SOCIO-ECONOMIC MODEL AND ICT IMPLEMENTATION FOR CLIMATE CHANGE MITIGATION AND ADAPTATION STRATEGIES

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and adaptation strategies, socio-economic development models, and the impact of ICT application have been widely discussed in today's society. However, its practical application is still a rather complicated matter. The role of approaches to obtain climate change mitigation and adaptation strategies using socio-economic models and ICT implementation is a problematic issue in the study and analysis of this research. This research aims to develop a research model and its hypothesis regarding Socio-Economic Models and ICT implementation for climate change mitigation and adaptation strategies. This research analyzes the conceptual and theoretical foundations socio-economic model development, ICT implementation, and climate change mitigation and adaptation strategies. This research uses a qualitative method approach, where theoretical studies are carried out through various literature studies data. The research results in this study resulted in the development of a new research model along with several hypotheses. It is hoped that this model framework can contribute to what is known about the relationship between the effects of IT implementation and developing socio-economic models and integrating them to support climate change mitigation and adaptation strategies, both on a national and global scale.

Keywords: *Adaptation and Mitigation Strategies; Climate Change, ICT Implementation; Socio-economic Model*

I. INTRODUCTION

Southeast Asia is part of the Asian regional region, such as Indonesia, Malaysia, the Philippines, Singapore, Thailand, Vietnam, Brunei, Laos, Myanmar, and Cambodia. Southeast Asia is also one of the regional areas that is vulnerable to the impacts of climate change. As one of the most vulnerable regions in the world to climate change, the Southeast Asia is faced with increasingly frequent and increasingly devastating extreme events weather events such as typhoons and droughts (Marquardt et al., 2021).Several significant climate change phenomena in Southeast Asian countries include sea level rise, drought and flooding, global warming, damage to ecosystems, changing rain patterns, decreased water quality and availability, and damage to coral reefs These phenomena show that Southeast Asian countries have big challenges in facing the impacts of climate change, and mitigation and adaptation efforts need to be taken seriously to reduce the risks and impacts.

Climate change can also disrupt a region's food security. Climate change can exacerbate social and economic inequality by reducing access to natural resources and economic opportunities. The occurrence of climate change can be a driving factor for human migration, both internally and across borders. Climate change can cause significant economic losses through infrastructure damage, reduced productivity, and adaptation costs. Countries that depend on economic sectors that will be

vulnerable to climate change, such as agriculture, tourism, and fisheries, may experience substantial economic losses. Reducing the social and economic impacts of climate change requires appropriate mitigation and adaptation efforts to reduce society's vulnerability to climate change. Unsustainable and continuous human activities have an impact on the phenomenon of climate change, which often occurs become more intense, periods of drought become longer, floods are incessant, and natural disasters occur. Forest fires occur more frequently.

Climate change mitigation reduces or eliminates greenhouse gas emissions by increasing the amount of activity that removes these gases from the atmosphere. Mitigation involves adopting renewable sources of energy, efficient use of energy, adoption of efficient technologies, recycling and re-use of resources, waste reduction, afforestation, and smart mobility (Bekaroo et al.,2016). On the other hand, adaptation to climate change is a behavior adjustment aimed at reducing the susceptibility of natural and human systems to actual or imagined climate change consequences. Adaptation can be realized by preparing for changing environmental and climatic conditions and building resilience of communities, target groups, environments, and ecosystems. Adaptation will help humankind to be more resilient to expected changes such as rise in sea levels, rise in temperature, unpredictable and erratic rainfall, increase in severity of dry spells and duration of heatwaves, landslides, flooding, melting of glaciers. The mitigation and adaptation measures should be anchored on sound policies that promote the utilization of ICT to harness their realization(Ajwang & Nambiro, 2022).

