

# Effect of Policy Analysis on Indonesia's Maritime Cluster Development Using System Dynamics Modeling

A Nursyamsi, A O Moeis and Komarudin

Systems Engineering, Modeling, and Simulation Laboratory, Industrial Engineering Department, Faculty of Engineering, Universitas Indonesia, Depok, Indonesia

aditya.nursyamsi\_ti2013@yahoo.com

**Abstract.** As an archipelago with two third of its territory consist of water, Indonesia should address more attention to its maritime industry development. One of the catalyst to fasten the maritime industry growth is by developing a maritime cluster. The purpose of this research is to gain understanding of the effect if Indonesia implement maritime cluster policy to the growth of maritime economic and its role to enhance the maritime cluster performance, hence enhancing Indonesia's maritime industry as well. The result of the constructed system dynamic model simulation shows that with the effect of maritime cluster, the growth of employment rate and maritime economic is much bigger that the business as usual case exponentially. The result implies that the government should act fast to form a legitimate cluster maritime organizer institution so that there will be a synergize, sustainable, and positive maritime cluster environment that will benefit the performance of Indonesia's maritime industry.

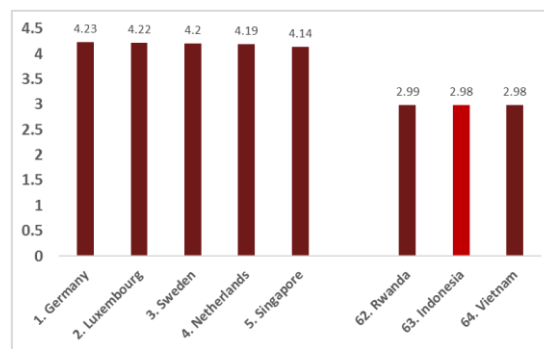
## 1. Introduction

As a large archipelago country with two thirds of its territory consist of water, Indonesia is known as maritime country. Therefore, it is not surprising that Indonesia should pay more attention to the maritime industry to support Indonesia's economic growth. Indonesia has various maritime industry sectors, ranging from fishery industry, shipyard, to logistics transportation.

Some maritime industries in Indonesia show good performance. One of these is the fishing industry, which ranks 4th in the world [1]. The result is accompanied by the development of catching fish in Indonesia which has the tendency to increase from year to year [2]. The logistics transportation industry in Indonesia is also good when viewed from the volume of loading and unloading of goods in the port that has a tendency to rise from year to year [3].

However, Indonesia's Logistics Performance Index (LPI) remains at number 63 [3], far below other countries, including neighbouring countries such as Singapore and Malaysia. This shows that Indonesia still insufficient in exploiting its maritime potential. In fact, according to Deputy Minister of Industry, Mr. Alex S.W Retraubun, "The maritime issues of the world exist in Indonesia. However, Indonesia's maritime industry has not been very good because there is no government support in terms of fiscal policy towards the development of technology, components, and Human Resources (HR)".





**Figure 1.** Logistic Performance Index

As a large maritime country, Indonesia has not been able to maximize the potential of its maritime industry. This can be seen from the contribution of the maritime sector in Indonesia that does not reach 20% of the total value of Gross Domestic Product (GDP) [2]. Whereas in other fellow maritime countries, their maritime industry can contribute up to 50% of its total GDP [3]. Without research related to maritime clusters, Indonesia will lose momentum to accelerate the of its maritime industry. Therefore, a maritime cluster research that can integrate the role of government and actors in the maritime industry to adopt a strategic policy to ensure the progress of Indonesia's maritime industry in the future.

The purpose of this study is to gain an understanding of the effects that can occur if Indonesia implements a maritime cluster policy on maritime economic growth and its role to maximize Indonesia's maritime industry potential, and, in the long run, can also advance Indonesia's economy. The output resulting from this research is a system dynamics simulation model, the comparison of simulation results when Indonesia implemented maritime cluster policy and not, and the result of policy analysis which can be the main recommendation to be taken or implemented by the government.

