

International Seminar:  
**The 3rd International Conference on Marine Technology - SENTA 2018**  
Surabaya – Indonesia  
5 – 6 December, 2018

Organizer:  
**Faculty of Marine Technology – ITS**

Paper:  
**Technical and Economic Analysis of Development of Steel Bridge on Ship Industry for Diversified Business**

Authors:  
**Rony Purwono, Heri Supomo, and I Ketut Suastika**

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Since 2001, Faculty of Marine Technology - Institut Teknologi Sepuluh Nopember (ITS) Surabaya has held the annual SENTA conference, formerly known as Seminar Nasional Teknologi dan Aplikasi Kelautan (National Conference on Marine Technology and Application), which provided a regular forum for researchers and engineers in Marine Technology in Indonesia. Then in 2016, SENTA conference has turned into an international conference in order to expand its research network.

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**Important Date**

Abstract submission	: 21 August 2018 (extended)
Abstract acceptance	: 7 September 2018 (extended)
Registration (early bird)	: 20—28 September 2018
Full paper and Poster submission	: 6 October 2018 (extended)
Full paper and Poster acceptance	: 24 October 2018
Registration (regular)	: 1—31 November 2018
<b>Conference Day</b>	<b>: 5 - 6 December 2018</b>

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Day 1 Quick Documentation

Day 1 Quick Documentation



**Topics**

All honorable authors are kindly encouraged to contribute to the conference through submissions of their research papers on all topics related to "Marine Technology for Food and Energy Sovereignty", including, but not limited to:

- Ocean Renewable Energy**
  - Renewable energy sources and management
  - Ocean Current Energy
  - Wave Energy
- Marine Aquaculture**
  - Marine Aquaculture Development
  - Ship design to support fishery and marine production
- Miscellaneous**
  - Oil and gas industry
  - Fisheries and marine biology
  - Marine environment

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## Topics

All honourable authors are kindly encouraged to contribute to the conference through submissions of their research papers on all topics related to **"Marine Technology for Food and Energy Sovereignty"**, including, but not limited to:

**Ocean Renewable Energy**

- Renewable energy sources and management
- Ocean Current Energy
- Wave Energy
- Wind Energy
- Ocean thermal energy
- Marine power plant and energy

**Marine Aquaculture**

- Marine Aquaculture Development
- Ship design to support fishery and marine production
- Sea transportation and logistics (supply, vessel)
- Feeding automation system for sustainable marine aquaculture
- Tropical marine fish hatchery technology

**Miscellaneous**

- Oil and gas industry
- Fisheries and marine biology
- Marine environment
- Coastal engineering
- Supply chain management
- Maritime logistics conceptual design
- Maritime defence and security design, innovation, and management
- Small island infrastructure and engineering
- Marine pipeline system
- Marine electrical, machinery and automation system
- Marine reliability and maintenance

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## Day 1 – Wednesday, December 5<sup>th</sup> 2018

ITS Research Center Building, Surabaya

07:00 – 08:30	On-site registration	11 <sup>th</sup> Floor Registration Desk
08:30 – 08.45	Opening Ceremony	11 <sup>th</sup> Floor Auditorium Hall
08:45 – 09:00	Welcome Speech	11 <sup>th</sup> Floor Auditorium Hall
09:15 – 10:15	Keynote Speaker: Ignasius Jonan [Indonesian Minister for Energy and Mineral Resources]	11 <sup>th</sup> Floor Auditorium Hall
10:15 – 11:15	Keynote Speaker: Susi Pudjiastuti [Indonesian Minister for Maritime Affairs and Fisheries]	11 <sup>th</sup> Floor Auditorium Hall
11:30 – 12:30	Lunch and Maritime Expo	1 <sup>st</sup> Floor Lobby
12:45 – 15:45	Parallel Session 1. Ocean Engineering 2. Aquaculture 3. Naval Architecture 4. Marine Engineering 5. Marine Transportation Eng.	Auditorium Hall, 11 <sup>th</sup> Floor Conference Room A, 11 <sup>th</sup> Floor Conference Room B, 11 <sup>th</sup> Floor Conference Room C, 10 <sup>th</sup> Floor Conference Room D, 10 <sup>th</sup> Floor
19:00 – 21:00	Gala Dinner <i>*transportation are available</i>	Balai Kota Surabaya

## Day 2 – Thursday, December 6<sup>th</sup> 2018

ITS Research Center Building, Surabaya

07:00 – 08:30	On-site registration	11 <sup>th</sup> Floor Registration Desk
08:30 – 08.45	Opening	11 <sup>th</sup> Floor Auditorium Hall
09:00 – 09:15	Coffee Break	11 <sup>th</sup> Floor lobby
09:15 – 10:00	Keynote Speaker: Prof. Kung-Yen Lee [Dept. of Engineering Science and Ocean Engineering]	11 <sup>th</sup> Floor Auditorium Hall
10:00 – 10:45	Keynote Speaker: Prof. Satriyo S. Brodjonegoro [AIPI Chairman]	11 <sup>th</sup> Floor Auditorium Hall
10:45 – 11.30	Keynote Speaker: Prof. Ikegami Yasuyuki [Leader of OTEC Division, Institute of Ocean Energy, Saga University]	11 <sup>th</sup> Floor Auditorium Hall
11:30 – 12:30	Lunch and Maritime Expo	1 <sup>st</sup> Floor Lobby
12:45 – 14:45	Parallel Session 1. Ocean Engineering 2. Aquaculture 3. Naval Architecture 4. Marine Engineering 5. Marine Transportation Eng.	Auditorium Hall, 11 <sup>th</sup> Floor Conference Room A, 11 <sup>th</sup> Floor Conference Room B, 11 <sup>th</sup> Floor Conference Room C, 10 <sup>th</sup> Floor Conference Room D, 10 <sup>th</sup> Floor
15:00 – 15:30	Awarding and Closing Ceremony	11 <sup>th</sup> Floor Auditorium Hall