Socio-economic model development is an approach that combines various social and economic factors to analyze, understand, and predict the behavior of systems in society. These models are used to design policies, make decisions, and solve complex problems in areas such as economics, environment, and social welfare(Petrov, 2020). Developing effective socio-economic models requires interdisciplinary collaboration, reliable data, and a holistic approach. By understanding and utilizing this model, policymakers can make better and more sustainable decisions for society and the environment. This socio-economic model offers a set of basic building blocks through which the effect of changes or interventions, such as IT implementations on development, can be studied. It adds to existing models that it offers an integrated, global perspective to the implementations of ICTs. The implications of this process model lie in enabling the effects of IT on social and economic development to inform research and practice. The following section outlines a qualitative research approach to the investigation of the effects of IT on development. This research approach is then used to analyze rich descriptions of case studies in IT for development which lead to the development of a theoretical model(Qureshi, 2005).

The International Telecommunication Union (ITU) has promoted ICT implementation use as part of its commitment to help battle climate change(Ajwang & Nambiro, 2022). This is because the use of ICT opens new channels for modeling and predicting climate change and aids the exchange of knowledge and information. According to Ajwang & Nambiro (2022), ICT has significant potential in its implementation to influence climate change mitigation and adaptation strategies, in three ways, namely (i) the ICT sector itself can reduce emissions by using more energy efficient equipment and networks such as the use of green computing, cloud computing technology. ; (ii) ICT can reduce emissions and enable energy efficiency and (iii) ICT helps in dealing with the impacts of climate change globally through the application of technology to track meteorological and environmental conditions around the world. Much attention has been paid to the potential of ICT in reducing greenhouse gas (GHG) emissions, increasing energy efficiency and security by investing in sustainability, as well as its contribution to e-waste and an increase in GHG emissions associated with ICT's energy use(Grunfeld & Houghton, 2013).

Several academics previously conducted related studies on Socio-Economic Model of Development ICT Development, Climate Change Mitigation and Adaptation. A study conducted in 2005 by

Qureshi, (2005). the reference for this study regarding the integration of theory and practice of socio-economic development models with the impact of ICT developments. However, this research does not discuss the topic of climate change. The study from Rublev et al. (2021), analyzes the conceptual and theoretical foundations of the political, social, economic, spiritual, environmental, scientific, technical and information stability of the state and development of the socioeconomic system. According to further research from Ajwang & Nambiro (2022), discussing Climate Change Adaptation and Mitigation using Information and Communication Technology. According to the results of their research, technological progress by sophistication. Innovation in the field of ICT is an effective way to combat climate change by uncovering climate change signals, analyzing and modeling climate change, and implementing mitigation and adaptation measures that increase human resilience. Another study in 2023 from Mohd Azman, et al., (2023) focuses on the Malaysian Ministry of Agriculture and Food Industry (MAFI) to address climate change and food security. In conclusion, as a developing country, Malaysian administrators need to be able to control the stabilization of agricultural activities.

This research aims to develop a research model and its hypothesis regarding Socio-Economic Models and ICT implementation for climate change mitigation and adaptation strategies. The specific targets or objectives to be achieved in this research are:

1) to analyze the conceptual and theoretical foundations socio-economic models.
2) to analyze the conceptual and theoretical foundations the effect of ICT implementation.
3) to analyze the conceptual and theoretical foundations climate change mitigation and adaptation strategies,
4) to develop research models and hypotheses about socio-economic models and ICT implementation for climate change mitigation and adaptation strategies.

This study analyzes and develops a research model with its hypothesis regarding socio-economic models and the implementation of ICT for climate change mitigation and adaptation strategies, which is a novelty produced in this research. The results of developing this research and its hypothesis can contribute to what is known about the relationship between the impact of IT development and the development of socio-economic models and integrating them to support climate change mitigation and adaptation strategies, both on a national and global scale in the future.

II. METHODS

Considers theoretical aspects and phenomena of socially and economically significant problems raised in the article. This study uses a qualitative method approach with theoretical level studies derived from various literature studies.

