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An Integrated Framework of System Dynamics and Life Cycle Assessment for Managing Sustainable Creative Industries

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Abstract

The creative industries played an important role in contributing to economic growth and employment. But attention to the environmental impact of the creative industries is lacking. This paper discusses the development of sustainable creative industries policy models, in which three creative industries impacts, namely: economic, social and environmental concerns simultaneously in the creative industries policy model. The policy modeling used in this research uses system dynamics method, while to assess the environmental impact caused by creative industries used Life Cycle Assessment (LCA) approach. The creative industries has been seen as having an important role in contributing to economic growth and employment. But attention to the environmental impact of the creative industries is lacking. This paper discusses the development of sustainable creative industries policy models, in which three creative industries impacts, namely: economic, social and environmental concerns simultaneously in the creative industries policy model. The policy modeling in this research used system dynamics method, while to assess the environmental impact caused by creative industries used Life Cycle Assessment (LCA) approach.

Keywords: creative industries, system dynamics, LCA

INTRODUCTION

The creative industries has gained a lot of attention for industries practitioners and researchers in recent decades, as the creative industries have not only had an economic impact but are also capable of having a broad social impact. Serrano et al. (2014) show empirically that there is a causality and feedback relationship between the performance of the creative industries and the Gross Domestic Product. The creative economy of the creative industries in Indonesia's Gross Domestic Product (GDP) in 2006 was about 4.75% (about Rp 170 trillion) and 7% of total exports in 2006. Furthermore, the development of the creative industries hit 7.3% in 2006, or higher than the national economic growth which ranges from 5.6% (Pangestu, 2008). Next creative industries share in 2007 increased to reach 5.67%. Socially, the creative industries sector is also able to contribute to the availability of employment for approximately 3.7 million or equal to 4.7% of total employment (Pangestu, 2008). Nevertheless, the contribution of creative industries in the period 2010 to 2013 shows a trend that tends to decline. The phenomenon can be seen in Fig. 1

Several approaches and models have been developed in previous studies to study the behavior of creative industries systems. For example, Galloway and Dunlop (2007) and Azevedo and Barbosa (2014). Meanwhile, Potts and Cunningham (2008) propose four models that can be used to predict the behavior of creative industries that have a negative, positive and neutral impact on economic growth. The first model referred to as the "welfare" model, which explains that creative industries have a negative impact on economic growth because they use more resources than they produce.

For example, excessive subsidies or government interventions. Next, the second model called the "competition" model, this model can predict that "the creative industries is not an economic slowdown, but effectively" is just an ordinary industries. Therefore, there is no need to develop a specific policy strategy for this industries. Due to the economic impact of the creative industries equivalent to all other sectors, while in the third model, the so-called "growth" model, assumes that the creative industries introduces new ideas into the economy and facilitates the adoption and retention of new ideas or technologies in other sectors (Fahmi and Koster, 2017). The fourth model, called the "innovation" model, explains that the role of the creative industries in the economy is not part of the economy that drives economic growth but is part of a wider system of innovation. Unfortunately, models proposed by Potts and Cunningham (2008) only see partial problems, so that the model proposed was divided into four models. In fact, the problems in the elements that exist in the creative industries system are interrelated. The complexity of the creative industries regarding both the sector involved and the impact it would have had should make the modeling of the creative industries accommodate that complexity into an integrated model. This phenomenon is researched by Azevedo and Barbosa (2014), in which a sustainable creative industries model integrates the relevant creative industries sub-sector to cope with major economic and social challenges. While Banks and Hesmondhalgh (2009) emphasize integrated policies on the development of creative industries.

