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A System Dynamics Model to Evaluating Ecotourism Sustainability at Tasik Kenyir, Malaysia

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ABSTRACT

The sustainability of ecotourism is the primary concern for the tourism industry. However, sustainability of ecotourism is unresolved issue, in terms of deep analytical for integrated simulation, material-energy flow, and the trends of the process generating constricting ecological and economical positive–negative impacts. In this study, a system dynamic model is developed based on the community's socio-cultural and economic factors, biodiversity, and tourism parameters for sustainable ecotourism of Tasik Kenyir were collected and evaluated. Data on wildlife was extracted from the management authorities. The analysis revealed that the variance portrayed in socio-cultural and economic aspects among the communities is influenced by ecotourism development, and positive contribution of conservation activities, local support for conservation and ecotourism, and upon the distribution of wildlife around Tasik Kenyir. This study contributes towards comprehending the natural resource of the community–ecotourism inter-relationship, besides bridging the knowledge gap that impedes the initiatives taken for biodiversity conservation.

Keywords: Sustainability, System Dynamic Model, Economy, Biodiversity, Communities, Kenyir Lake

JEL: Q56, R58

INTRODUCTION

The global growth of tourism poses a significant threat to both cultural and biological diversity. Therefore, the needs of sustainable tourism for the purpose of environmental conservation are in great demand for parks and nature tourism. Hence, "sustainable tourism" has emerged as a subject of debate, especially on environmentally integrated tourism development, and largely as a result of the insight that the environmental consequences of rapidly growing industry can no longer be ignored (Hunter & Green, 1995). Thus, in order to incorporate scientific value within the tourism niche in Malaysia, synergy between behavior and the complex system of tourism itself has to be understood (Ross & Wall, 1999). As such, this study probed into the dynamics that lies in the tourism industry to cater certain information based on real time analysis. Furthermore, the core foundation of this study suggests that ecotourism is indeed the best option to be given focus, as its core essences revolve around the sustainability of its subjects.

In addition, ecotourism has been widely recognized as a form of nature tourism that is expected to contribute to both conservation and development (Ross & Wall, 1999). In fact, sustainable ecotourism is definitely a crucial aspect for sustainable development, and is capable of generating income, providing job opportunities, and protecting local biodiversity (McCool & Moisey, 2001). Moreover, the principles held in sustainable ecotourism should be able to meet the needs of economic, social, and local biodiversity. On top of that, sustainable ecotourism applies the resources of an area with the attempt to create a balance between new potential and the existing activities. Additionally, several pertinent factors, such as equity, justice, poverty alleviations, and local community empowerment, appear to be the key-factors in socio-elevation, which is also associated with the aspect of sustainability (Dhanoa, 2013).

Tracking the history backwards, environmentalists have prioritized ecotourism as early as in the 1980s as an aspect of leaving a green legacy for the future. Moreover, researchers have persisted for years to find ways to boost not only economic value in tourism, but also to produce sustainable ecosystems for the future. This has led several agencies, such as UNESCO and vast numbers of researchers, to devise effective plans (Pedersen, 2002). In addition, it is apparent that the former methods of mass tourism demand drastic changes, especially upon recognizing the fundamental truth pertaining to the nature of traditional tourism is primarily to consume resources and generate waste, in which requires pressing specific needs to meet the demands of infrastructure (Sander, 2012). Therefore, in order to promote prolonged use of tourism areas and to empower sustainable activity, ecotourism emerges as a sound alternative. Nevertheless, over time, ecotourism has yet to appear as one of the many core justifications for the preservation of natural areas worldwide—primarily in conservation areas, as highlighted in some studies: Costa Rica (Sander, 2012; Narayan, 2015), a national park in Turkey (Açiksöz et al., 2010), an Italian eco-park (Montaguti & Mingotto, 2015), the sustainability of eco-resorts in Australia (Lee & Moscardo, 2005), and other places that have opted for conservation worldwide. Hence, this industry in Malaysia generates economic surplus, which was estimated to be approximately MYR72.0 billion in revenue for 2014 (Hassan, 2012). With such figures, ecotourism is indeed a significant industry that seeks to take advantage of the present market trends. This is the main reason for many developing countries to embrace the concept of ecotourism, besides embedding this notion in their economic development and conservation strategies (Kiper, 2013). Furthermore, ecotourism has been perceived as a potential effective tool for sustainable development.

Furthermore, the principle of future ecotourism is inclusive of the true meaning of ecotourism—to protect nature and educate locals and tourists, thus empowering the local stakeholders—into their (the comprehensively modern tourism principle) ventures, instead of focusing on tasks based on individual basis (Sander, 2012). Nonetheless, as a tool for empowering economics, this segment holds value in boosting and generating income for those involved in ecotourism (Montaguti & Mingotto, 2015). This segment should also function as an essential contributor in preserving the natural landscape, while offering a solution to empower local's economics for regions, especially those which are facing problems such as underdeveloped region and poverty. Moreover, as ecotourism seems to be uniting two goals of ecological conservation, economic development and successful ecotourism require the maximization of their mutual benefits while simultaneously minimizing ecological damage; unfortunately, however, numerous ecotourism projects fail in completely attaining their objectives (Boo, 1993; Chang et al., 2008). However, one should note the other side of the coin, where the implementation of ecotourism is also prone to be fatal towards strategic development; that is, preserving the environment for future generations while allowing for economic development to vigorously occur is a challenge (Sander, 2012; Garry, 2004). Nonetheless, these factors worsen as some studies have determined the glitch underlying the ecotourism principle in certain areas: lack of interest amongst stakeholders (e.g., investors) (Briker, 2009), factors beyond reach such as the control of private sector enterprises (Briker, 2009 ; Lee & Moscardo, 2005), government policies (Garry, 2004; Bricker, 2009), and last but not least, the need to address and respond to actions taken by contemporary competitors (Bricker, 2009). However, upon recognizing the delicate interaction of all pros and cons of ecotourism, as well as the weight of positive interaction in ecotourism, the needs of ecotourism have to be met as quickly and carefully as possible, before the notion of ecotourism turns weary and future eco-tourists become too disheartened to care. With that, this research aids in underlining the significance of developing ecotourism by addressing several important factors and demands, such as forecasting the size of the market and segmented market to rule out the viability of a conservation plan, behavior patterns that include tourism preferences, ups and downs related to socio-demographics, as well as purchasing patterns generated from the tourism sector.