*NB: Each presenter will be given 15 minutes to present and discuss their paper.*

**PARALLEL SESSION 1**  
**WEDNESDAY 12:45 – 15:45**

**1. NAVAL ARCHITECTURE I**  
Conference Room A, 5<sup>th</sup> Floor

**Chair :** Ir. Wasis Dwi Aryawan, M.Sc., Ph.D.

**Invited Speaker :**

Prof. I Ketut Aria Pria Utama, M.Sc., Ph.D. [Dept. of Naval Architecture, ITS Surabaya]

“Reducing Ship Emissions: A Review of Potential Practical Improvements in the Propulsive Efficiency of Future Ships”

Paper Presentation:

**1. Technical and Economic Analysis of Development of Steel Bridge on Ship Industry for Diversified Business**

Rony Purwono, Heri Supomo and I Ketut Suastika

**2. Application of Wearable Device for Real Time Monitoring System of Shipyard’s Fabrication Workers**

Triwilaswandio Wuruk Pribadi

**3. Human Resource management application in the Ship Repair Industry Web Based**

Mohammad Sholikhan Arif, Triwilaswandio Wuruk Pribadi, Salsabella Sam Aldini and Rizky Chandra Ariesta

**4. Preliminary Computational Fluid Dynamic (CFD) Resistance Simulation of Crocodile Ship Prototype**

Wisnu Wardhana and Agung Purwana

**5. Analysis of Access and Monitoring Systems Implementation on Human Resources to Improve The Performance in Shipbuilding Industry**

Triwilaswandio Wuruk Pribadi, Ilham Salo and Sufian Imam Wahidi

**6. Comparative Study on Ferry Ro-Ro’s Car Deck Structural Strength by Means of Application of Sandwich Materials**

Tuswan, Achmad Zubaydi, Agung Budipriyanto and Septia Hardy Sujiatanti

**7. Study of Shear and Pressure Flow on The Variation of Ship Hull Shapes as One of The Biofouling Growth Factors**

Muhammad Auliya Alamsyah, Muhammad Luqman Hakim and I Ketut Aria Pria Utama

**8. Application of Image Processing Technique on the Simple Open Free Running Test of A Ship Model for Rudder Evaluation**

Aries Sulisetyono and Andre T.S. Imran

## 2. MARINE ENGINEERING I

Conference Room B, 5<sup>th</sup> Floor

**Chair :** Ir. Agoes Achmad Masroeri, M.Eng., D.Eng

**Invited Speaker :**

Prof. Semin, ST., MT., Ph.D [Dept. of Marine Engineering, ITS Surabaya]

“Application of Gas Fuel in Ship to Reduce the Operation Cost and Emissions”

Paper Presentation:

1. **Concept Design of LNG Mobile Floating Bunkering Pontoons in Port of Perak Surabaya**  
Hayy Nur Abdillah, Ketut Buda Artana and I Made Ariana
2. **The Effect of Angle of Attack and Chord Length of The Foil on Winged Air Induction Pipe Optimization Toward Drag Reduction by Using Numerical Approach**  
Yanuar, Muhammad Alief, M. Akbar and Fatimatuzzahra
3. **Influence of Hydrofoil Clearance towards Total Drag Reduction on Winged Air Induction Pipe for Air Lubrication using Numerical Study**  
Yanuar, Fatimatuzzahra, Muhammad Alief, M Akbar and Made Susena
4. **Thermodynamic Analysis of Cascade Refrigeration System using CO<sub>2</sub> - NH<sub>3</sub> Refrigerant for Fish Cold Storage Application**  
Nazaruddin Abubakar and Sutopo Purwono Fitri
5. **Numerical Study of The Influence of Stagger Angle on A Savonius Vertical Axis Water Turbine Performance in front of Returning Blade**  
Priyo Agus Setiawan, Triyogi Yuwono and Wawan Aries Widodo
6. **Development of Spare Parts Models in Inventory Systems with The Concept of Vendor Managed Inventory in The Mining Industry**  
Mohammad Cipto Sugiono, Iwan Vanany and Niniet Indah Arvitrida
7. **The Sustainability Naval Base Model using System Dynamic Methods**  
Okol Sri Suharyo, Avando Bastari, Harun Bektı Ariyoko and Indra Agustian
8. **Naval Technology Development Strategy in The Integrated Fleet Weapon System For Supporting The Principal Task of Indonesian Navy**  
Ahmadi Ahmadi, Avando Bastari, Bill Saudiaz and April Kukuh Susilo