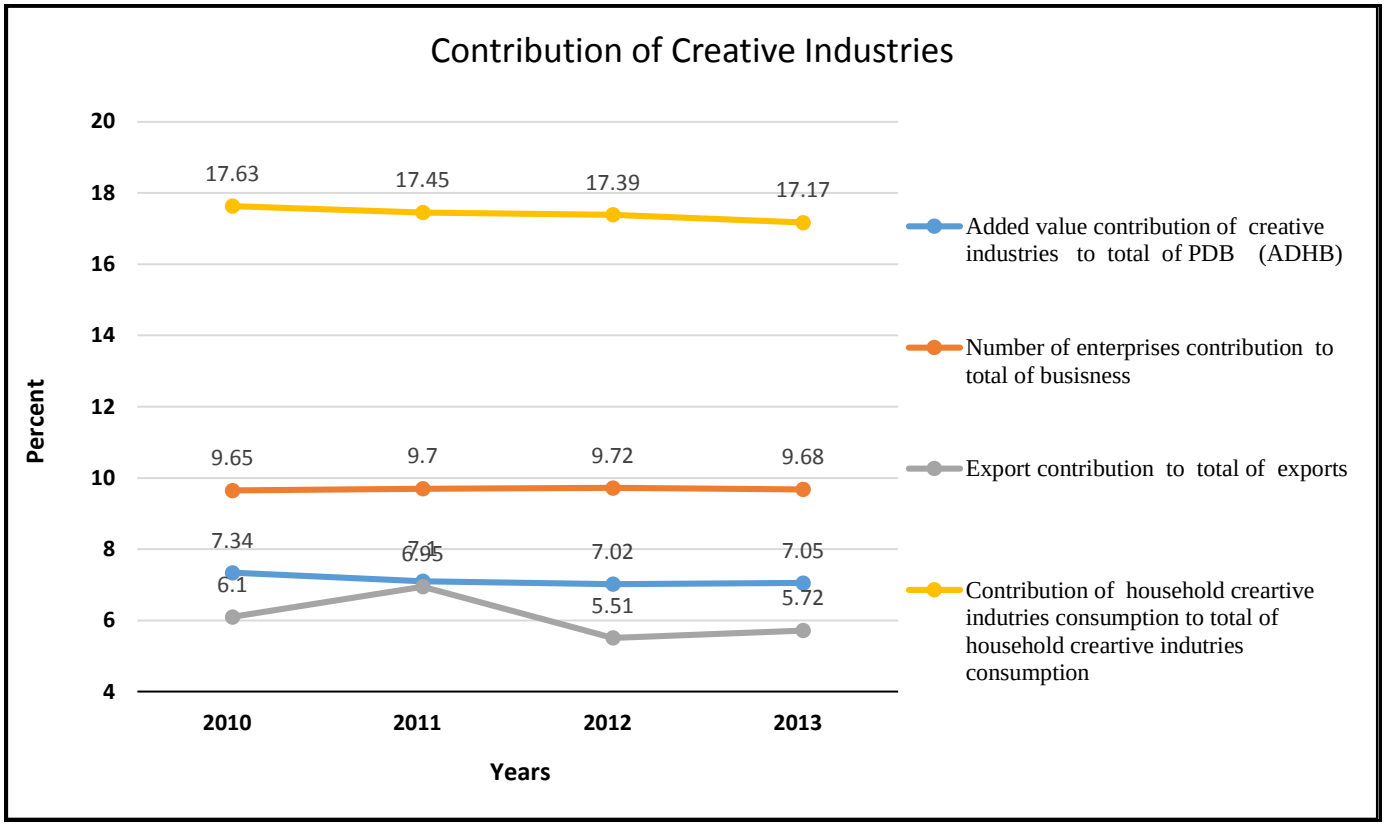

Figure 1: Graph of creative industries contribution in Indonesia (www.kemenpar.go.id)

Based on the literature study on some previous research as described above it can be drawn some initial conclusions related to the condition of the creative industries today. The first condition, the creative industries contributes to the Gross Domestic Product, but in Indonesia, over the last few years the contribution tends to decrease. The second condition, much research discussed creative industries modeling but, the elements of creative industries are still considered partial. The third condition is that the impact of the creative industries is still limited to economic and social impacts, while the environmental impact has not been considered.

Based on these three conditions, in this paper will be discussed the proposed integrated model of Life Cycle Assessment (LCA) and system dynamics for the development of sustainable creative industries policy. Life Cycle Assessment is a method to evaluate input, output, and environmental impact of the system, product or process on its life cycle (ISO 14040: 2006). Furthermore, by system dynamics methodology, the problems of creative industries system are not seen as an exogenous explanation but are considered to be caused by the internal structure (endogeneous explanation). The main focus of the use of system dynamics methodology is to gain an understanding of the creative industries system so that problem-solving steps provide feedback on system understanding. Although integration of life cycle sustainability assessment (LCSA) and system dynamics has been done by Onat, et al. (2016) to solve the transportation problem, but the integration of both methods to solve the problem of creative industries system has never been done. Because the creative industries in Indonesia is a dynamic system, as indicated in Kaderi et al. (2015). In line with this, the right policy design for the creative industries in Indonesia according to Fahmi et al. (2016) still require further research.

FRAMEWORK

In the first stage is an environmental impact assessment using LCA. The LCA approach differs from the environmental impact analysis (AMDAL), which does not pay attention to the upstream and downstream of the system. LCA not only pay attention to the product but the product system. What is meant by a product system is a collection that is materially and energy connected to a unit process that performs one or more functionalized functions (ISO 14040: 2006). Ideally, product systems can be modeled by determining the inputs and outputs and boundary constraints in which the elements flow. Furthermore, the LCA framework diagram can be seen in Fig. 2.