## 2. Theoretical Background

### 2.1. Indonesia's Profile

Indonesia is undoubtedly one of the world's largest countries. Based on the total area (land and sea), Indonesia is ranked 7th of the world with total area of 5,193,250 km<sup>2</sup>, where total land of Indonesia reaches 1,811,569 km<sup>2</sup> and total of Indonesia ocean reach 3,288,681 km<sup>2</sup>. Geographically, Indonesia lies between two continents, namely Asia and Australia, and between the two oceans, the Pacific Ocean and the Indian Ocean. Because of its strategic location, Indonesia is famous in the eyes of the world as an International trade route.

As a developing country, Indonesia has a strong population and economic power. With a total population of over 250 million people, Indonesia ranks 4th in the world as the country with the largest population and with a fairly stable population growth rate of 1.3% per year [2]. Indonesia has a labour force participation rate of 65.8% of the total population or about 168 million people. However, the unemployment rate in Indonesia is still relatively high in the range of 6.2% or about 15 million people. This indicates that Indonesia still lacks industry or employment to absorb unemployment.

Indonesia has a pretty good and stable economic profile. One of the economic parameters that can be taken is total Gross Domestic Product (GDP). Indonesia's GDP in 2015 reached more than 11 trillion rupiahs, with economic growth rate reaching an average of 4.8% per year [2]. However, despite having so much GDP, the value of GDP per capita in Indonesia is relatively small compared to other ASEAN countries at 45.2 million rupiahs, while neighbouring countries such as Singapore can reach 52 thousand USD or around 670 million rupiahs [3].

As a country with an area of the ocean more than two-thirds of the entire region, it is not surprising that Indonesia should depend on its maritime power. As per the direction of the President, it is time for Indonesia to return to the sea, again making the sea as the power of the nation, so that Indonesia can become the World Maritime Fulcrum [4] – [7]. The vision of Indonesia to be a World Maritime

Fulcrum based on historical reviews, geo-strategic location, and the desire for the existence of the nation should be increasingly taken into account at regional and global level. This vision is a long-term step that requires consistency of policy, cooperation, and sincerity to achieve it. To achieve the vision to be World Maritime Fulcrum, several important aspects of maritime possessed by the nation are clearly mapped out their strengths and weaknesses, as well as known challenges. Furthermore, the President conveyed 5 (five) pillars of Maritime Fulcrum Development [7] in his speech at East Asian Summit 2014 covering:

- a) Develop maritime culture
- b) Maintain and manage marine resources
- c) Development of maritime infrastructure and connectivity
- d) Strengthening maritime diplomacy
- e) Build a maritime defense force

## 2.2. Industry Cluster

Cluster concepts have long been a hot topic of research discussed in major countries in terms of economic analysis. Research related to the analysis of economic relations to clusters began to grow rapidly since Michael E. Porter conducted related research in his writings "The Competitive Advantage of Nations" [8]. Porter developed the theoretical basis for cluster concepts as a competitive advantage for a country. According to Porter, industrial clusters are a cooperative group with an adjacent geographic scope that includes suppliers, users, supporting industries, government and support institutions such as universities. In a later study, Porter reiterated his understanding of industry clusters, a group of interconnected firms together with related institutions in a specific field, adjacent geographically, linked by similarity and complementarity [9]. Morosini then provides his understanding of the industrial cluster as a socio-economic entity categorized by the social community of persons and populations of economic agents residing within the same geographical environment [10]. Based on the description, can be drawn character from a cluster concept as follows [11]:

- Regional economic activity is located at various levels: community, geographic area, global
- Limited to specific industries
- Covers both vertical relationships such as supplier-factory-dealers-users as well as horizontal relationships like other sectors in the same industry
- The company has the same or interconnected business areas
- Each company competes with each other but through their own specialization contributes to the development of clusters
- The company's closeness generates social relationships and a sense of trust
- Common infrastructure used to innovate due to strong knowledge transfer and supported by universities and research centers

While there is no definite theory of clusters yet, the advantages of a cluster have been observed, as well as the main reasons that such research is often the focus of research [8], [10], [12]:

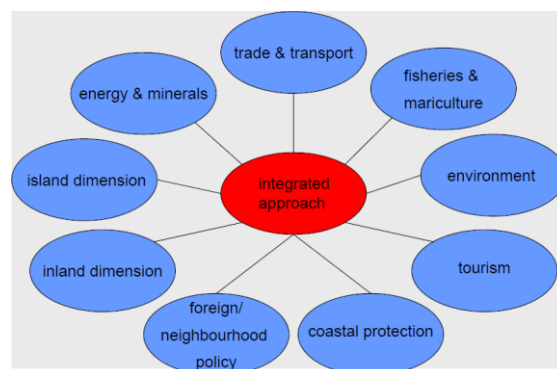
- High concentrations of firms generate an increased market and provide opportunities to get more buyers
- Reduced transportation costs
- Easier access to resources
- Opportunities for new companies that see potential in a cluster environment
- Offers a high level of specialization for products and services within a cluster development
- A more competitive environment serves as a better motivation
- Stronger cooperation among cluster members; Intimacy between companies increases trust between companies and improves communication
- Concentration of companies engaged in the same field provides an expert field of labor in the field
- Better access to reliable employees

In the case of cluster development, the government should have an important role. Governments have an important role to play in facilitating the development and enhancement of a cluster quality. According to Norman and Venables, government policy also has an important role in cluster development. Without a government policy, the number of industrial clusters will be too much, and each cluster will become too narrow, which in turn will reduce the output that should be generated [13]. Governments can encourage cluster development in a variety of ways, one of which is to remove barriers and reduce constraints, including human resources, infrastructure and related regulations.

### 2.3. Maritime Cluster

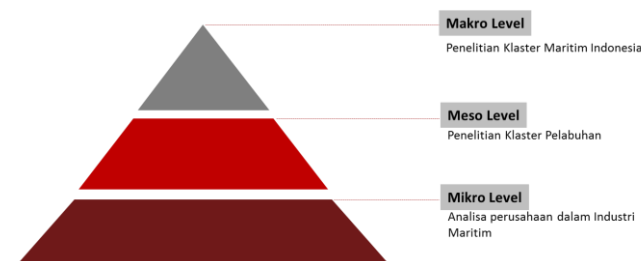
Given the relationships created through a cluster, the maritime industry recognizes that there is a great advantage of agglomeration or adjacent locations within a region [14] – [15]. These advantages are in the form of knowledge dissemination, the availability of sufficient labor, a strong innovation culture, and a supportive market.

In developing a maritime cluster, the important points to note one of which is what industry or company deserves to be included. Each country can define what industry or company it wants to include in establishing a maritime cluster depending on the conditions of their country. Thomas Engelke defines sectors in the maritime sector to 9 sectors (Figure 2) [16]. The ninth should be strengthened by using an integrated approach to create a strong maritime sector within a country.



**Figure 2.** Maritime Cluster.

In the development of a maritime industry system, known as multi-level perspective. As can be seen in Figure 3, the perspective in the development of the maritime industry can be divided into 3 levels. First, the macro level in the form of maritime cluster research with coverage of Indonesia. Next there is a intermediate level that can address one node in the maritime cluster, for example a port cluster research. Then there is a micro level that can discuss about the company's performance analysis in the maritime industry.

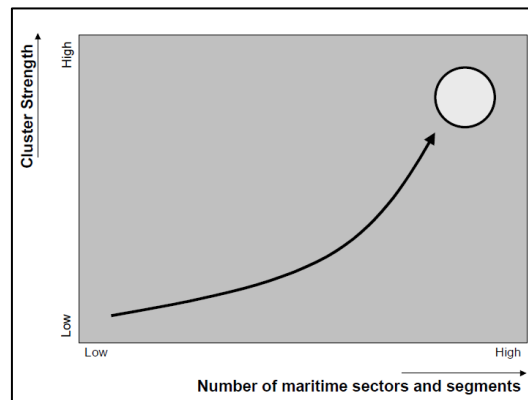


**Figure 3.** Multi-level perspective on Maritime Industry Research.

The concept of whether or not a cluster is strong is determined by the type and number of its maritime sector companies [15]. The more types of companies in a cluster, the greater the synergy and strength generated by the cluster. The relationship between cluster completeness in terms of type of

company and cluster strength can be seen in Figure 4. It is seen that there is a non-linear relationship in the relationship.

