Serious Simulation Game as an Intervention Tool for Analysis and Design of Port Cluster Network Governance Structure

Research proposal summary by
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Introduction and Research Background

Seaports have become an essential part of supply chain networks, especially for large and wide archipelagic state. As the international and domestic trade is dominated by maritime transport, seaports are not only viewed as transport nodes but also as an essential element in shaping economy (De Langen and Haezendonck, 2012; Montwiłł, 2014). One of the common strategies to improve the productivity of the seaports is to develop a port cluster. A port cluster is defined as an integrated area that consists of several enterprises that reside in the same port area and are engaged in port-related activities (De Langen and Haezendonck, 2012). The standard components that usually appear in a port cluster are logistics, transport, and cargo handling enterprises that can form a competitive advantage.

Developing port clusters for a vast archipelagic state, such as Indonesia, seems a promising way of maximizing economic growth. Indonesia is an archipelagic state with 17.504 islands and around 104.000 kilometers of coastline. In addition, 17.28% of its population live in the coastal area. Because of the diversity in land availability, capital, resource, and educated workers, Indonesia has many specialized economic zones (SEZs) that only focus on producing particular commodities. Previous research concludes that port clusters can strengthen the connectivity between the port and the commodity center (Sunaryo, 2015). Also, port cluster development also can support equitable and sustainable development in Indonesia (Yudiarso, 2013).

However, the development of port cluster infrastructure is not a guarantee to maximize the economic growth output. There are many ongoing arguments which state that the port cluster governance structure is an essential factor to make the port cluster development more beneficial (Helsley and Strange, 1998). There are several forms of port cluster governance structure, from hiring a private sector to become Port Authority as a local cluster manager, or using State-Owned Enterprise to become a national port authority as a centralized cluster regulator (De Langen and Haezendonck, 2012). The effective formulation of port cluster governance structure at the beginning of development is a mandatory as the governance structure can influence port performance. For example, a centralized governance structure in India shows the principal-agent problem which makes the monitoring cost very high. However, too much decentralization also can decrease the port cluster performance because the small jurisdiction port authority cannot invest and expand outside the jurisdiction when the port traffic increase (Langen, 2004; Ducruet, Notteboom and Langen, 2010).

Based on the explanation above, formulating an effective port cluster governance structure is a challenging task. The complexity to determine which port cluster governance structure to manage port cluster emerges because of several factors: (1) the heterogeneity of agents (multi-actors) involved in port cluster activities that dynamically interconnected each other; (2) the presence of multi-level objectives and conflicting goals for every actors involved; and (3) each agent has different responsibility and operational decision to fulfill their objectives. In the case of Indonesia, as a vast archipelagic state, the complexity is growing because there are several unique characteristics. First, Indonesia has many diversities in commodity production based on its geographic area, which encouraging to build many port cluster infrastructures. Second, the implementation of decentralization policy where local governments have their authority to regulate regional planning, increasing the chance of developing port cluster in proximity, forming a port cluster network as shown in figure 1.

The characteristics explained above lead to the conclusion that Indonesia port cluster network is denoted as a Complex Adaptive System (CAS) (Holland, 1995). As a consequence, the port cluster network is hard to understand and manage. Furthermore, the partial understanding of the system can lead to the low-quality result of the policy-making process (Bekebrede and Mayer, 2006). For example, the partial understanding can lead to policy making that only brings sectoral benefits and leads to inequitable and unsustainable development (Montwiłł, 2014).

This research proposal argues that there is an urgency for policymaker and related stakeholder in a port cluster network should understand and comprehend the whole picture of the system to find the effective governance structure to achieve the desired multi-level objectives. Providing adequate understanding by improving awareness of different perspective from each role involved in the system can thus help policy maker enhance the quality of the governance structure design (Bekebrede and Mayer, 2006; Bilsen, Bekebrede, and Mayer, 2010). In this

regard, further research is required to explore the powerful and practical approach to address this issue.