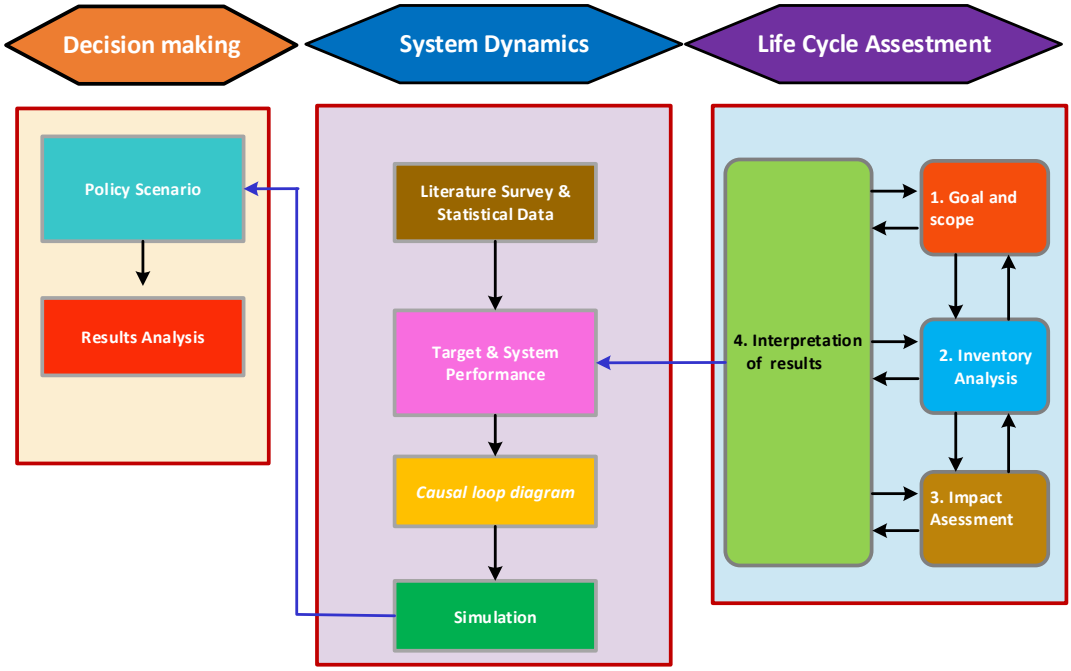

Figure 2: Integrated framework of *Life Cycle Assessment* and *System Dynamics*

The stages in the Life Cycle Assessment are divided into four phases (Curran, 2012).:

1. The phase of goal and scope definition, at this stage, determined the purpose and scope of the study and level of details. The boundary of creative industries systems and the policies studied are stipulated at this stage. In the study using LCA this stage is the most important step that must be done.
2. Life Cycle Inventory (LCI) phase, at this stage all processes must be measured in a strong native manner. For example related mass, energy consumption, carbon emissions, waste generated in products, processes, and activities that exist throughout the product life cycle.
3. The Life Cycle Impact Assessment (LCIA) phase is the stage of impact assessment on human and environmental health from the identification and inventory of life cycle inventory stage. The Life Cycle Impact Assessment (LCIA) phase is the stage of impact assessment on human and environmental health from the identification and inventory of life cycle inventory stage.
4. The phase of interpretation is the stage to answer the objectives that have been set at the beginning with the analysis of the results, explaining the limitations and recommendations based on the findings in the LCA phase.

At the stage of development of models with system dynamics is more emphasized to the purposes of how the behavior of the system arises from its structure. Applications dynamics system has been widely used in various scientific fields, including engineering /engineering, economic, social, ecological and environmental, etc. Problems that can be appropriately modeled using system dynamics methodology are (Tasrif, 2006): the problem has dynamic properties (changing over time) and the phenomenon structure contains at least one feedback structure. Feedback should be formed because of a causal (cause-and-effect) relationship. In other words, a feedback structure is a causal loop. The complex dynamic relationship between social, environmental, and economic indicators in a creative industries system can be modeled in a causal loop. This feedback structure is a model-forming block expressed through closed circles. The feedback loop expresses the causal relationship between the circular variables, rather than expressed relationships due to statistical correlations (Tasrif, 2006). At the stage of development of models with system dynamics is more emphasized to the purposes of how the behavior of the system arises from its structure. Applications dynamics system has been widely used in various scientific fields, including engineering / engineering, economic, social, ecological and environmental, etc. Problems that can be appropriately modeled using system dynamics methodology are (Tasrif, 2006): the problem has dynamic properties (changing over time) and the phenomenon structure contains at least one feedback structure. Feedback should be formed because of a causal (cause-and-effect) relationship. In other words, a feedback structure is a causal loop. The complex dynamic relationship between social, environmental, and economic indicators in a creative industries system can be modeled in a causal loop. This feedback structure is a model-forming block expressed through closed circles. The feedback loop expresses the causal relationship between the circular variables, rather than expressed relationships due to statistical correlations (Tasrif, 2006).