The development of specific territories from the viewpoint of ecotourism is indeed an intricate study area. This is for several reasons that are presented in this study, including the management of vast resource areas (Sterman, 1992; Bricker,2009), disparate interest among varied groups that manage resources, and interrelations of the selected variables (Boo, 1993; Chang et al., 2008). Furthermore, this consecutive disorientation has been highlighted by prior research, either in conceptual or empirical evaluations of ecotourism. As such, in order to grasp the core of ecotourism, many researchers have proposed varied models to address numerous issues that have emerged in the tourism field. Some of the topics focused upon revolve

around tourism destination (Lee & Moscardo, 2005; Açiksöz et al., 2010; Sander, 2012; Narayan, 2015; Montaguti & Mingotto, 2015;), tourism capacity (Hunter & Green, 1995; McCool& Moisey, 2001), managerial effectiveness analysis (Ross & Wall, 1999), as well as other quantitative analyses topics, such as willingness to pay (WTP). Undeniably, the insights proposed by these prior studies could indeed pave a path for future development, but as they address differing aspects of issues in sustainable tourism, discrepancies occurred and resulted in varied focal points, as well as proliferation, in ecotourism. Therefore, in order to address the research gaps, a more sophisticated model that integrates all variables is needed. Hence, to attain overall understanding in ecotourism, correlations between variables must be determined in an attempt to develop a model that is capable of pointing out the effects that derive from the interactions of dependent variables. With that, this dependency is highlighted in a dynamic and complicated interaction by employing the system dynamic model. System dynamic (SD) refers to a model that analyses the behavior of complex systems over time. Moreover, it deals with internal feedback loops and time delays that influence the behavior of the entire system. Thus, this particular system could aid in describing non-linear events and dynamic changes that occur from certain events that have been suggested (Sterman, 1992).

In addition, in the field of sustainable development, the SD method had been applied in several prior studies, mainly to provide an experimental simulation platform for a long-term environmental sustainability analysis within interconnected strategic issues, along with their interconnected context (Isa, at al., 2020(a); Isa, at al., 2020(b)). With an SD model, the impact of environmental policy upon investment and development decisions in the mining industry was identified within the context of sustainable development by analyzing the existing data in a quantitative manner (Muhanna, 2006). With that in mind, a system dynamic model is constructed by embedding five subsystems: population, economy, housing, transport, and developed land either on sustainably used land or urban development, such as that in Hong Kong. On top of that, this model has been used to examine the outcomes of development policy scenarios and to make forecasts. System dynamic has been proven to be beneficial in providing information and analysis. Thus, it could be used to build models for the sustainable tourism and ecotourism framework, as investigated for Tasik Kenyir (Kenyir Lake) located in Terengganu, Malaysia, which is described in detail in this study.

Furthermore, several empirical questions are answered in this study, such as (1) how does the dependency of a variable affects tourism activities; and (2) how do changes in variables affect other dependent variables (either positively or negatively). These research questions are the essence of the primary research objective of this study: to determine ecotourism behavior and its effects upon the Tasik Kenyir area. Therefore, this research is deemed crucial to outline the economic value of bio-diversity in the Tasik Kenyir area as a measure to generate not only income, but also to promote the sustainable development from the economic viewpoint within the related environment. To achieve this objective, the notion of sustainable ecotourism in an exotic and rich tourism spot is investigated in Terengganu, Malaysia due to an undeniable fact that Terengganu holds the charms and splendor from other states found in Malaysia. Despite the rapid development and modernization, the state has managed to retain all rustic and idyllic charms, making it a unique place in comparison to other tourist destinations. Additionally, the abundance of coastal area with pearly white beach and breathtaking islands has made Terengganu one of the most popular islands for tourism activities. However, beginning from early November until mid-February, all activities related to the sea cease to function due to monsoon season. This has caused a gap in income for the tourism activity in Terengganu. Remarkably, many are unaware that Terengganu does still offer a unique retreat, such as Tasik Kenyir and other attractive places to be explored.

Tasik Kenyir is the largest man-made lake in the Southeast Asia. Tasik Kenyir houses an abundance of natural wonders and is rich in biodiversity. As illustrated in Figure 1, Tasik Kenyir covers more than 340 islands that spread out in a water catchment area of 38,000 hectares (Othman et al., 2010). The biggest island is estimated to be as large as Singapore, and Tasik Kenyir is named after of the rivers known as Kenyir River, which is present beneath the lake when Tasik Kenyir is almost filled by rainfall and surrounding water sources. Besides, with over 30 rivers flowing in and out, this lake is also comprised of 25 waterfalls and approximately 300 species of freshwater fish (Shen et al., 2009). Dotted with more than 340 islands throughout the lake, which were once mountaintops and highlands, Tasik Kenyir is home to more than 14 cascading waterfalls, cooling waters, an abundance of rapids and rivers, as well as an idyllic sanctuary to numerous species of freshwater fish and exotic wildlife (KETENGAH, 2014).

