The root definition will be formulated using the CATWOE model to capture the situation's essence clearly, while placing the stakeholder in the appropriate position in this problem. RD will be analyzed using each stakeholder motivator as the base of the analysis; this will be used to create a complete picture of how each stakeholder motivation interacts. As for the AI team, which is the main driving force of AI implementation, the RD will be centered around the problems that arose during the implementation.

Table 1. CATWOE Analysis RD 1

RD 1 Lighter Workload For Operational Expert	
Element	**Description**
Costumer	Operational Expert
Actors	AI Team
Transformation	Faster and Stronger Data Analysis and Report Generation by using Artificial Intelligence that has learned from past reports
Wordfiew	Currently, there are many repetitions, and the expertise of one expert does not practically help others when they are on different projects.
Owner	Management, Customer
Environment	The AI team will need operational expertise to create the AI. Therefore, communication between the two will need to be facilitated.

The first root definition is from the viewpoint of Operational Experts. With Artificial Intelligence, these experts can spend less time looking at many reports and data to finish their work. This technology also enables past report–making experience to influence present projects, either by checking inconsistencies or by giving a better foundational knowledge, thus making reports' quality more robust and standardized across all projects. The main worry is the reduced financial worth of the project they worked on and the fear of being replaced by the tools.

Table 2. CATWOE Analysis RD 2

RD 2 Company Competitiveness for Management	
Element	**Description**
Costumer	Management
Actors	AI Team, Operational Expert
Transformation	Increased company competitiveness based on increased operational speed and better quality of work
Wordfiew	Currently, the quality of the project is significantly dependent on the quality of the expert involved in the project; with the help of AI, this can increase project quality across the entire company.
Owner	AI Team, Customer
Environment	Artificial Intelligence is gaining popularity. Therefore, infrastructure and expertise in the field are in high demand. Other than that, customer data use needs to be addressed.

The making of an AI needs many resources. Planning must be done to allocate resources for the AI team. Other than that, as the AI needs to be trained through past reports, an important NDA with the clients must be addressed for the AI Implementation to start.

Table 3. CATWOE Analysis RD 3

RD 3 Faster Speed of Service for the Client	
Element	**Description**
Costumer	Clients
Actors	AI Team, Operational Expert
Transformation	The faster the service is provided, the faster the business cycle rolls.
Wordfiew	As maritime inspection often assesses regulatory compliance, the faster the speed of the service, the faster compliance can be proven, thus allowing businesses to start/continue.
Owner	Manager
Environment	Artificial Intelligence is gaining popularity. Therefore, infrastructure and expertise in the field are in high demand. Other than that, customer data use needs to be addressed.

AI is considered a plus in the maritime sector. It is viewed as a powerful tool that produces accurate results when used by an expert. Therefore, operational data secrecy is the main obstacle to AI adoption. For the AI implementation to be successful, the client needs to be convinced that the data used will not harm them in any way whatsoever.

Table 4. CATWOE Analysis RD 4

RD 3 AI Team Needs	
Element	**Description**
Costumer	AI Team
Actors	Operational Expert, Client
Transformation	Adding expertise, proper data, and good infrastructure will ensure the project's success.
Wordfiew	The expert in the field of AI is in high demand, and insufficient data and structure will make the project take longer to finish.
Owner	Manager
Environment	Permission is needed to Gett data from each data holder for the AI team to use.

The AI team is where the work of implementing an AI is done. Often, companies will not have specific expertise to work on this project. Therefore, additional experts will be needed. Considering the current market

and how fast AI is developing, this AI Implementation could be resource-intensive, and those experts need to be internalized so that the company does not fall behind on the rapid progress of AI advancement.

4.3. Step 3: Generating and Comparing Conceptual Models

A conceptual model is needed to plan and design the solution for companies' AI implementation. The conceptual model will focus on 'what needs to be done' or 'what needs to happen' for AI implementation to succeed. Then, a comparison will be made with the assumption that the company has no IT resources specific to this AI sector and has not taken any action towards implementing AI.

Table 4. Conceptual Model

Conceptual Model	
RD1	**Operator Viewpoint**
Condition 1	AI must be understood as a tool to help, not a threat.
Condition 2	An expert must be willing to give data and insight to assess the usefulness of the AI developed by the AI team and to give suggestions for improvement.
RD2	**Managerial Viewpoint**
Condition 1	Managers must be convinced that AI is a potent tool; therefore, they must be willing to provide the team with much-needed resources.
Condition 2	Must be willing to talk to clients and negotiate permission for data usage
Condition 3	Must plan the internationalization of the newly acquired AI experts, who often have vastly different working cultures from maritime inspection experts
RD3	**Client Viewpoint**
Condition 1	Must be convinced that their data will not harm them in any way
Condition 2	Communication with the client so that clients are willing to pay more for faster and better quality of work
Condition 3	Must plan the internationalization of the newly acquired AI experts, who often have vastly different working cultures from maritime inspection experts
RD4	**AI Team Viewpoint**
Condition 1	Data and Infrastructure must be robust, as AI training speed and quality depend heavily on these aspects.
Condition 2	There must be a team of experts on AI training who are focused on AI and its advancement.

V. Conclusion

Through this research, soft systems methodology has helped to clear up the multi-layered needs of each stakeholder for AI implementation in the maritime inspection and consultation sector. The model captures each condition that each stakeholder needs to meet for the implementation of AI to succeed. To fulfill each condition, each company and its teams will have different considerations and therefore different solutions that are out of the scope of this research. Each company different environment may also produce different CATWOE analysis, therefore the result of this research should be taken in a broad sense as what that will happen when in AI implementation, and how this problem will surface will and in what form that will happen will be an unavoidable problem in the hands of each team.

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