### 3. OCEAN ENGINEERING I

Conference Room C, 11<sup>th</sup> Floor

**Chair :** Dr. Ir. Wahyudi, M.Sc.

**Invited Speaker :**

Dr. Eng. Rudi Walujo, S.T., M.T. [Dept. of Ocean Engineering, ITS Surabaya]

“Multi-planar Tubular Joint Analysis for Offshore Structures”

Paper Presentation:

1. **Dynamic Response of Circular, Hexagonal and Rectangular Shaped Floating Fish Cage in Waves**  
Yuni Ari Wibowo and M. Romdonul Hakim
2. **Impact of Alum Sludge Direct Discharge into Surface Water**  
Rizkiy Amaliyah Barakwan and Yulinah Trihadiningrum
3. **Social and Individual Risk Assessment of Gas Pipelines Leakage on Residential Zones**  
Budhi Santoso and Maria Margareta Zau Beu
4. **Development Of Debrice in Coastal Marine Areas Based on Blue Economy of The Marine Environment**  
Dhani Priatmoko and Saut Gurning
5. **A Review of Application and Implementation of Blue Economy on The Maritime Tourism, Case Study: Dullah Island**  
Donny Endra Prastya and Raja Oloan Saut Gurning
6. **Analysis of Impact and Handling of Montara Oil Spills in Timor Sea**  
Salsabilla Gucchaka Prajwalita Hening Putri, Mukhtasor and Daniel M Rosyid
7. **Dredging Volume Analysis Using Multi Beam Echo Sounder Data**  
Khomsin Khomsin, Eko Yuli Handoko, Danar Guruh Pratomo and Irfan Maulana Yusuf
8. **Crowdfunding as an Alternative Financial Instrument to Develop Infrastructure for Economic Sustainability on Alor Island**  
Desta Rifky Aldara and Raja Oloan Saut Gurning

## 4. MARINE TRANSPORTATION ENGINEERING I

Conference Room D, 11<sup>th</sup> Floor

**Chair :** Dr.Eng. I.G.N. Sumanta Buana, S.T., M.Eng.

**Invited Speaker :**

Firmanto Hadi, S.T., M.Sc. [Dept. of Marine Transportation Engineering, ITS Surabaya]

Paper Presentation:

1. **Estimating Capital Cost of Small Scale LNG Carrier**  
Muhammad Habib Chusnul Fikri, Kriyo Sambodho, Jooned Hendrarsakti and Galih Budiarto
2. **Big Data Analysis for Hybrid Straddle Carrier in Container Terminal to Improve Energy Performance**  
Putu Hangga and Takeshi Shinoda
3. **Sea Transportation Moda to Support The Implementation of Short Sea Shipping in The South Coastal Area of Java Island**  
Teguh Budhi Iwan Setiawan and Ariston Yoga Pradhana
4. **Study on Implementation of Risk Based Inspection using FMEA-FTA Method on Ro-Ro Ship Bastiong-Sofifi Trip**  
Bagus Gelis Pratama Putra, Wasis Dwi Aryawan and Yani Nurita Purnawanti
5. **Analysis of Supply and Demand of Coal Terminal in Sumatera**  
Christino Boyke Surya Permana, Hasan Iqbal Nur and Syaughy Alif Fadhila
6. **The Implementation of Traffic Separation Scheme in The Sunda Strait and Its Future Impacts**  
Fadilla Indrayuni Prastyasari, Takeshi Shinoda, Ketut Buda Artana, A.A.B. Dinariyana
7. **Design Evaluation Methodology for Ship's Outfitting Equipment by Applying Multi-criteria Analysis: Proper Choices Analysis on Ballast Water Management Systems**  
I Gusti Ngurah Sumanta Buana, Katsuhisa Yano and Takeshi Shinoda



**5. AQUACULTURE I**  
Auditorium Hall, 11<sup>th</sup> Floor

**Chair :** Silvianita, S.T., M.Eng., Ph.D.

**Invited Speaker :**

Dr. Eng. Yeyes Mulyadi [Dept. of Ocean Engineering, ITS Surabaya]

Paper Presentation:

**1. MANAGING OPERATIONAL RISKS OF INDONESIAN OFFSHORE AQUACULTURE**

Putu Karningsih, Dewanti Anggrahini, Agni Swastika, Novi Dwipayanti and Nur Syahroni

**2. Capture of Sea Fish Life in Application Maritime Blue Economy in Indonesia**

Suratno . and Raja Gurning

**3. Coastal Open-Water Modelling Integrated Multi-Trophic Aquaculture (IMTA) Based on Blue Economy**

Abdul Ghofur Ragil Insani and Raja Oloan Saut Gurning

**4. Connecting SDG (14) with the Blue Economic Concept “Conserve Use the Ocean Seas and Marine Resource for Sustainable Development Life Below Water in Indonesia”**