At the decision-making stage, the model that developed the hope is to be eligible and able to be used as a means of analysis to formulate (design) policy which is a vehicle to find ways and ways of effective intervention in a system (phenomenon), this as proposed by Tasrif (2006). It is through this means and means of intervention that the desired behavior of the creative industries system can be obtained and on the other hand the undesirable behavior of the creative industries system can be avoided. Tasrif (2006) recommends setting up policy scenarios (policy alternatives) in the (real) system with the model through manipulation through parameter changes, structural changes (decision rules), or; its combination

CONCEPTUAL MODEL

Generally speaking, the developed model includes ten sub-systems that affect the performance of the national creative industries system: labor, household, technology education, production, government, environment, raw materials, capital goods and financial sub-system. The conceptualization of a sustainable creative industries system can be explained by the Causal Loop Diagram (CLD) as shown in Fig. 3 and described by each loop in the CLD. In CLD sustainable creative industries systems are composed of several sub-models (sectors) and there is a causative relationship between sub-models or variables. So CLD is a review of sustainable creative industries system through simplification through the system point of view Broadly speaking, the developed model includes ten sub-systems that affect the performance of the national creative industries system: labor, household, technology education, production, government, environment, raw materials, capital goods and financial sub-system. The conceptualization of a sustainable creative industries system can be explained by the Causal Loop Diagram (CLD) as shown in Fig. 3 and described by each loop in the CLD. In CLD sustainable creative industries systems are composed of several sub-models (sectors) and there is a causative relationship between sub-models or variables. So CLD is a review of sustainable creative industries system through simplification through the system point of view inside the CLD there are several loops (multi-loops) that can be broadly divided into 2: positive (reinforcing) and negative (balancing). Reinforcing means the occurrence of reinforcement of an impact of a causal relationship variable related variables). While balancing means the occurrence of attenuation / decrease an impact of a causal relationship variable related variables. In the structure of the system dynamics model proposed in this research, there are 50 loops. With the help of simulation software VENSIM PLE version 5 50 loops. The environmental impact assessment resulting from the LCA is incorporated into the environmental sub-system, where the Stock and Flow Diagram of the environmental sub-system is shown in Fig. 4.