Several studies and framework analyses from previous research in this study, including those related to the socio-economic model development and the influence of ICT implementation on climate change for mitigation and adaptation climate change strategies. From several previous framework analyses, then developed a research model and hypothesis development related to socio-economic model research and ICT implementation for climate change mitigation and adaptation strategies. The study in this study carried out analysis of several previous research frameworks so that the results of the analysis of this study produced a proposed research model and the development of its hypotheses. To validate the future model, it is best to use empirical analysis in a quantitative study(Creswell & Creswell, 2023).

III. RESULTS AND DISCUSSION

3.1 Results of Analysis of the Conceptual and Theoretical Foundations of Socio-Economic Models

Given that both social and economic development are key to the study and practice of development, this paper follows a socio-economic definition in which development is considered to be the improvement of social systems as well as economic growth. The concepts described thus far on social and economic development are summarized in the following model of social and economic development (Figure 1).

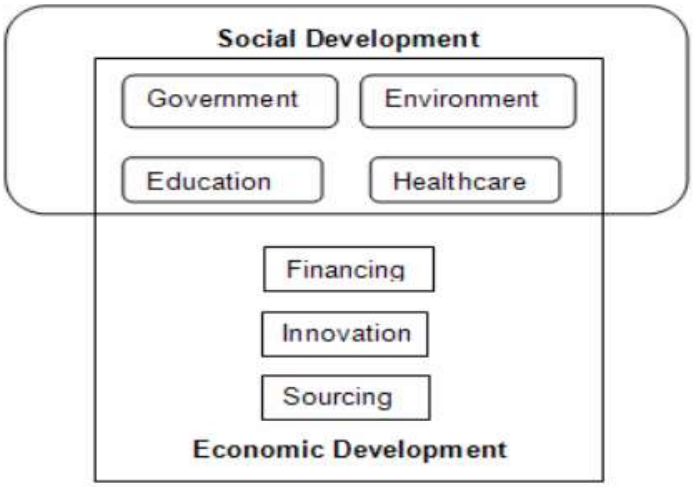

Figure 1: Socio-Economic Model of Development(Qureshi, 2005)

This model of development encompasses the practice of social development by depicting the key areas in which its activities are most prevalent: government, healthcare, the environment and education. The social perspective on development adds a more dynamic perspective to the concept of development and enables it to be investigated as a product of human activity systems. This view is in fact closer to the reality of development and has had the greatest effect on the practice of development. At the same time, economic development is seen to contribute to development through financing in the form of loans, aid and/or trade agreements, the use of knowledge and expertise for innovation and the sourcing of raw materials goods and services needed for production. These can inform public policy and impact education and healthcare.

Economic development theory can also help study changes in economies. Schumpeter's contribution to development economics is the concept that economies go through cycles of growth. He suggests that through technical and organizational progress, development takes place as knowledge progresses. New technical innovations can bring about development if they offer opportunities for new enterprises. In addition to being an economic phenomenon, Schumpeter suggests that development is essentially a disturbance of equilibrium of the economy which he suggests is a static one. The third characteristic of development according to Schumpeter is that it occurs in a waves or separate partial developments that
follow one upon the other. While development brings about gains in value it also leads to losses in value (Schumpeter, 2002).

3.2 Results of Analysis of the Conceptual and Theoretical Foundations of ICT Implementation

Several cases highlight the effects of ICT implementation on social and economic development if implemented appropriately to support local needs. This socio-economic model offers a set of basic building blocks through which the effect of changes or interventions, such as IT implementations or development, can be studied. It adds to existing models in that it offers an integrated, global perspective to the implementations of ICTs. The implications of this process model lie in enabling the effects of IT on social and economic development to inform research and practice. Model of The Effect of ICT Implementation, shown in Figure 2,

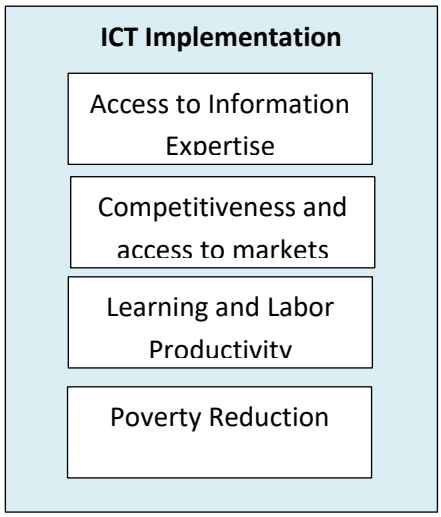

Figure 2: Model of The Effect of ICT Implementation(Qureshi, 2005)