Assessment indicators for a cluster can be measured qualitatively and quantitatively. Quantitative indicators such as economic growth, GDP, number of labor, number of companies in clusters, and so forth. As for the qualitative indicators for example are trust and coordination, the general impact on the economy, as well as the relationships created between the company with other companies, research institutions or education, as well as policy makers. In a cluster, apply the concept that the more players, the stronger the cluster. The concept applies to all indicators.



**Figure 4.** Relationship between number of sectors and Cluster Strength

In order to build a good maritime cluster, model makers need to understand what factors can strengthen the cluster. Wijnolst has defined 7 factors that can make a cluster successful. These are the following factors [14] – [15]:

- Define clusters clearly
- Create an industry policy to support the cluster
- Strengthen the demand-pull sector
- Overseeing the company's operations so that there is no element of fraud
- Promoting export and internationalization
- Strengthen innovation and R&D
- Strengthen the quality of education and manpower

Policy is one of the factors that can support the quality of maritime clusters. With the right government and policy support, a country has a great opportunity to strengthen its maritime cluster. Engelke provides several examples of policies that can be taken to support the development of a maritime cluster [16]. These policies are governance, education, public awareness, cluster, regional planning, maritime technology, and research. The policy should be made with an integrated approach so that it can create the correct policy package as needed.

#### 2.4. System Dynamics

In 1960, Jay W. Forrester, a researcher from MIT published the results of his research he has done for about 4 years about dynamic system modelling. According to Richardson, the dynamic system approach itself is actually a combination of several approaches, computing technology, computer simulation, strategic decision making, and understanding of feedback in a complex system [17].

There are four basic concepts that are important to keep in mind when constructing a dynamic system model in order to clearly illustrate the structure and behaviour of a complex system, which are the nature of a closed system (endogenous), the effect of feedback, there are basic variables of levels and rates, and there are success parameters from model development.

The main purpose of developing a dynamic system model is to study, recognize, and understand the structure of a complex system so that it can then understand the role of policy and the delay of a decision in influencing the behaviour of the system. The main focus of the system dynamics

methodology is to gain an understanding of a system, so that problem solving steps provide feedback on system understanding.

### 2.5. Uncertainty in Model

The concept of uncertainty can be interpreted in general as a limited knowledge of the future, past, or events in the present. Regarding policy-making issues, the concept of uncertainty is also influenced by subjectivity, as it relates to satisfaction of existing knowledge, which is influenced by the values and perspectives of policy makers and the various actors involved in the policy-making process, and Influenced also by the choice of decisions available to them. Uncertainty does not necessarily mean that lack of knowledge, Funtowicz and Rayetz describe uncertainty as a situation where there is insufficient information. Inadequate information is in the form of inappropriateness, unreliable sources, and bordering on ignorance. Walker provides four ways to address the issue of deep uncertainty in policy making [18]:

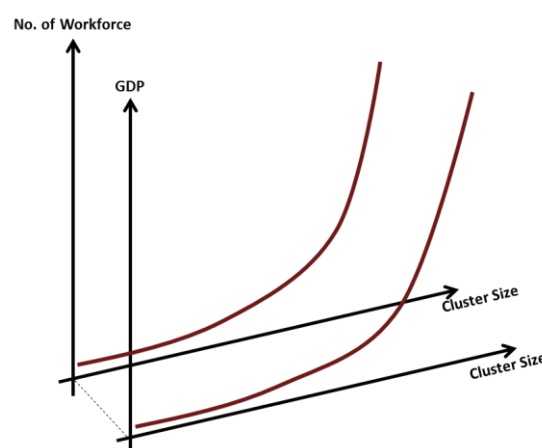
- *Resistance*: Plan for all possible worst case in the future
- *Resilience*: Whatever happens in the future, be sure to have policies that can neutralize the situation
- *Static robustness*: Implement policies that can work in different types of circumstances
- *Adaptive robustness*: Prepare to change policy, if conditions change

## 3. Methodology

The study was conducted using the principle of continuous iteration. The purpose of iteration process is that each step requires a feedback, which then the feedback will be implemented in the following process as well. Research is focused on developing a system dynamics model and observing at the effects of policies that can occur. Reference modes and system diagrams are formed as a basis for developing the dynamic systems of this research.