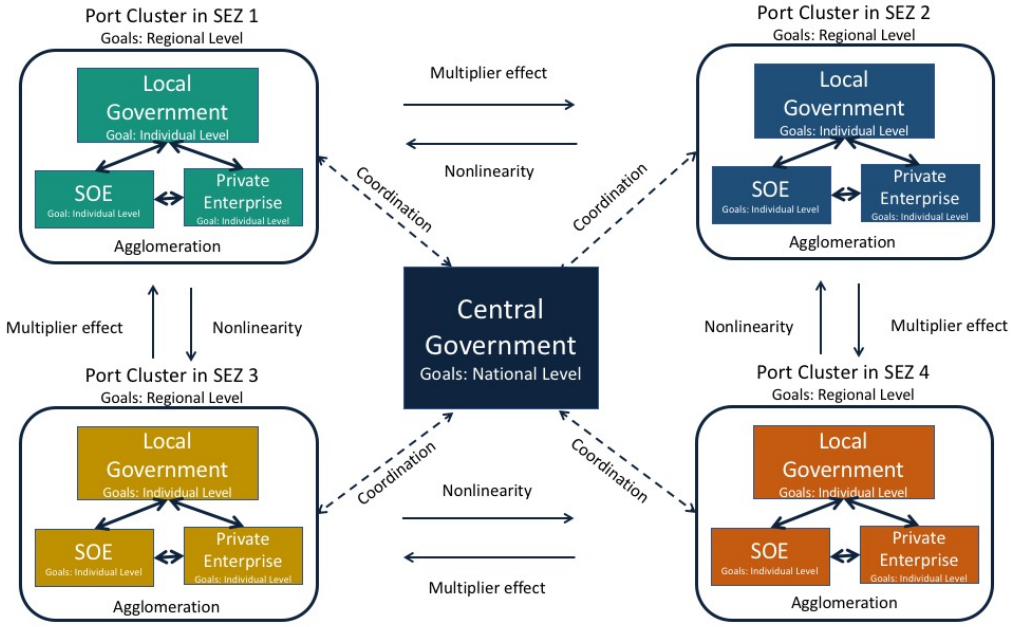

Fig 1. Illustration of port cluster network as a complex adaptive system (CAS)

Problem Statement

Based on the explanation in the introduction section, this research tries to explore and investigate what is the powerful and practical approach to support effective decision-making process for determining governance structure design in a port cluster network, to achieve equitable and sustainable development goals. This research is necessary because as the development of maritime and port infrastructure is become priority nowadays; there is an urgency to investigate and find the tools to support the decision-making process for preventing the low-quality result of policymaking that can lead to unsustainable and inequitable development.

The novelty of this research are: (1) to address the gap in investigating the decision support tools in the context of policy formulation for port cluster network governance structure, as the previous research is focused on only single port development (Bekebrede and Mayer, 2006; Hamzah *et al.*, 2014; Gabe, Dickerson and Rubin, 2015); (2) to find what is the factors that can influence the quality of policymaking in the context of archipelagic state, like Indonesia, that form a port cluster network in proximity under one nation, as the previous research focuses on European Union (Mayer, 2009; Mayer *et al.*, 2013, 2014).

Research Objectives

The primary objective of this research is to investigate the role of ***Serious Simulation Game*** as an intervention tool in supporting effective decision-making process for determining governance structure design in **Indonesia port cluster network**, to achieve equitable and sustainable development goals. Serious simulation games, a term coined for a simulation game for a non-entertainment purpose, have often been used as a learning platform in the field of policy making and complex system analysis (Roukouni, Lukosch, and Verbraeck, 2018).

The research objectives can be met by answering the following question:

Research Question: *To what extent can serious simulation games influence the quality of design of governance structure of Indonesia port cluster network by the player to achieve sustainable and equitable development goals?*

Through the scientific foundation proposed by Lukosch (2018), this research expected to find out the effective

serious simulation game design which is proven to influence the quality of governance structure design, specifically in a context of Indonesia port cluster network. The quality of decision making is defined by Postmes *et al.* (2001) as the degree to reach the correct solution to achieve the objectives. This influence is investigated to know the game effectiveness in the transfer of learning level and as feedback for better game design in the future.

Rationale

Serious Simulation Game (SSG) is a well-known intervention tool that has proven to support the decision-making process by helping the actors understand and having situational awareness in the complex adaptive system. Bilsen (2010) argues that by using SSG, the players can understand the system by getting real-time feedback as the result of conducting experiments or interventions without breaking out the real system. Also, using SSG can push the players to understand the system deeper because the players actively involved in the experiential learning cycle (Gloria *et al.*, 2014). In the context of port infrastructure and complex system development, SSG has often been used as a learning and intervention platform. For instance, the project of a computer-supported simulation game, SIM Maasvlakte 2 (SIM MV2) is used to explore the initial design of port infrastructure in the Port of Rotterdam (Bekebrede and Mayer, 2006).

Another example is Maritime Spatial Planning (MSP) Challenge 2050, which encourages related stakeholders to ensure maritime activities, especially in the ocean, take place sustainably and efficiently (Mayer *et al.*, 2014). The nature of those simulation games can help the players to become a system thinker. Referring to Sweeney and Sterman (2000), system thinkers can see the whole picture to understand how the behavior of the system emerges because of the interaction of its agents over time.