The following section outlines a qualitative research approach to the investigation of the effects of IT on development. This research approach is then used to analyse rich descriptions of case studies in IT for development which lead to the development of a theoretical model. This effect of the ICT Development Model suggests that social and economic development activities can benefit from the ICT implementation, including better access to information and expertise, increased competitiveness and access to markets, including global markets, and increased learning and labor productivity, and poverty reduction.

3.3 Analysis Results Related to The Conceptual And Theoretical Foundations Of Climate Change Mitigation And Adaptation Strategies.

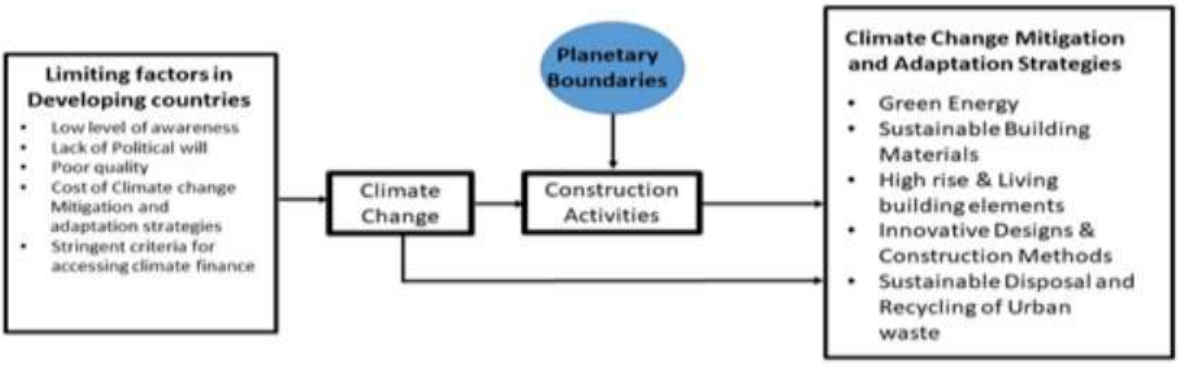

Figure 3 shows the Conceptual Framework of Climate Change Mitigation and Adaptation Strategies

Figure 3: Conceptual Framework of Climate Change Mitigation and Adaptation Strategies (Tunji-Olayeni et al., 2019)

Adapting to this new climate era is important for the continued existence of life on the planet. Moreover, mitigating the effects of climate change is crucial for sustainable development. Tunji-Olayeni et al. (2019), study shows that it provides a conceptual framework for climate change mitigation and adaptation strategies and the limitations of developing countries (Figure 3). Next, climate change mitigation and adaptation strategies, including: Green Energy, Sustainable Building Materials, High Rise and Living Building Elements, Innovative Designs and Construction Methods, Sustainable Disposal and Recycling of Urban Waste.

Explanation regarding Climate Change Mitigation and Adaptation Strategies factors, as follows:

(1) Green Energy
Fossil fuels are the most common form of energy in developing countries. Emissions from fossil fuels contribute significantly to the impact of Greenhouse Gases. Green energy is energy that produces little or zero environmental impact. This includes all forms of clean and renewable energy sources, namely: wind energy, solar energy, water energy, geothermal energy, and biofuels. Mainstreaming green energy will reduces Aerosol Optical Depth (AOD). AOD is the main trigger for climate change. Green energy mitigating the risks associated with climate change.

(2) Sustainable Building Materials
Energy emissions contained in buildings also contribute to the Green greenhouse gas effect. When considering the volume of building stock globally, the extent of the problem can usually be seen better than imagined. Sustainable Building Materials are replaced with conventional building materials so they are aerosol.