Figure 1. Location map of Tasik Kenyir.

Tasik Kenyir is under the jurisdiction of Terengganu Tengah Development Authorities (KETENGAH). KETENGAH is an agency under the Ministry of Rural and Regional Development was incorporated on 12 April 1973 by the Parliament Act No. 104/73 to carry out economic and social development in the area of 443.876 hectares. The whole area covers the interior of Dungun, Kemaman, and Hulu Terengganu districts. On 12 June 1993, the Tasik Kenyir Development area in Hulu Terengganu extending an area of 209,199 hectares was gazetted via LN (B) 356 (subsidiary legislation in Malaysia) with area gazette plan No. PW486 as part of KETENGAH, making KETENGAH region a total of 653,075 hectares (Shahrom, 2012; KETENGAH, 2014, Abdullah, 2016).

The federal government had injected funding for massive infrastructural development projects undertaken at Tasik Kenyir. With 130 million years of rich history and high biodiversity found in Kenyir, sustainable tourism development is required. Recent data show a fair amount of increment in tourism activities in Kenyir since its establishment under KETENGAH (Hassan, 2012). It was suggested that Tasik Kenyir should have its own planning in balancing its ecosystem value, economic development, as well as community engagement (Lola et al., 2019). With propose planning, it is expected to increase the number of visitors without losing its natural resources and heritage. Table 1 presents the number of tourists who have visited Tasik Kenyir based on the data provided from KETENGAH over the past decade (from 2008 until 2018), which is used as reference in this study.

Table 1. Number of tourists in Tasik Kenyir.

Year	Tourist in Kenyir
2008	133,000
2009	189,000
2010	225,000
2011	275,000
2012	397,000
2013	467,000
2014	649,000
2015	706,000
2016	507,000
2017	808,336
2018*	265,846
Total	4,622,182

* Until June 2018.

METHOD

System Dynamic

System dynamic (SD) was developed in the mid-1950s (Nasser, 2003), and has been applied in several research fields. SD refers to a methodology and computer simulation modelling technique for framing, understanding, and discussing a system with intricate issues and glitches. Furthermore, this research method was selected for this study because it has been widely applied for economic simulation as well as social and environmental studies, in which

the results obtained have managed to reveal dynamic changes, to offer feedback, and to identify other variables of cause-and-effect. Hence, by employing SD in this study, insights into positive and negative effects could be derived from an artificial model based on the actual surrounding environment (Nasser, 2003; Lola et al., 2016; Isa, et al., 2020a; Isa, et al., 2020b).

The typical purpose of an SD study on sustainability issues is to simulate the complex interrelationships between the sustainability variables, as well as to seek appropriate quantitative solutions to measure environmental, economic, and social aspects within the whole system (Isa, et al., 2020a). Besides, the SD model is more beneficial in explaining the developing trends of dynamic behaviors in the long-term, mainly due to its feedback structure and its capability to function under various parameter settings and initial inputs. On top of that, the SD model can assist decision makers in developing sustainability policies with its simulation results (Forrester, 1997; Xu and Coors, 2012; Lola et al., 2016).

Three general steps are involved in building the SD model (Figure 2). These steps were taken to analyze the dimensions of the socio-economic and environmental impacts of ecotourism upon the communities surrounding Tasik Kenyir. These steps begin with the description of problem that involves the processes of understanding problems, developing system characteristics, and identifying its impact upon social, economic, and biodiversity aspects. Next, a dynamic hypothesis was developed where causality between the factors in the causal-loop diagram were determined. Lastly, the process ended as the SD model was built via computer simulation (Safiih et al., 2016).

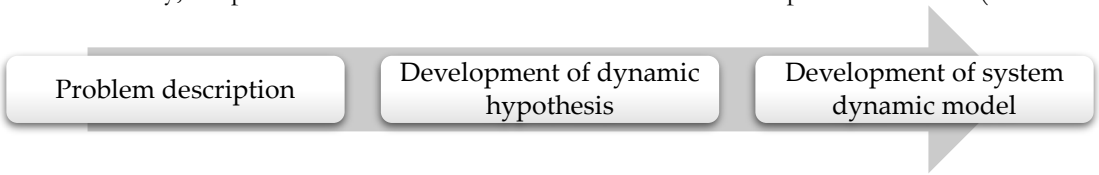

Figure 2. The process of system dynamic model development (Safiih et al., 2016).

Material and Method

Problem Description

In this research, SD was employed to study the correlation between eco-based tourism development in Tasik Kenyir and tourist arrival, and to determine whether the eco-based tourism does produce sustainability in economic, community, and ecological development in Tasik Kenyir. In addition, SD was applied to determine the relationship between tourism-based development and geo-heritage value in Tasik Kenyir. On top of that, the SD was also undertaken to investigate the intricate inter-relationships between ecotourism and financial benefits, as well as empowerment among the indigenous people. Furthermore, the effect of ecotourism in raising awareness of socio-political issues in Tasik Kenyir had also been examined via this system. As such, to achieve the objective outlined in this research, the sustainable management of ecotourism in Kenyir is focused on dynamic interaction between community, biodiversity, and tourism. Moreover, this study applies a framework (Figure 3) that spells out ecotourism as a network of synergistic links and uses indicators to ascertain whether the existing correlations do allow community, biodiversity, and tourism to make a positive contribution to the other (Ross & Wall, 1999). In fact, one significant purpose of this study is to analyze the dimensions of the socio-economic and environmental impacts of ecotourism upon communities that reside surrounding Tasik Kenyir. This should result in a new policy, which could be introduced by policymakers as a new benchmark. Therefore, an SD model known as "Sustainable Management of Ecotourism–System Dynamics" or "SMEc-SD" is built based on ecotourism interrelationships.