### 3.1. Reference Mode

In this study, the expected model behaviour is an assumption because the author will model a system for the future. The indicators of behaviour that are seen are the number of maritime workforce as well as the total maritime economic output driven by the industrial sector and the effects provided by the maritime cluster. According to Wijnolst, the relationship that will be created from the cluster against its effects on the economy and workforce is an exponentially growing relationship [14] – [15].

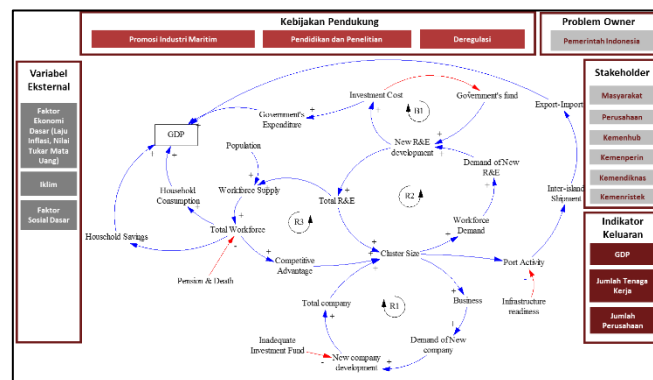


**Figure 5.** Reference Mode on Maritime Cluster

### 3.2. System Diagram

The system diagram is used to see the overall system of interrelationships between variables and the feedback that occurs on the context of the problems. A system diagram can show related actors, reciprocal relationships in the problem, and most importantly the output indicators of the model being created. Figure 6 illustrates the system diagram of this study.





**Figure 6.** System Diagram

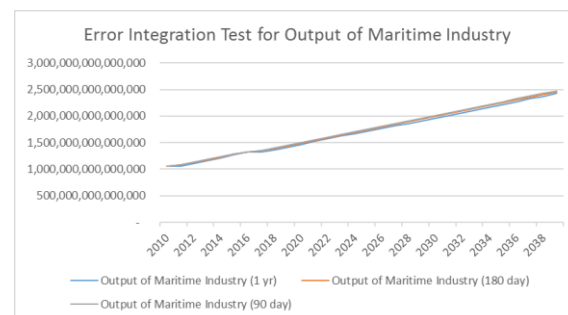
## 4. Result and Discussion

### 4.1. Model's Validation and Verification

Model verification is done regarding whether there are no more signs of error on each variable. The verification process is done directly within the software used in the model creation of Powersim Studio, where there are no more undefined variables and relationships.

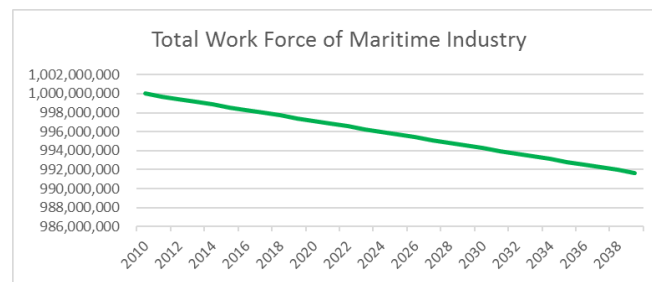
Model validation is important to determine whether the model is appropriate or similar in representing the real system. However, to note is the statement that "all models are wrong". Validation test is done using 4 methods:

**4.1.1. Error Integration Test.** This test is performed by running simulations using 3 different timesteps; 1 year, 6 months, and 90 days. Based on the results obtained, there is no significant difference between the three timesteps as can be seen in Figure 7. This shows that model is valid based on the integration error test.