Al Taqna Adam Wijaya and Raja Olan Saut Gurning

**5. OPTIMISING OF SMART INTEGRATED NEAR SHORE FISH AGGREGATING DEVICE FOR INDONESIA OCEAN BASE ON BLUE ECONOMY**

Jangka Rulianto and R. O. Saut Gurning

**6. Mapping Installation Risk of An Offshore Aquaculture**

Dewanti Anggrahini, Nani Kurniati, Putu Dana Karningsih and Agni Dipta Swastika

**7. The Conceptual Model of National Resilience Based on Indonesia Maritime Culture**

Avando Bastari and Abdul Hakim

**8. Tourism Development Of Gili Iyang Island Based On Blue Economy**

Safira Imania and Raja Gurning

**PARALLEL SESSION 2**  
**THURSDAY 12:45 – 14:45**

**1. NAVAL ARCHITECTURE II**  
Conference Room A, 5<sup>th</sup> Floor

**Chair :** Aries Sulisetyono, S.T., M.A.Sc., Ph.D.

**Invited Speaker :**

Dr. Heri Supomo [Dept. of Naval Architecture, ITS Surabaya]

Paper Presentation:

9. **Effects of longitudinal shifts of centre of gravity on ship resistance: a case study of a 31m hard-chine crew boat**  
Soegeng Riyadi, Ketut Suastika, Ikap Utama and Xuefeng Zhang
10. **Numerical Study of Changing Position LCG Influence to Resistance in Crew Boat 31 Meter**  
Soegeng Riyadi, Ketut Suastika and Ikap Utama
11. **Analysis of The Effect of Flaw Depth and Size in Casting Material using Ultrasonic Testing Straight Beam Probe**  
Wing Hendroprasetyo and David Andreas Kostaman
12. **Damage Identification of the Sandwich Plate Having Core from Rice Husk-Epoxy for Ship Deck Structure**  
Abdi Ismail, Yudiono -, Achmad Zubaydi and Agung Budipriyanto
13. **Mechanical Properties Analysis of Slat Inter-Lay Joint Gap of Bamboo Laminates for fishing Boat Construction**  
Heri Supomo, Eko Budi Djatmiko and Achmad Zubaydi
14. **Numerical Study on the Section Design of a Wing in Surface Effect**  
Septia Hardy Sujiantanti, Wasis Dwi Aryawan, Gita Marina Ahadyanti, M Solikhan Arif and Ardi Nugroho Yulianto
15. **The Using of Simulation on Vibration Analysis and Mode Shape of Orthotropic Material on the Construction of Wooden Ship**  
Debby Raynold Lekatompessy and Achmad Zubaydi

## 2. MARINE ENGINEERING II

Conference Room B, 5<sup>th</sup> Floor

**Chair :** A.A.Bagus Dinariyana Dwi P., ST., MES., Ph.D

**Invited Speaker :**

Dr. I Made Ariana, S.T., M.T. [Dept. of Marine Engineering, ITS Surabaya]

“A Method for Selecting Optimum Propeller Considering Hull Interaction and Engine Matching”

Paper Presentation:

9. **Study of Sloshing LNG Tanks with and without Baffle by Computational Fluid Dynamic (CFD) Method**  
Muhammad Arif Pradana and Aries Sulisetyono
10. **Experimental Study The Influence of Addition H<sub>2</sub>-(HHO) Generator and Turbo Cyclone on Performance Engine 110 CC**  
Pramoda Agung Sumadhijono, Nizar Arief Ibadurrohman, Mochamad Yusuf, Getar Satria Kartikadaru and Bambang Sudarmanta
11. **Numerical Study of Multistage Municipal Solid Waste Gasification Downdraft System with Air Ratio Pyrolysis, Oxidation, and Reduction 1:8:1**  
Rizqiana Yogi Cahyaningtyas, Bambang Sudarmanta and Arif Rahman Saleh
12. **Experimental Study on The Analysis of The Use of Forward and Rearward Wingtip Fences 90° Cant Angle on Wing Airfoil Eppler 562**  
Bayu Cahyo
13. **Stability Behavior of Water-in-Diesel Fuel Emulsion and Currents Trends Engine Performance and Emission**  
Rosid Rosid, Bambang Sudarmanta and Endah Purwanti
14. **Performance Analysis Of Radial Fluks Interior Permanent Magnet Generator 24Slot 16Pole at 1000 rpm Using Finate Element Analysis**  
Wahyudin Gorang and Purwadi Agus Darwito
15. **Modeling of Mechanical Energy Harvesting System by Utilizing The Weight of Vehicle as A Source of Electrical Energy for The Portal Gate System**  
Joni Dewanto and Oegik Soegihardjo
16. **Utilization of Arafura’s Ocean Current Potential Using Gorlov Helical Turbine as an Energy Source for Cold Storage Platforms and Fuel Distribution in Overcoming Fisheries Logistics Problems in Eastern Indonesia**  
Muhammad Rizqi Mubarak and Raja Oloan Saut Gurning

### 3. OCEAN ENGINEERING II

Conference Room C, 11<sup>th</sup> Floor

**Chair :** Nur Syahroni, Ph.D.

**Invited Speaker :**

Ir. Mukhtasor, M.Eng., Ph.D. [Dept. of Ocean Engineering, ITS Surabaya]

Paper Presentation:

9. **Seanerg : Electiric Power Plant Powered by Ocean Stream and Ocean Wind, with The Use of Gorlov Helical Turbine and Savonius Wind Turbine as A Solution of Electricity Crisis in Indonesia**  
Yanuar, Muhammad Alief, M. Akbar and Fatimatuzzahra
10. **Aerodynamic Performance Analysis of Vertical Axis Wind Turbine (VAWT) Darrieus Type H-Rotor Using Computational Fluid Dynamics (CFD) Approach**  
Wisnu Wardhana and Elyas Nur Fridayana
11. **Numerical study of influence of turbulence model to a vertical axis Savonius turbine**  
Priyo Agus Setiawan, Sudiyono Sudiyono, Rini Indarti, Arief Subekti, Nopem Ariwiyono, Anda Iviana Juniani and Adi Wirawan Husodo
12. **The Design of Physical Model and Preparation of Experimental Study on Articulated Tower – Ocean Wave Energy Conversion (AT-OWEC)**  
Eko Budi Djatmiko, Heri Supomo and Setyo Nugroh
13. **OTEC Potential Studies for Energy Sustainability in Riau Islands**  
Ibnu Kahfi Bachtiar and Risandi Dwirama Putra
14. **Renewable and Sustainable Energy Development to Improve people's Welfare towards the Availability of energy: A Review**  
Hari Subagyo
15. **Design Innovation of Electrical Power Plan on Traditional Fishing Boat in Puger Jember Using Vortex Induced Vibration (VIV)**  
Muammar Kadhafi, Agus Triono and Robertoes Koekoeh K.W
16. **Smart Grid Concept as Distribution Power Solution in The Bawean Island to Improve The Marine Tourism**  
Prasetyo Adi Wibowo and Raja Olan Saut Gurning

## 4. MARINE TRANSPORTATION ENGINEERING II

Conference Room D, 11<sup>th</sup> Floor

**Chair :** Hasan Iqbal Nur, S.T., M.T.

**Invited Speaker :**

Dr-Ing. Setyo Nugroho [Dept. of Marine Transportation Engineering, ITS Surabaya]

Paper Presentation:

8. **Understanding The Integration of Maritime Policy to Accomodate Marine Environment Sustainability**  
Guntur Rhoma Dony and Raja Oloan Saut Gurning
9. **Indonesia Sea Transportation Network Based on Blue Economy**  
Lutfi Farissandi and R.O Saut Gurning
10. **The Study on the Resistance Test Performance of BPPT Mini-Submarine**  
Erwandi Erwandi, M. Ridwan Utina, Totok Murwatono and Siti Sadiyah
11. **Structural Failure of hull RoRo passenger ferries applied by IACS material regulation under collision incidents**  
Aditya Rio Prabowo, Bangun Ir Harsritanto, Teguh Putranto and Jung Min Sohn
12. **Design Architecture Cargo Acquisition for Traditional Shipping**  
Eka Ardhi
13. **Design Concept of Catamaran Passenger Solar Power Boat for Gili Ketapang Island, Probolinggo – Indonesia**  
Ahmad Nasirudin and Abdul Hamdan
14. **The Strategy of Production Improvement in The Medium-Sized Shipyard to Support the Tol Laut Programme**  
Muhammad Riyadi
15. **The Comparison of Characteristics Profile of the Traditional Boats in Lamongan, Probolinggo, and Pasuruan, Indonesia**  
Yugowati Praharsi, Mohammad Abu Jami'In, Gaguk Suhardjito and Hui-Ming Wee

**5. AQUACULTURE II**  
Auditorium Hall, 11<sup>th</sup> Floor

**Chair** : Dr. Eng. M. Zikro, ST., M.Sc.

**Invited Speaker** :

Dr. Dewi Hidayati [Dept. of Biology, ITS Surabaya]

“Potential of Tuna Aquaculture in East Java : The Biological Aspect”

Paper Presentation:

9. **Ecological study of epiphytic diatoms in Eucheuma denticulatum cultivation areas of Indonesia**  
Ma'Ruf Kasim, Ade Winesti and Wa Nurgayah
10. **Effect of paranet shade on the growth and morphological characteristics in six mangrove seedlings**  
Mohammad Basyuni
11. **The Diversity of Echinoderms (Echinoidea and Ophiuroidea) in Sarangan Beach, Gunung Kidul, Yogyakarta**  
Anggun Cinditya Putri, Puti Hana Ramadhani, Alfi Fatona Putri, Gina Salsabiila, Herdin Surya Dwi Putra, Nadya Ulfa N Firdaus and Achmad Mustofa Huda
12. **Seagrass Diversity in Intertidal Zone of Taman Nasional Laut Kepulauan Seribu**  
Shafira Arini Sundari, Afifah Nur Aini Putri, Arisa Ayuda Prasmiasari, Nofita Ratman, Muhammad Miftah Jauhar, Duwi Ayu Sulistiyani, Aditiana Vimala Guna, Abdul Basith Azzam, Epa Yohana Toga Torop, Afni Yuliyanti and Sri Eko Purwanti
13. **Seaweed Abundance and Diversity in Intertidal Zone of Porok Beach Gunungkidul, Yogyakarta**  
Afifah Nur Aini Putri, Shafira Arini Sundari, Abdul Basith Azzam, Aditiana Vimala Guna, Muhammad Miftah Jauhar, Arisa Ayuda Prasmiasari, Sri Eko Purwanti, Nofita Ratman, Duwi Ayu Sulistiyani, Epa Yohana Toga Torop and Afni Yuliyanti
14. **Preparation of Cellulose Biofilms from Coastal Pandanus (Pandanus odorifer) leaves and Its Characterization**  
Salprima Yudha S, Morina Adfa, Irfan Gustian, Aswin Falahudin, Putjha Melati, Herlina and Agus Mailiza
15. **Microencapsulation Methanol Extract Of Solanum Muricatum Aiton By Using Chitosan**  
Devi Ratnawati, Eni Widiyati and Agus Martono Hadi Putranto Martono Hadi Putranto