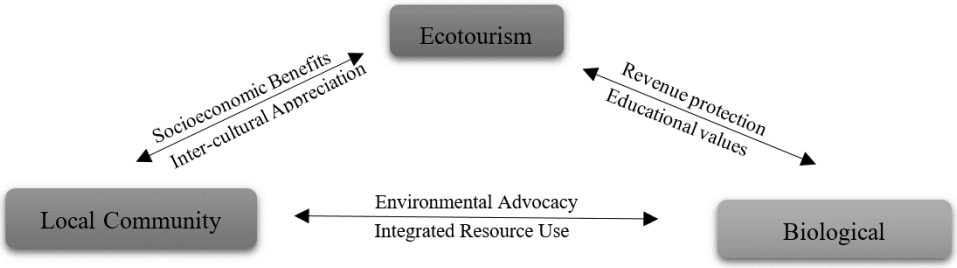

Figure 3. A conceptual framework for "Sustainable Management of Ecotourism–System Dynamics" (SMEc-SD) (Safiih et al., 2016).

Dynamic Hypothesis

In this study, three interview sessions were conducted with a total of 20 key informers, who varied from government strategic planners to local authorities, in order to gain information concerning the impact of ecotourism upon the local community, the tourism sector, and biological diversity. Additionally, a set of questionnaires was distributed to tourists in order to gain information about their willingness to pay for conservation, their level of satisfaction with facilities and tourism activities offered by Tasik Kenyir, as well as

revisit plan to Tasik Kenyir. Next, three isolated visits were made in order to gain experience as a tourist, besides observing the environment at Tasik Kenyir, including the facilities, the services provided by the employees, and the tourism activities. After that, the findings retrieved from interviews, questionnaires, and visits were converted numerically (Xu and Coors, 2012). These data were used to represent the value in causal loop diagram to analyze the dimension of the impact of ecotourism at Tasik Kenyir (David, 2017; Bartholomew, 2017; David, 2019; Adanan, 2019; Ramlee, 2020).

Furthermore, the SD modelling approach applied the causal-loop diagram to portray the feedback structure of the system. A causal-loop displays the cause–effect relationships between the system variables, besides enlightening the dynamic process of the system, where the chain effects of a cause are traced via a set of related variables back to the original cause. Moreover, a causal loop is formed when a set of variables is linked together in a connected path. These cause–effect variable pairs are positively related, hence represented by a plus sign added to the link; otherwise, a minus sign. A positive-feedback loop could trigger an embedded system variable growth process over time, whereas a negative-feedback seeks a goal and responds by attaining a stable state (Maani and Cavana, 2010; Lola & Kamil, 2021) [24,29]. Other than that, a causal loop can also be represented by an arrow-headed line with "+" symbol, which means a change in the influencing variable could lead to a change of the same direction in the target variable, while the "-" symbol reflects the effect in the opposite direction between the influencing variable and the target variable. In fact, these correlations of causal loops are beneficial in predicting the impact of the desired factors in a system in a holistic manner (Sterman, 2001; Nasser, 2003; Maani & Cavana, 2010) [24,29,30]. Furthermore, based on the framework illustrated in Figure 3, the casual loop diagram of the SMEc-SD model is designed and displayed in Figure 4.

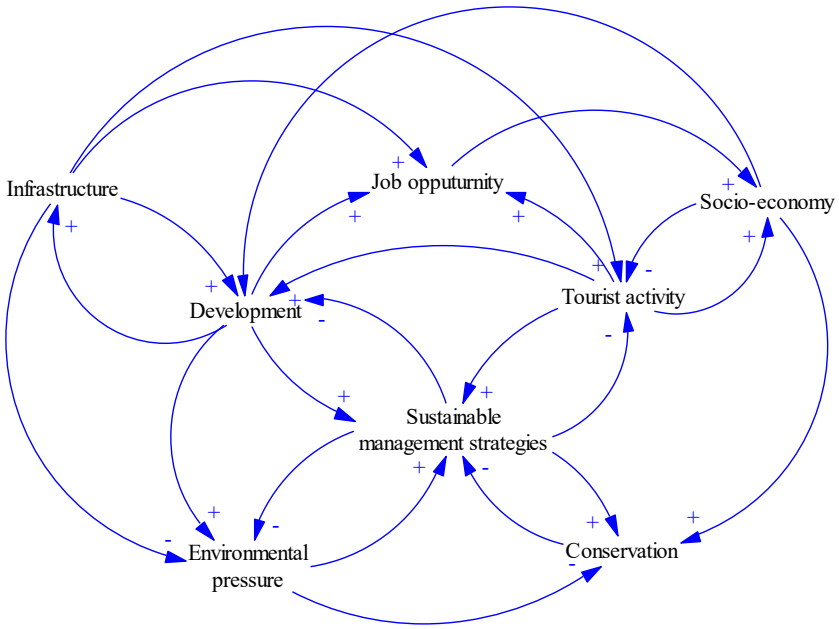

Figure 4. The causal loop diagram of the SMEc-SD model.