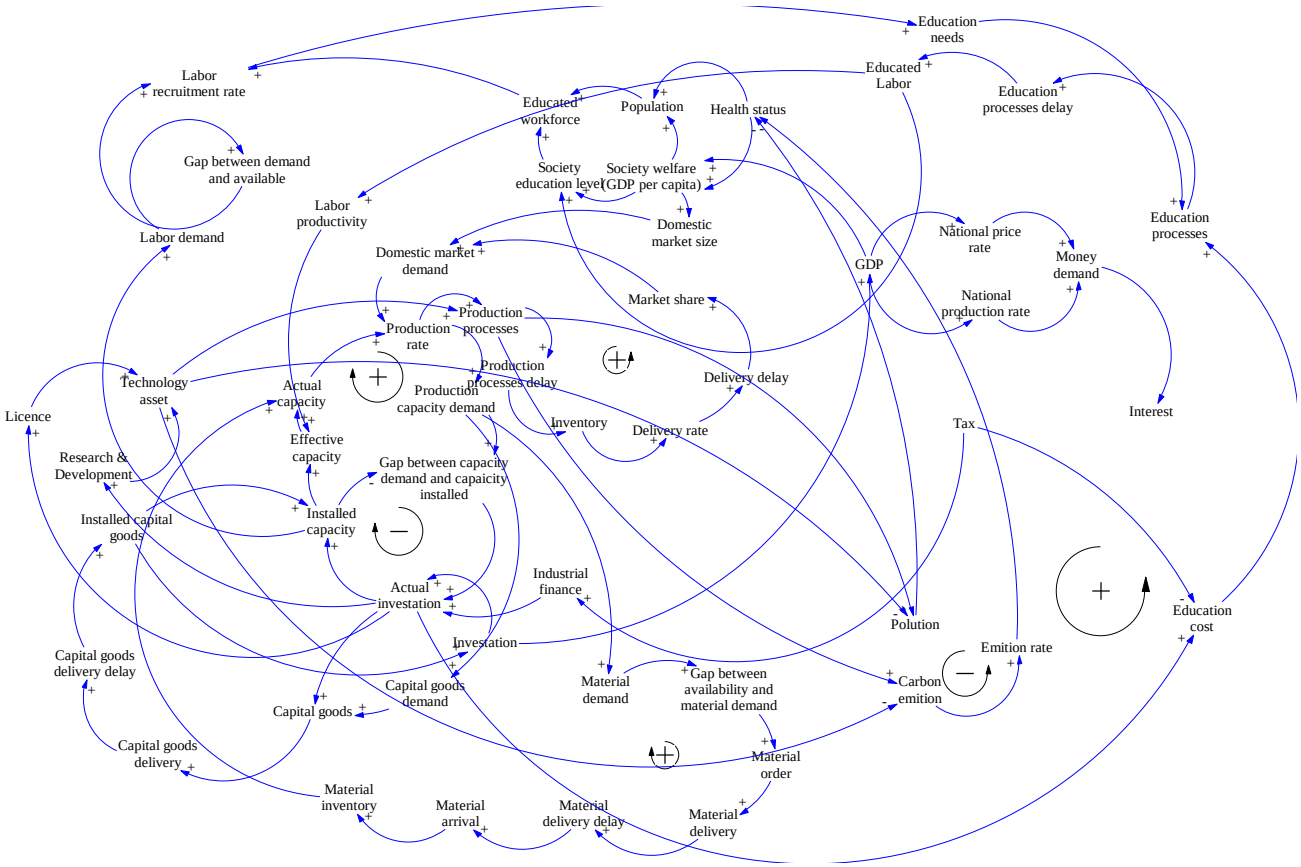

Figure 3: *Causal loop diagram* of sustainable creative industries (adapted from Mustajib and Ilhamsah (2016))

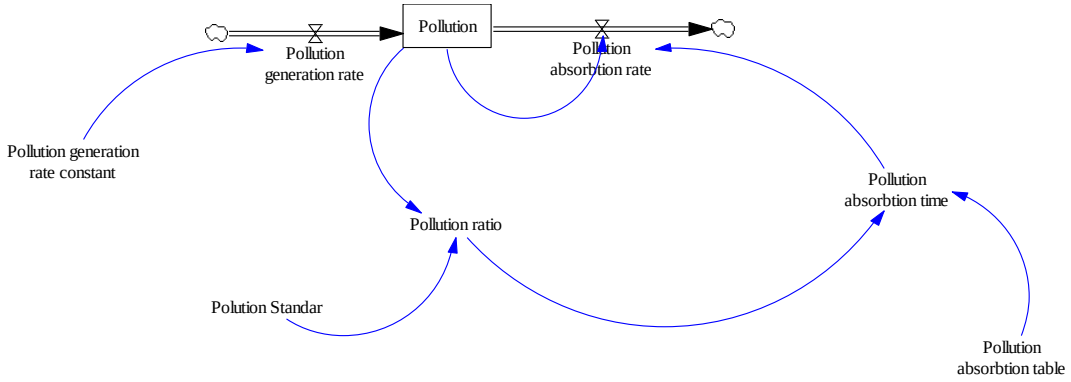

Figure 4: *Stock and Flow Diagram* Sub-Model of Environment

CONCLUSION

The creative industries has contributed to the Gross Domestic Product, but unfortunately in Indonesia for the past few years has decreased. On the other hand, there are many studies that discuss the modeling of the creative industries to study the behavior of creative industries systems but, the elements of the creative industries are still considered partial. In the meantime, the impact of the creative industries under consideration is only economic and social, while environmental impacts have not been taken into account.

In this paper, we have discussed the integrated Life Cycle Assessment (LCA) model and the creative system is seen not caused by external influences but is thought to be due to internal structure. So with the system dynamics obtained an understanding of the dynamics industries system for the development of sustainable creative industries policy. LCA is a method to evaluate the input, output, and environmental impact of the system, product or process on its life cycle (ISO 14040: 2006). While the system dynamics methodology, the problem of creative industries system so that the problem-solving steps provide feedback on the understanding of the system. The developed model includes ten sub-systems that affect the performance of the national creative industries system: labor, household, technology education, production, government, environment, raw materials, capital goods and financial sub-sistem. The environmental impact assessment resulting from the LCA is incorporated into the environmental sub-system.

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