# Technical and Economic Analysis of Development of Steel Bridge on Ship Industry for Diversified Business

Rony Purwono<sup>1</sup>, Heri Supomo<sup>1</sup>, and I Ketut Suastika<sup>1</sup>

<sup>1</sup>Naval Architect, Naval Architect Department, Faculty of Marine Technology ITS, Surabaya, Indonesia

**Abstract.** Shipyard is one of businesses in the field of maritime sector development. The minimum job order in the shipyard conditions in shipbuilding make the shipyard to do one step in the form of diversification. The scope of work of the shipyard which usually focuses on the work of new ship construction and reparation by expanding the business by built steel bridge in the shipyard that is still related to the business in PT.PAL Indonesia. This research, it can be concluded that the capacity of dockyard is 12 ton / m<sup>2</sup>, large enough and the production capacity is 9468.93 ton / year. The equipment are adequate with 300 ton goliath crane and the workforce is 39 people at center span assembly work. If the remaining capacity is utilized to the maximum, it will give benefit to the shipyard. From the economic aspect of the bridge construction, the shipyard gets the profit IDR 14,927,485,799 per year.

**Keywords:** Shipyard, Capacity, Bridge.

## 1 Introduction

As the maritime countries, Indonesian is important to develop the shipyard industry. Shipbuilding has played a particular role in industrial development in many countries [1]. The shipyard industry is a labor intensive, capital intensive and technology intensive industry, where the shipyard industry involves a lot of human resources, requires a large amount of capital and a modern technology [2]. In the current era of globalization and free trade, the domestic shipbuilding industry, especially shipyards that are engaged in the shipping industry, are required to be able to survive and compete. Presently commercial shipbuilding sectors are dominated by China, Japan, Korea, European Countries; whereas naval shipbuilding sector is dominated by USA, China, EC, Russia, Japan, and India. In 2018, many shipyard industries have sleep caused the minimum order was happened [3].

Domestic market of Indonesian national shipbuilding has decreasing make the shipbuilding industries to do strategy that's diversifies with build steel bridges which still related with the core of their business in the shipyard industries. Indonesian shipyards are trying to spur on vessel completion while getting new orders as market conditions decline in the marine and shipbuilding industry. The role of strategic management becomes very important for any business entity and revenue in sustainable shipbuilding industry. The addition scope of work to a company will result in a change from the company which originally focused on the construction of new ships and repairs with expanding the

business field by building bridges in PT.PAL Indonesian shipyard.

PT.PAL Indonesian is the one of the national shipbuilding industry with the construction of new ship, ship maintenance and repair, either for warships or commercial ships [4]. The additional work of the construction steel bridges will have an effect in shipyard condition, both changes in terms of workers, facilities, buildings and financial aspects of the company.

Therefore, in this study discusses the facilities of the shipyard, man hour consumption and financial for the construction of steel bridges in PT. PAL Indonesian.

## 2 Literature review

### 2.1. Shipping fleets

As the world's largest archipelago nation, two-third of Indonesia's territory is consisted of water. The sea and ocean make up as the country's largest asset by area, a crucial component for improving connectivity in the archipelago. But, due to the lack of adequate port infrastructures, sea transportation in the country is inefficient, with uncompetitive shipping prices. President Joko 'Jokowi' Widodo realizes this problem as he prioritizes on improving sea connectivity through his "Sea Toll" projects. The President pushes for the construction and expansion of more ports, aiming to increase access and competitiveness within the archipelago, especially in under-developed regions [5]. One way to connection to the region is by providing sea transportation in the form of a shipping

fleet. The number of shipping fleets Indonesia in 2014-2017 increased. Figure.1 shows that the number of shipping fleets Indonesian increase [6].

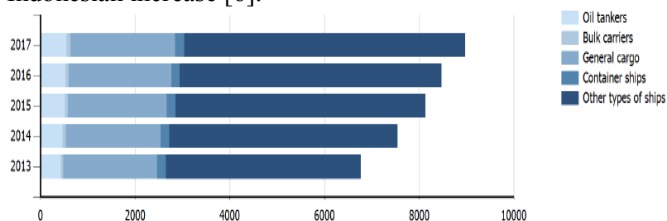


Figure.1 The number of shipping fleets  
(Source : Maritime Profile, UNCTAD 2017)

On the other hand, fleets that sailed in Indonesia in large part were foreign-made vessels or used and few ships made in domestic shipyards. The government with the maritime highway development program expects the shipyard industry to grow and can support the existence of these policies.

## 2.2 Shipbuilding industry

Indonesia has approximately 250 shipyards all across in archipelago, four of them have owned by government such as, PT. PAL Indonesia, PT. DPS, PT. DKB, PT. IKI, and the others are private company [7]. As shipbuilding is a highly capital intensive industry so strong government support and political stability is prerequisite to survive this industry [8].