Figure 4 displays a causal loop diagram of the SMEc-SD model encompassed with the central node of sustainable management strategies, which ends with environmental pressure and tourist activities. Besides, the positive and negative feedback loops explain the three subsystems of the dimension as the impacts of sustainable ecotourism towards social, economy, and biodiversity aspects in Tasik Kenyir. The negative-feedback-loop describes the increment in tourist activities, which could potentially decrease the quality of nature at the Tasik Kenyir area. Consequently, the declining quality of nature should suppress activities related to tourism. Meanwhile, the central node—referring to sustainable management strategies—is linked with all the key elements found in the system and generates several loops. These loops would mitigate the negative human impact upon the ecosystem and move the state of the system towards sustainability.

Development of System Dynamic Model

Figure 4 presents all the factors that were investigated in this research, which were transformed into stock and flow diagrams (Figure 5) by using the Vensim software program in developing the SD model of "Sustainable Management of Ecotourism—System Dynamics" (SMEc-SD). The development of the SD model includes several types of variables, including stocks, flows, converters, and connectors. Moreover, this SMEc-SD model contains three main impacts upon social, economic, and biodiversity aspects.

Stock (also known as "levels") functions as a reservoir that accumulates quantities (represented by a rectangle in Figure 5) and describes the condition of the system. The increase (inflow) and the decrease (outflow) of the flows are known as rates (represented by a valve symbol). The condition of stock relies on the rates, whereas the rates are affected by the factor that affects inflow or outflow, better known as converter or auxiliaries (represented by circles in the diagram). Lastly, the connectors represent cause-and-effect links within the model structure and are represented by a single-line arrow (Lola et al., 2016).

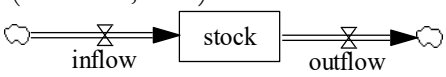

Figure 5. Basic Stock-Flow Diagram For System Dynamic (SD).

The stock-flow diagram reflects the core of the SMEc-SD model, and it is also the processes of quantization and materialization of the causal loop diagram by using the Vensim software program. Moreover, based on the stock-flow diagram illustrated in Figure 5, the related mathematical equation in the mathematical model of system dynamics is presented in Equation 1:

$$\frac{dx}{dt} = x = netflow = inflow - outflow \tag{1}$$

From Equation 1, x is denoted as a Stock, and $\frac{dx}{dt}$ derives from $\frac{\Delta x}{\Delta t}$, where Δx is a change in x and Δt is a change in t (Coyle, 1996 Sterman, 2001). In this study, the differential equations were developed by the stock flow diagram, in which the whole ecotourism system had been investigated quantitatively and dynamically by using the Vensim software program format, as exemplified in Figure 6.

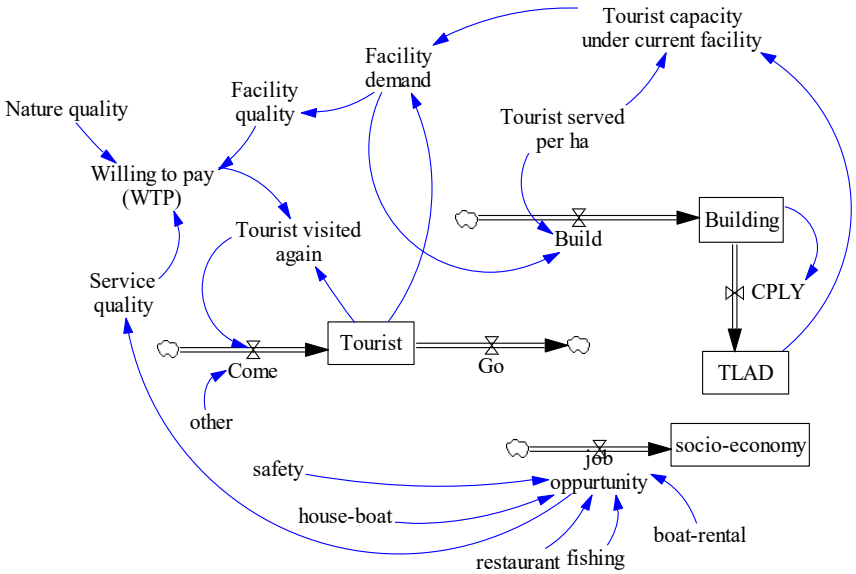

Figure 6. Stock-flow diagram for ecotourism in Tasik Kenyir. CPLY: monthly land area finishing construction; TLAD: total land development area.

Figure 6 demonstrates the stock-flow diagram of the socio-economic subsystem, which denotes the critical socio-economic factor interactions (e.g., tourist activities and land development). Furthermore, the aspect of willingness to pay (WTP) determined whether tourists would revisit, and thus serves as a bridge that connects the key factors in all subsystems. Besides, the WTP was examined by using contingent valuation to portray object marginal valuation under study, depending on both present and expected utilization patterns. In addition, the WTP aspect represents the degree of attraction among tourists, which could be associated to tourist population (Coyle, 1996). Moreover, the variable WTP links two key elements in the system: (i) the land area under construction, and (ii) the accumulated number of tourists, each represented by stock variables BUILDING and TOURIST, respectively. With that, the WTP model was developed based on tourist travel experiences using several key parameters, for example, facility quality (FQ), nature quality (NQ), and service quality (SQ), as given in Equation 2 (Kirkwood, 1998).

$$WTP = SQ \times NQ \times FQ \quad (1)$$

FQ is influenced by facility demand (FD), which is the deviation of TOURIST and tourist capacity under the present facilities (F_TC), where tourist capacity is sustained by the present facilities. F_TC can be determined by multiplying constant tourist number served per hectare (ha) (A_COTS) by the total land development area (TLAD), as portrayed in Equation 3.

$$F\_TC = A\_COTS \times TLAD \quad (2)$$

Other than that, the stock variable TLAD accumulates the land area under construction from the stock variable BUILDING, and thus, the association between WTP and BUILDING could be determined. Furthermore, BUILDING varies depending on two flow rate variables: (i) monthly land area under construction (BUILD), and (ii) monthly land area finishing construction (CPLY).