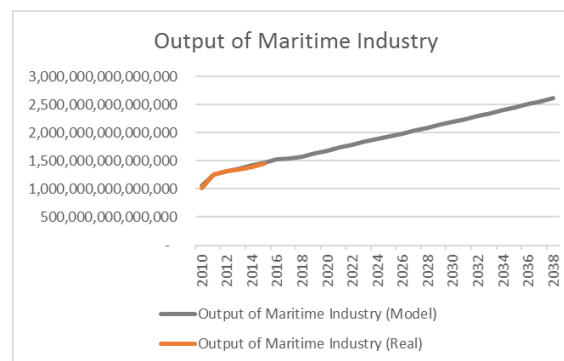
**Figure 7.** Validation Test - Error Integration

**4.1.2. Extreme Condition Test.** This test is done by changing the input value on the initial amount of maritime industry workforce. When the author changed the number to very extreme; from 6 million to 1 billion, the model shows that there will be no labor requirement so that there will be no increase in labor, only reduction. As can be seen in Figure 8, the trend of the labor force that occurs only decreases. Because the model still delivers sensible results when given extreme conditions, it can be said that this model is validated under extreme conditions tests.



**Figure 8.** Extreme Condition Test on Workforce

**4.1.3. Behaviour Reproduction Test.** This test is done by comparing the behaviour between the value of the Maritime Industry output generated by the model with reality. It can be seen in Figure 9 that both of them have the same upward trend in both the simulation model and the reality with an error value of less than 5%.



**Figure 9.** Behaviour Reproduction Test on Output of Maritime Industry

**4.1.4. Structure Assessment Test.** The created model already has a structure that is relevant to the system and concept of the existing problem. This can be seen from the suitability between the simulation model created on the causal loop diagram with the System Diagram as the framework.

## 4.2. Result Comparison Analysis of the Model

**4.2.1. Growth Analysis of Small and Medium Enterprises following the Policy of the Maritime Cluster.** The total number of small and medium enterprises between Business as Usual (BaU) and Maritime Cluster (MC) simulation models has a significant difference. The final total number of small and medium enterprises for BaU simulation model is 805 thousand business while for MC simulation model as much as 1.2 million business.

MC simulation model has a more positive growth rate compared to BaU simulation model. Both models also have different CAGR values, ~4% for BaU simulation model and ~5% for MC simulation model. This indicates that the simulation result using the MC simulation model is better than the BaU simulation model.



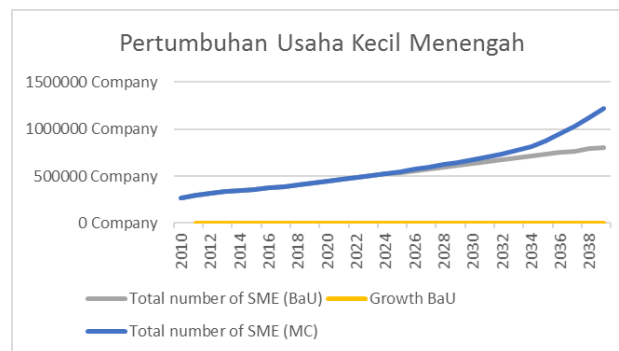


Figure 10 Growth Comparison on Small Medium Enterprises

**4.2.2. Growth Analysis of Industry following the Policy of the Maritime Cluster.** The total number of large Industries between BaU and MC simulation models has not significantly different, about 1000 companies. The final total number of large industry for BaU simulation model is 3451 companies while for MC simulation model as many as 4556 companies. However, because the contribution provided by large industries is greater than that of small and medium-sized businesses, even though the difference in quantities is only 1000 but the effect it provides on other indicators is considerable.

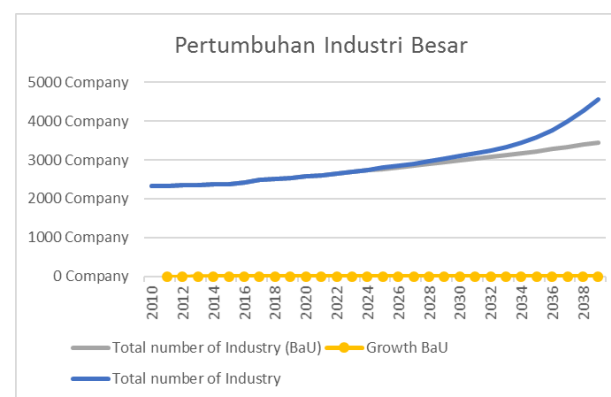


Figure 11 Growth Comparison on Industry

MC simulation model has a more positive growth rate compared to BaU simulation model. Both models also have different CAGR values, which is ~1% for BaU model and ~2% for MC simulation model. This indicates that the simulation result using the MC simulation model is better than the BaU model.