Since the government in 2014-2019 makes a policy "Indonesia becomes global maritime axis". They order around 150 ships for Fiscal Year 2015-2017 [3]. They has made maritime industry players growth, with the existence of these policies development in the maritime sector has become greater. Infrastructure development for the shipyard industry supports the existence of this policy by getting orders for ship projects from the government. On the other hand, government projects in ordering ships have been completed, the shipyard industry will experience difficulties due to lack of orders or declining demand.

One of the national shipyard gets a ship order from the government, with the capacity owned by the shipyard also getting a job by building two steel arch bridges.

## 2.3 Bridges

Steel bridges are widely used around the world in different structural forms with different span length, such as highway bridges, railway bridges, footbridges. The main advantages of structural steel over other construction materials are its strength, ductility, easy fabrication, and rapid construction [9]. The arch bridge is based on the arch, which is one of the most common shapes in nature [10].

## 3 Methodology

The first data collection method review to relevant research information from previous studies and documents collected from relevant published publications in relation to the

condition of shipyard, literature about shipbuilding market developments and shipbuilding homepage. The second method by calculating the production capacity owned by the shipyard to build the ship project such as fabrication process, assembly, and joint erection with design capacity of the shipyard.

Remaining capacity of the shipyard include for the size of building birth facility, main workshop productions, and the number of man-powers for additional work to assembly the bridges. Interviews with members of the shipbuilding company involved production capacity of the shipyard such as, planning facilities, equipment, and human resources needed in the process of building bridges in the shipyard.

Steel bridges assembly is done by preparing existing areas and equipment to be carried out in the shipyard. Determine for economic aspect the assembly bridges by calculate production cost.

## 4 Result and discussion

### 4.1 Shipbuilding project

In this research, One of the national shipbuilding industry is PT.PAL. This shipyard is the biggest one with modern facility have delivered some foreign orders up to 50.000 DWT of commercial ships, and also many ships for military purpose. Sub-marine production facility is now available in this yard. Production division in PT. PAL for new building consist of two division there are naval ship division and merchant ship division (PT.PAL). The largest production division is in the merchant ship division.

Merchant ship division (DKN) in the organizational structure of PT. PAL Indonesia, together with the naval ship division (DKP), is part of the production executing division. In carrying out the work of building new ships, DKN also needs information and support from other divisions or departments. Merchant ship division have which currently has orders to work on Landing Platform Dock (LPD) 124 meters ship from the Indonesian navy [11], with a capacity owned by PT. PAL shipyard also gets a bridge construction project which is a program of infrastructure development.

### 4.2 Production capacity

In this shipyard of ship construction at DKN by working on LPD ships that have principal dimensions; Lpp:124 m, Width: 21.4 m, Height: 11.3 m, Draft: 5 m, and displacement 7200 tons with a construction weight 3203,307 tons. The capacity production can be calculated by the capacity production of the workshop to complete the process with the construction weight of the ship, thus obtaining a remaining capacity is 9468,963 tons with the remaining production capacity can be used to work on bridge construction. Production capacity in the merchant ship division (DKN) is as follows in Table 1. The process production in the workshop area shipyard starting for steel



stock house until joint erection process can be calculated for one year output production.

Table 1 Workshop capacity production

No	Workshop	Activity	Output per month
1.	Steel stock house	Blasting	1,056piece
2.	Fabrication	Fabrication	1,018tons
3.	Sub Assembly	Sub assembly	492 tons
4.	Assembly MPL (main panel line)	Assembly & welding	891 tons
5.	Assembly CBL (curve block line)	Assembly & welding	259 tons
6.	Block blasting	Blasting & painting	44,000 m <sup>2</sup>
7.	Grand Assembly	Loading until fitting	48joint
8.	Erection	Loading until fitting	39.6 joint

Source: PPC PT. PAL Indonesian

Table 2 Some difference between steel bridge construction and ship building

No	Items	Steel Bridge	Ship
1.	Standard Regulations	AASHTO, AISC, AWS D1.5	IACS, SOLAS, IMO
2.	Part of components	Few of variation	Varies
3.	Duration	Relative short	Long time
4.	Joint method	Bolt, Welding, & Rivet	Welding
5.	Building method	Sequence	Spiral design
6.	Erection method	Scaffolding, Cantilever, and Launching	FOBS, Modular

The additional work for the arch bridges that done in the shipyards can be shown Figure.2

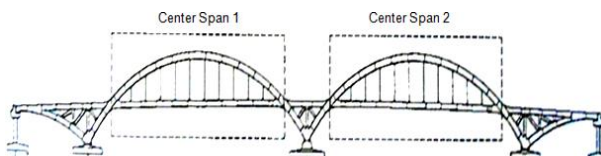


Figure.2 Bridges construction (Source: PT.PAL Indonesia)

The arch bridge parts have dimensions for lengths 120 metres and width 21 metres, for the construction consists of two constructions namely upper and lower construction.

1. The lower construction is in the form of main girder (mg) which is a lower position which serves as the strength of the construction extending the bridge, while the cross girder (cg) which functions for the strength across the bottom of the bridge, stringer is a part of the lower construction that connects the cross girder which functions for strength the foundation between cross girder and wind bracing which is the lower part of the construction which serves to tie between girder and cross girder from the wind resistance that occurs.