Additionally, WTP is also linked to the number of tourists visited again (NTVA). A higher value of WTP reflects a high potential of revisit among tourists' due to good traveling experiences. Besides, the socio-economic subsystem displays strong connections with both environmental and ecological subsystems in order to address the integration issue, as required by the intricate problem faced in managing sustainable ecotourism.

RESULTS

Ecotourism could face failure due to ineffective management (Muhammad Safiih et al., 2016). This is because the management of subsystems enables users to perform scenario analysis in which system variables and managerial planning relations are adjusted based on designated strategies. Therefore, decision makers can in this way evaluate diverse strategies and provide strong decision support functionalities. In fact, four major management strategies have been outlined, which are i) cover land development, ii) protected area, iii) entrance fees, and iv) wastewater treatment. Land development limitation could overcome the threat of reducing species and the loss of habitats at Tasik Kenyir. Furthermore, it is significant to ascertain the quality of the available natural experiences, especially at protected areas.

The Willing to Pay (WTP) Evaluation

Figure 7 illustrates the simulation results of willingness to pay (WTP) among tourists who visited Tasik Kenyir. From the findings obtained, the aspect of WTP proved that the number of tourists who were willing to pay for sustainability at Tasik Kenyir had increased. As WTP functions as the bridge that connects the key factors in all subsystems, it may also affect other parameter(s) (Hassan, 2008). Besides, Figure 7 vividly portrays that the escalation in WTP hiked the number of tourists. Therefore, to make Tasik Kenyir a more sustainable destination than it is now, increment in WTP should be able to rejuvenate the qualities of nature, services, and facilities. Subsequently, the flourishing quality for nature should enhance the tourism-related activities in Tasik Kenyir.

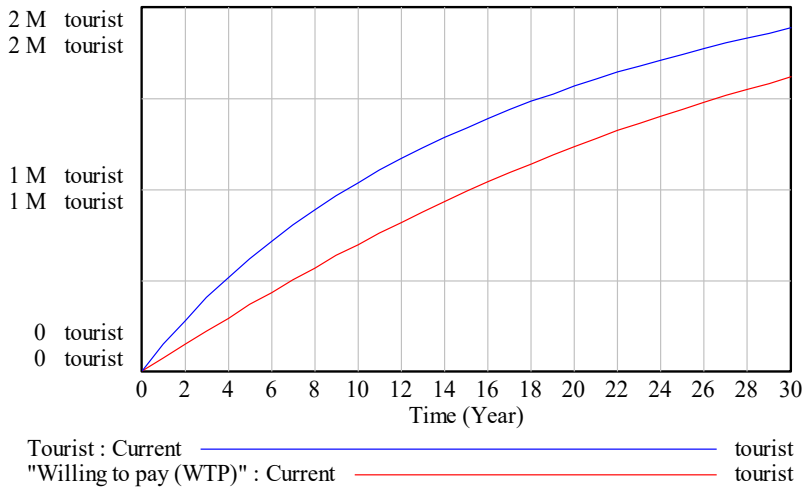

Figure 7. The willingness to pay (WTP) in Tasik Kenyir.

Tourist Capacity

The value of tourist capacity under current facilities (F_TC) was found to increase rapidly (Figure 8). This reflects that as the total land development area increases, the number of tourists served per hectare is deemed to increase as well. For instance, as a water theme park, Kenyir is indeed fully developed, and thus could be the reason

behind the increment in tourist capacity. Initially, Tasik Kenyir is given more focus on the nature experience for nature lovers, who are mostly adults. Moreover, most of them did not bring their children, as the adventurous activities promoted by Tasik Kenyir are suitable for adults only. Nonetheless, tourists can bring their children to Tasik Kenyir at present times because activities suitable for children have been made available. This increased the number of tourists visiting Tasik Kenyir.

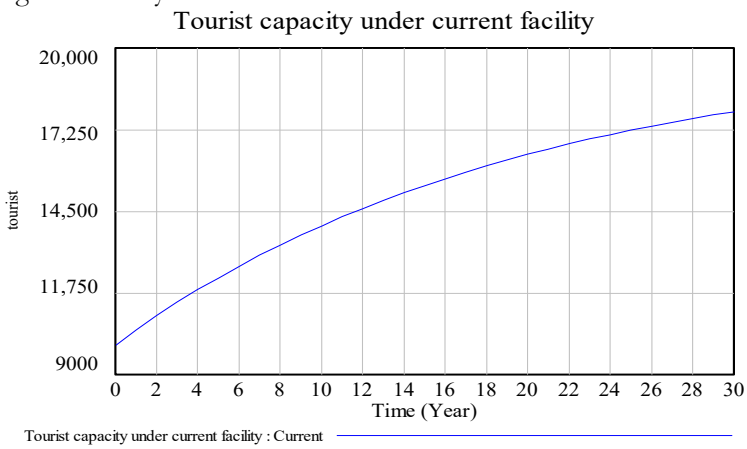

Figure 8. The value of tourist capacity under current facilities (F_TC).