Research Methodology & Research Timeline

This study will employ the research step based on the compilation of widely-accepted methods in serious game design and evaluation by Lukosch et al. (2018). The scientific foundation explained from the paper is helpful to design, implement, and evaluate serious simulation game for analysis and design of complex systems. To answer the research question, this research would be split into three sub-projects: (1) Design Phase; (2) Execution Phase; and (3) Evaluation Phase. The timeline of the research is shown in table 1.

Design Phase **(Q1 – Q4 2019)**

As stated by Lukosch et al. (2018), there are three approaches which equally crucial in supporting serious game design. The approaches explained by Duke (1981), Harteveld (2011), and Peters and van Westelaken (2014) is proven to give an important value in the game design phase. Furthermore, Lukosch et al. (2018) synthesized those three approaches into seven iterative processes of serious games design.

Execution Phase **(Q1 – Q4 2020)**

Execution phase would be conducted after the serious game has valid. As stated by Lukosch et al. (2018), this phase tries to find the ability of the game to transfer the learning objective and to improve the quality of decision making in the context of designing governance structure of Indonesia port cluster network.

The experiment would be conducted using a quasi-experimental design to explore the effectiveness of the game. As this game is not to designed for everyone and targeting the group which has adequate knowledge and experience in port cluster development, the quasi-experimental design is chosen to help create a reasonable control group. Quasi-experiment is carried out to minimize the research difficulty and get rid of the uncontrollable variables (Sheskin, 2004) which can make the result more valid and reliable.

Evaluation Phase **(Q1 2021 – Q2 2022)**

The effectiveness of serious game is measured by the ability to achieve the goal or expected learning outcome. This phase focused on finding how the serious game as an intervention tool brings the influence to players in formulating governance structure design for Indonesia port cluster network. The evaluation phase then will

become a scientific proof if the game can effectively influence the learning and behavior outcome.

As the extension to answer the research question, the mapping between learning mechanics – game mechanics in the serious game mechanics (SGM) proposed by Arnab (2014) seems useful to carry out what elements of the game which mainly influence the in-game player performance. However, the inferential statistical analysis should be conducted to validate the causality relationship in the result of the SGM mapping. The analysis result is expected can answer the question like, "what would have been to the player performance if the game elements X or Y is included/excluded?"

Table 1. Research timetable for Ph.D. research 'Serious Simulation Game as an Intervention Tool for Analysis and Design of Port Cluster Network Governance Structure'

Quarters (Year)	Q1 (19)	Q2 (19)	Q3 (19)	Q4 (19)	Q1 (20)	Q2 (20)	Q3 (20)	Q4 (20)	Q1 (21)	Q2 (21)	Q3 (21)	Q4 (21)	Q1 (22)	Q2 (22)	Q3 (22)	Q4 (22)
Subproject 1 - Design Phase - Literature Review - Brainstorming & FGD - Conducting 7 process of game design - Session of prototype testing - Validating games as a research tools - Gathering and Analyzing feedback - 1st and 2nd conference paper																
Subproject 2 - Execution / Experiment Phase - Group experiments - Game performance assessment - Behavior mapping - Descriptive inference analysis - 1st journal article - 3rd conference paper																
Subproject 3 - Evaluation phase - Serious Game Mechanics (SGM) Mapping - Evaluating game effect in the long term - Causal inference analysis, based on the data from experiments - Recommendation of game elements in retaining learning outcome - 2nd journal article																
Writing Project - 3rd journal article - Dissertation																

Research Significance

Based on the research novelty, this research carrying opportunity to give a scientific contribution in various international journal and conferences. Each subproject is expected to lead a publication in the reputable international journal. Possible journals include *Simulation and Gaming, Ocean and Coastal Management,* and *International Journal of Game-Based Learning.*

Meanwhile, the practical contribution of this research is the opportunity to put the foundation of serious simulation game application to support decision-making process in formulating a policy of governance structure in the context of Indonesia port cluster network which can be replicated in the other archipelagic states or regions with similar characteristics to achieve equitable and sustainable development.

Additional Information

The proposed doctoral research has been accepted by Delft University of Technology and will be carried out for approximately four years starting from early 2019. The approximate funding for Ph.D. research in TU Delft is 10,000 Euro per doctoral programme and 10.000 Euros per year for the Bench fee. The researcher expected to be fully funded by the Indonesian BUDI-LPDP Program.

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