2. The upper construction consists of a box that serves to force the upper part of the bridge from the compressive force from below, while the frame serves to connect between boxes and as a reinforcement of the construction of the upper part of the bridge. The connection for the lower construction uses a bolt system, while for the upper construction uses welding. The lower construction and

upper construction are connected with main girder and main box at the ends of the center span of the bridge. Upper construction can be speed up with the material handling by Goliath crane capacity 300 tons in the shipyard.

The overall plan the assembly arch bridges as follows: assembly jig → shot blasting → fabrication mg & mb → assembly mg & mb → painting → assembly jig II → assembly CS I & Arch → assembly CS II & arch II → load out.

**Bearing Capacity**

Bearing capacity is the capacity of soil to support the loads applied to the ground. The bearing capacity of soil is the maximum average contact pressure between the foundation and the soil which should not produce shear failure in the soil [12]. The stability of foundation is an important factor for foundation design [13]. Bearing capacity is an important factor in the assembly process of steel frame bridges for stability of foundation. Bearing capacity of the land owned by shipyard is 12 ton/m<sup>2</sup> which is satisfies the admissible factor of sound can safety requirement for construction the bridges. Pressure for the ground can be illustrated with the pressure formula which pressure is defined as force per unit area. The formula to determine foundation is as follows:

$$\text{Required area (m}^2\text{)} = \frac{\text{Support forces (ton)}}{\text{Stress ground shipyard (} \frac{\text{ton}}{\text{m}^2}\text{)}} \quad (1)$$

Determined the number of bridge foundations according to the number of load points on the bridge. Where in Figure.3 the required area greater than the others that's indication the largest load of foundation is at the end of the center span of the bridge.

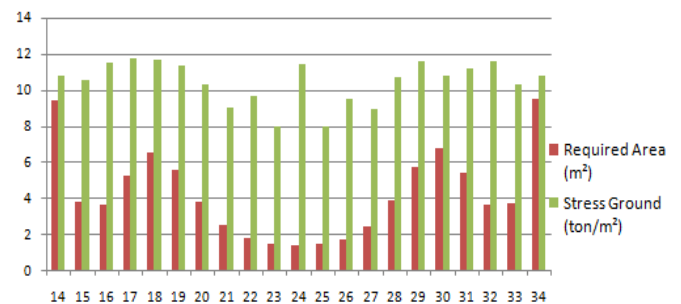


Figure.3 Requirement area for the bridges in shipyard (Source: PT. PAL Indonesia)

**4.3 Shipyard production cost**

Shipyards used to divide the cost of estimation into material and labour cost. Material estimates are provided as costs based on the ship particular; however labour estimates are showed in labour hours. The labour estimates showed in man-hours to maintain confidentiality of shipyard labour rates [14]. Material consumption is the material needed at each stage of making a bridge assembly such as material for assembly, welding, and painting. The highest material consumption for the assembly bridges in assembly CS II and

arch. Table 3 shows material cost for assembly the bridge in the shipyard.

Table 3 Material cost

No.	Items of work	Cost (IDR)
1.	Assembly Jig	224000000
2.	Shot Blasting	475700000
3.	Fabrication MG and MB	620630000
4.	Assembly MG and MB	440070000
5.	Painting	850300000
6.	Assembly Jig II	127000000
7.	Assembly CS I and Arch	359300000
8.	Assembly CS II and Arch	939300000

Man-powers involved for the project determine by man hours. Man hour working day is eight hour a day and effective working day 80 percent from normal working day [15]. The Table 4 shows total man hour for assembly project arch bridge.

Table 4 Total man hour

No.	Items of work	Amount of worker	Total man hour
1.	Assembly Jig	30	4256
2.	Shot Blasting	37	5525
3.	Fabrication MG and MB	46	6875
4.	Assembly MG and MB	23	3656
5.	Painting	13	2296
6.	Assembly Jig II	18	2738
7.	Assembly CS I and Arch	37	5482
8.	Assembly CS II and Arch	39	5878
9.	Load out	22	3173

Assembly CS I and CS II have little difference about the number man hour with the same type of work, one of them is caused they are experienced in the job. Table 5 shows cost/man hour for items of work. Cost per man hour for painting work as the smallest cost.

Table 5 Cost per man hour

No.	Items of work	Total man hours	Cost/ Man hour (IDR)
1.	Assembly Jig	4256	116320312
2.	Shot Blasting	5525	142450000
3.	Fabrication MG and MB	6875	180386718
4.	Assembly MG and MB	3656	92941406
5.	Painting	2296	51953125
6.	Assembly Jig II	2738	69835937
7.	Assembly CS I and Arch	5482	144019531
8.	Assembly CS II and Arch	5878	151511718
9.	Load out	3173	86761718

Profit from the building bridge is the cost of development reduced by production costs coupled with labour costs. The development of the build bridge is 20 Billion IDR. Shipyard will receive the profit from build the bridges is 14,927,519,535 billion IDR.

## 5 Conclusion

Potential of bridge assembly by PT. PAL Indonesia can be carried out with the carrying capacity of the land owned by 12 tons / m<sup>2</sup>. The remaining production capacity is 9468.93 ton / year. The assembly of the bridges speed up due to the goliath crane capacity 300 ton with the involved workforce is 39 people at center span assembly work. With the

remaining capacity to use the assembly the bridges will be give advantage 14 billion rupiah per years to the shipyards.

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