Socio-Economy

As tourism activities have become more popular in Tasik Kenyir, the number of tourists visiting Tasik Kenyir has increased. In other words, the local residence (direct or indirect) will get the benefit from the tourism activities, and it will increase the ecotourism industry as well. The simulation results in Figure 9 demonstrate the socio-economic conditions of the locals have improved with the increment in tourism activities. The net benefit of tourism is indeed occurring to the locale community. The tourism activities offer plenty of job opportunities among the local residence. For instance, they can work in forestry, hospitality, restaurants, houseboats, security, and as tourist guides. Hence, ecotourism in Tasik Kenyir have a positive impact upon the local community.

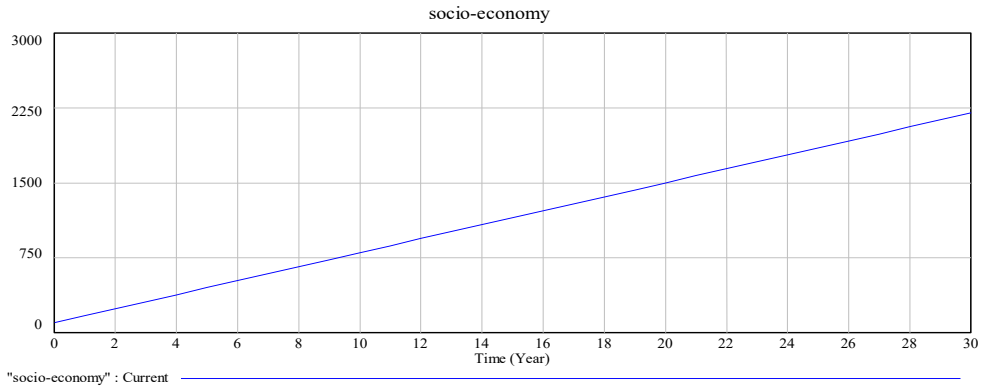

Figure 9. Socio-economy in Tasik Kenyir.

DISCUSSION

Improvement Policy Using SMEc-SD

The SMEc-SD has allowed users to evaluate the performance exerted by a system based on the future trends of the corresponding simulation for the next 30 years. Nevertheless, this study has considered only human-induced disturbances, which could pose a threat to the quality of nature, thus affecting the tourism industry in Kenyir. The critical parameters related to managerial strategies in this current study have been identified as land development and entrance fee collection. The first exemplifies the status of stock variable in socio-economic and ecological subsystems, inclusive of the number of tourists past 30 years (TOURIST), and land development pressure, mainly from construction (BUILDING).

Model Structure Assessment Test (Zero Action)

In addition, Figure 10 presents the proposed SMEc-SD model, which is not meant for quantification, but to demonstrate an intricate system and display a reasonable long-term trend. In this case, the zero action scenarios were configured to determine whether the simulated results did preserve ecological system relations. Moreover, zero action dismisses any additional management strategy (Chang et al., 2008). As a result, the simulation shows that the number of tourists is expected to rise steadily over time until it reaches a peak. Even if the simulation reflects an increment in the number of tourists, the quality of nature could be jeopardized. Besides, the main reason for tourists to visit Kenyir may not be due to the nature quality anymore, but largely due to other factors—for instance, water theme park and duty-free shopping at Kenyir, which are being developed.

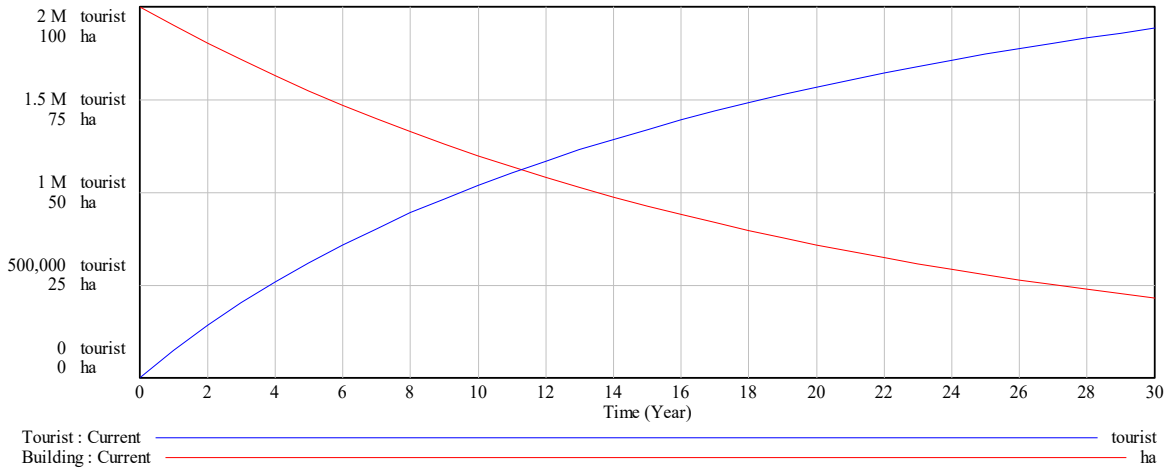

Figure 10. System performances under "zero-action" scenario.