(3) High rise and Living building elements
High-rise buildings can reduce the loss of biodiversity. Although not all soil has good load-bearing capacity, several types of foundations such as piles, rafts and the pad is intentionally designed for poor load-bearing soils. In high-rise construction, terrestrial land is less used up thereby conserving more land and conserving plant and animal species. In addition, living building elements can facilitate the adaptation of plant and animal species in cities centers where urbanization is inevitable, thus preserving terrestrial biodiversity. Specifically, the roof and walls can be designed to accommodate some forms of life such as flowers and small shrubs. By doing that, the elements of life absorb carbon in the atmosphere and also provide habitat for living creatures on small land masses living creatures to easily adapt to ecological and health disturbances resulting from development activities.

(4) Innovation Designs and Construction Method
The use of innovative design and construction methods can minimize conventional impacts construction on the environment and also minimize the use of natural resources. Dry construction is possible reduce the use of clean water in buildings. Dry construction is construction that uses little or no water. This includes the use of glass, aluminum and steel. Modular construction and use of prefabricated buildings elements can also minimize water use in construction. There are other innovative systems that can be used to control water use in buildings.

(5) Sustainable Disposal and Recycling of Urban waste
Improper disposal of urban waste is a threat to oceans and water bodies. Unsustainable disposal Municipal waste originating from agriculture, industry and households poses a major threat to the oceans and water body. Wastewater recycling can have a positive impact on water conservation. Water recycling is one of the identified water preservation techniques

3.4 Results of Research Model Development and Hypotheses Related to Socio-Economic Development
and ICT Implementation for Climate Change Mitigation and Adaptation Strategies.

The results of the study and framework analysis from several previous studies are conceptually and theoretically integrated into a new research model and hypothesis development, as shown in Figure 4

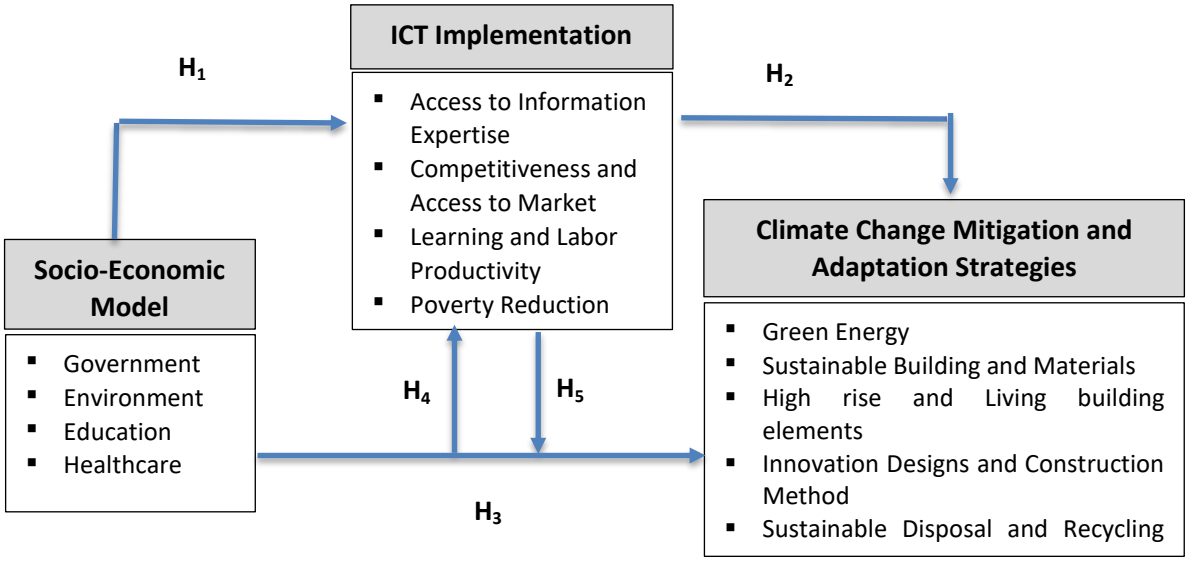

Figure 4. Socio-Economic Model and The ICT Implementation for Climate Change Mitigation and Adaptation Strategies as a Research Model