**4.2.3. Growth Analysis of Maritime Industry Workforce following the Policy of the Maritime Cluster.** MC model has a more positive growth rate compared to BaU model. Both models also have different CAGR values, ~4% for BaU simulation model and ~7% for MC simulation model. This indicates that the simulation result using the MC simulation model is better than the BaU simulation model.

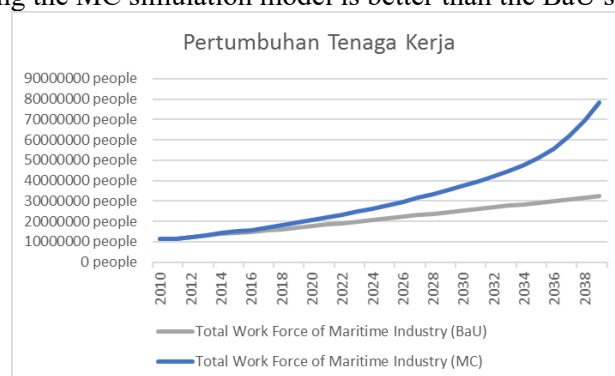
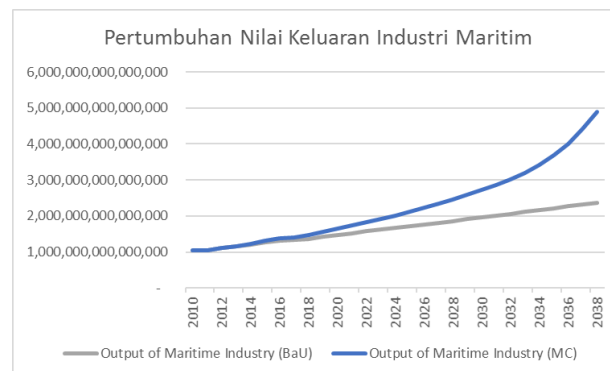


Figure 12 Growth Comparison on Workforce

**4.2.4. Growth Analysis of Maritime Industry Output following the Policy of the Maritime Cluster.** MC model has a more positive growth rate compared to BaU model. Both models also have different CAGR values, ie ~3% for BaU simulation model and ~6% for MC simulation model. This indicates that the simulation result using the MC simulation model is better than the BaU simulation model.



**Figure 13.** Growth Comparison on Output of Maritime Industry

## 5. Conclusion

### 5.1. Conclusion

Based on the analysis of the development process and the results of the model made, it can be concluded the things as follows:

- The model was developed to see the impact that could have occurred if Indonesia had a maritime cluster policy as a means of supporting the performance of the Maritime Industry.
- The model was developed based on the concept of maritime clusters that had already been developed in developed countries such as the European Union.
- Based on the results of the simulation, Indonesia will have higher economic and social value if it has implemented sustainable maritime cluster policy.
- Based on the workforce module simulation results, Indonesia will have a total workforce for maritime field with a CAGR of ~7% when applying a maritime cluster policy compared to normal circumstances which only produce CAGR of ~4%
- Based on simulation result of economic module, Indonesia will have total value of Maritime Industry output with CAGR ~6% when applying maritime cluster policy compared with normal condition which only produce CAGR ~3%.
- Indonesia needs to establish a maritime cluster management institution in order to create a seamless, sustainable, and positive Maritime Cluster environment for the performance of the Maritime Industry in Indonesia.

### 5.2. Recommendation

Based on the conclusions of the research conducted, suggestions that can be given by author are:

- For further research can be explored further about the role of technology, culture of innovation, and environment towards the development of maritime clusters in Indonesia.
- Based on the results of the study, which still has limited data and information, it is expected that the Indonesian government may consider having a data center or conducting a special survey related to the statistics of the Maritime Industry in Indonesia in order to make it easier for researchers to conduct research related to maritime field in Indonesia.

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