Improvement Policy for Ecotourism under "No Construction" Scenario

Land development has emerged as the primary cause for the deterioration of water quality, which could further cause soil erosion and runoff (Browne & O'Regan, 2010). Therefore, to retain the main attraction of Tasik Kenyir, which is Mother Nature, this paper suggests banning all land development at Tasik Kenyir. This continuous land development may badly affect the quality of nature in Kenyir (e.g., the quality of its water). Moreover, simulation without any construction showed that the number of tourists is forecasted to increase rapidly for the next 30 years. On top of that, the results of the simulation depicted in Figure 11 vividly show that the main attraction among tourists visiting Tasik Kenyir is the nature itself. Without construction, tourists would be able to embrace the beautiful nature scenery with a variety of flora and fauna species found at the picturesque Tasik Kenyir. Without further development, Tasik Kenyir would remain a great attraction among nature enthusiasts. In fact, these findings agree with those obtained in a prior report (Chang et al., 2008), in which nil construction could improve coral reef coverage, as well as the number of tourists visiting the Kenting Coastal zone located at Taiwan. Unfortunately, as the number of tourists increased, the aquatic environment began to degrade. Therefore, Tasik Kenyir stakeholders should encourage a greater ethical environmental standard of behavior for tourists (Novotny, 2003). As the time increases, the number of tourists increases accordingly until it reach to the maximum point of the carrying capacity in Kenyir.

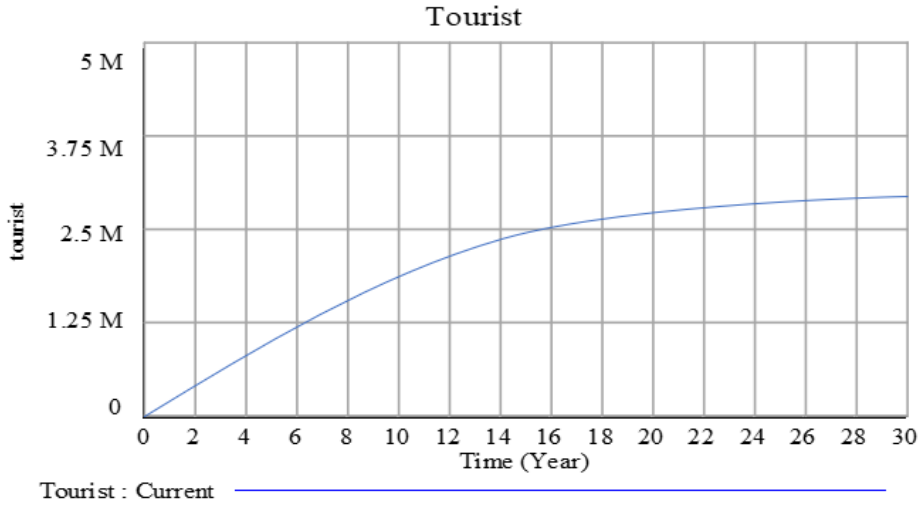

Figure 11. System performances under "no construction" scenario.

The results retrieved from this study highlight the role of tourists, which is significant to address the challenge of sustainability. Besides, sustainable tourism should also maintain a high level of tourist satisfaction, ascertain a meaningful experience among tourists, raise awareness concerning sustainability issues, and promote sustainable tourism practices among them (World Travel Organization, 2004). Besides, to develop and manage the ecotourism industry successfully within the country, the consideration of economic impacts must be understood. Moreover, the notion of sustainable ecotourism could attain achievement if economic, environmental, social, and cultural impacts are weighed together (Ross, 2002). Other than that, the results obtained from this study corroborate with those advocated by recent literature. Moreover, regarding WTP analysis, research conducted in Andalusia, Spain pointed out that the tourist segment with high levels of "sustainable intelligence" exerted willingness to pay more to visit a more sustainable tourism destination (Pulido-Fernández, 2016). Meanwhile, a study that investigated Gunung Gede Pangrango National Park located at West Java, Indonesia found that in order to sustain the benefits derived from the resources at the park, the visitors agreed that various organizations involved must cooperate to both conserve and protect the resources of ecotourism. Additionally, the results indicate that income, gender, and residence emerged as significant factors that influenced the aspect of WTP among tourists (Nuva et al., 2009).

CONCLUSIONS

System Dynamics has been proven to be an effective and useful method in analyzing complex systems, as well as integrating the related subsystems and parts into a whole, which could then be simulated to develop insights into its dynamic behavior. As such, this paper presents an SD-based model to implement the concept of sustainable ecotourism management at Kenyir. Therefore, an SD model entitled "SMEc-SD" had been built and applied to simulate and analyze the ecotourism system case. Based on the simulation results, the potential risk, as well as the positive and negative effects of the system, have been successfully identified. Finally, the policies related to the system enhancement should suggest risk elimination, as well as the expansion of both ecological and economic positive effects. Other than that, the positive WTP marks a good indicator to conduct and to exercise promotion for both ecotourism and the total economic value of greater Tasik Kenyir, as well as its surrounding area.

Postscript: Since the emergence of the coronavirus SARS-COVID-2 in Wuhan, Malaysia had imposed partial lockdown by movement control order from the 18 March 2020 to 12 May 2020. The travel, hospitality, and tourism industries are the most affected with zero tourist arrival. Some foreign tourists were caught unaware of the situation and stranded in national parks and off-coast island resorts. However, the government had injected RM260 billion (USD59 billion) to assist her citizens, private industries as well as tourist guides who are out of job for several months.

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