The socio-economic model, which is a combination of social development and economic development, indicates government, environmental, education, and healthcare factors(Qureshi, 2005). The development of socio-economic models will have an effect on ICT implementation(Qureshi, 2005). In addition, the important role of ICT in processes related to climate change and issues relevant

to sustainability and climate change (Grunfeld & Houghton, 2013). With climate change, a strategy is needed to mitigate and adapt(Tunji-Olayeni et al., 2019).
This research model which provides the hypothesis:
H1: The socio-economic model influences ICT Implementation,
H2: The ICT Implementation influences climate change mitigation and adaptation strategies,
H3: Socio-Economic model influences climate change mitigation and adaptation strategies,
H4: The ICT implementation mediates the influence of the socio-economic model on climate change mitigation and adaptation strategies,
H5: The ICT implementation moderates the influence of socio-economic models on climate change mitigation and adaptation strategies.

3.5 Discussion

The urgency of this research is the main reason why studies related to climate change are most important to consider. Indonesia, which is in the Southeast Asia region, is still very vulnerable to climate change, which is sometimes very extreme. This is as revealed by research from Marquardt et al., (2021) which states that Indonesia is one of the most vulnerable regions in the world to climate change, Southeast Asia is faced with increasingly frequent and destructive extreme weather events such as typhoons and drought.

This study emphasizes climate change mitigation and adaptation strategies, which refer to the influence of the development of socio-economic models and the implementation of ICT. For the Southeast Asia region, a study related to climate change was conducted in Malaysia by Mohd Azman, et al., (203), where the study focused on the Malaysian Ministry of Agriculture and Food Industry (MAFI) to address climate change and food security. The conclusion of their study, as a developing country, Malaysia must be able to control the stabilization of agricultural activities with climate change. A study conducted in 2005 by Qureshi (2005). the reference for this study regarding the integration of theory and practice of socio-economic development models with the impact of ICT developments. However, this research does not discuss the topic of climate change. This study is also in line with research by Ajwang & Nambiro (2022) which discusses Adaptation and Mitigation of Climate Change Using Information and Communication Technology.The results of literature studies and analysis of several frameworks from socio-economic models(Qureshi, 2005)., ICT implementation(Qureshi, 2005; Grunfeld & Houghton, 2013) , and climate change mitigation and adaptation strategy frameworks(Tunji-Olayeni et al., 2019) produce research models related to Socio-Economic Models and ICT Implementation for Climate Change Mitigation and Adaptation Strategies.

This study has theoretical implications, especially in integrating the concepts and theories of socio-economic models with the concepts of ICT implementation and concepts and theories of climate change mitigation and adaptation strategies. Meanwhile, the technical implications for implementation in the field require a lot of regulations to implement climate change mitigation and adaptation strategies.

The limitation of this study is that it is only a review study to produce a research model and develop some hypotheses and does not discuss model validation tests that can be carried out in future studies.

IV. CONCLUSION

In summary, research with a qualitative approach emphasizes the development of a research model related to the Socio-Economic Model and The ICT Implementation for Climate Change Mitigation and Adaptation Strategies.

The results of the study in this study resulted in the development of this research model which provides the hypothesis: (1) H1: The socio-economic Model influences ICT Implementation, (2) H2: The ICT Implementation influences Climate Change Mitigation and Adaptation Strategies, (3) H3: Socio-Economic Model influences Climate Change Mitigation and Adaptation Strategies, (4) H4: The ICT Implementation mediates the influence of the Socio-Economic Model on Climate Change Mitigation and Adaptation Strategies, and (5) H5: The ICT Implementation moderates the influence of Socio-Economic Models on Climate Change Mitigation and Adaptation Strategies.

In future research, the resulting research model needs to be tested empirically with quantitative research. As Artificial intelligence (AI) technology advances, future research might be conducted to investigate the application of AI to promote climate change mitigation and adaptation, particularly in Indonesia.

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