MODELLING OF THE IMPACT OF NATIONAL STRATEGIC TOURISM DESTINATIONS ON THE GROWTH OF THE TOURISM IN INDONESIA

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Abstract- Indonesia as the biggest archipelago country has great potensial in tourism. However, the number of tourists who visit Indonesia is still lower than the number of the tourists in Singapore. Now, Indonesian government has a plan to develop National Strategic Tourism destinations to increase number of tourists. A mathematical model of tourism to study the impact of developing the National Strategic Tourism destinations is contructed using the system of differential equation. The variables defined in this model are the number of tourists, rooms, and National Strategic Tourism destinations. In the absence of dissatisfaction effect due to the growing crowd of tourists, the results show eight equilibrium poinsts of the system. But only one stable positive real equlibrium point. Our analysis and simulation results show that maximazing number of tourists who visit National Strategic Areas will quicken the growth of tourists in Indonesia.

Keywords- Indonesia, Tourism, National Strategic Tourism destinations, System of Differential Equation

I. INTRODUCTION

Indonesia, the biggest archipelago country in the world, consists of more than 13.000 islands,which habitant over 215 million people and 200 ethnics [1]. Indonesia is a country with mega biodiversity after Brazil and has many natural resources, either renewable or nonrenewable natural resources [2]. All of advantages, that Indonesia has, could be a potential and be used to accelerate the economic growth. Now, Indonesia has the Masterplan for Acceleration and Expansion of Indonesia's Economic Development in 2011 – 2025. The focus of development is divided into eight main programs, consisting twenty two economic activities. The eight main programs are agriculture, mining, energy, marine, tourism, telecommunication, and developing the strategic areas [2]. Tourism becomes one of the sector to accelerate Indonesia's economic growth. Tourism is the sector that gives contribution to goverment incomes after oil and gas, coal mining, and palm oil sectors [3]. In the future, tourism is expected to be the first sector for giving the biggest contribution in Indonesia's income. Since 2011, in order to develop tourism in Indonesia, the goverment plan to develop new 88(eighty eight) National Strategic Tourism destinations or Special Economic Zones for Tourism [4]. Eventually, one hundred National Strategic Tourism destinations are expected to be realized in the near future [5]. But, tourist attraction in Indonesia is still below neighboring countries, such as Singapore, who hasbeen visited by more than eleven million tourists in 2013 [6]. With all of advantages owned by Indonesia, Indonesia has potential to further develop tourism sector.

A mathematical model to study the impact of developing the National Strategic Tourism destinations on the number of tourists and rooms is discussed in this paper. Mathematical model is one of the best way to explain the dynamics of tourism. By using mathematical model, we can study from the phenomenon even with limited data. Hence, the model is expressed as a system of ordinary differential equations. In second section, mathematical model will be described. Third section explains analysis of the model, fourth section shows numerical simulation, and last section will be discussion of the results.

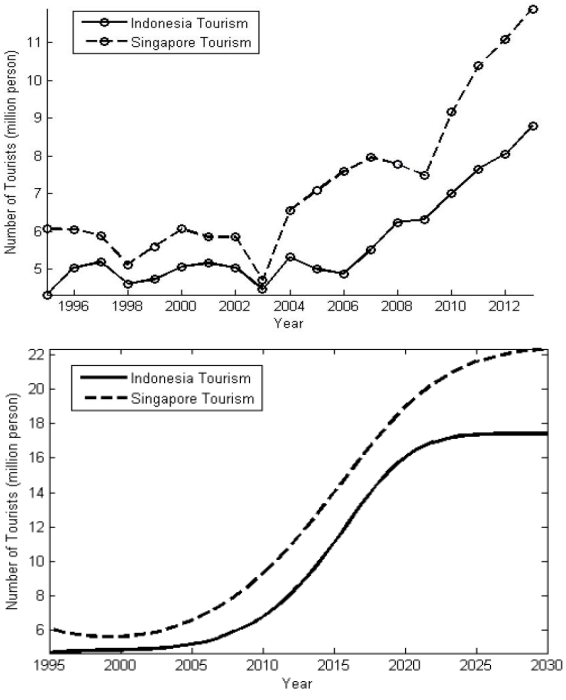

Fig 1. Indonesia and Singapore Tourism

II. MATHEMATICAL MODEL

Now, Indonesian government puts an action the Masterplan for Acceleration and Expansion Economic Development in 2011 – 2025. One of its

programs is developing tourism in Indonesia. Indonesia tourism is still behind Singapore. We can see a comparison of the number of Indonesia tourist and Singapore tourist in upper Fig 1. Using the least square method, we predict the functions of number of tourists in both countries using Pearl and Reeds equation [6] according to the number of tourists data since 1995 until 2013 from World Bank [7]. The equations of number of tourists of Indonesia and Singapore are respectively written as $I(t)$ and $S(t)$. We show the graphs in lower Fig 1.

$$I(t) = \frac{17.4134616}{1 + 2.7157\exp(-0.0254473t + 0.0048532t^2 - 0.0003739t^3)}$$

$$S(t) = \frac{22.4796329}{1 + 2.6739\exp(0.054t - 0.0064113t^2 - (4\times10^{-7})t^3)}$$

From Fig 1, we can see the number of tourists that visit Indonesia is way below Singapore. Hopefully, developing Indonesia tourism through National Strategic Tourism destinations could increase the number of tourists up to equal or greater than Singapore. To study the impact of the development ofNational Strategic Tourism destinations , we also consider the number of hotel rooms occupied for tourists.

Let $x(t)$ represents the number of National Strategic Tourism (NST) destinations at time t (year), $y(t)$ represents the number of tourists at time t (year), and $z(t)$ represents the number of hotel rooms at time t (year). To develop the mathematical model, we consider the following assumptions :

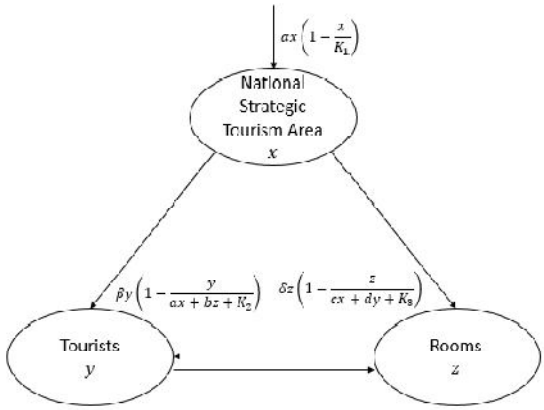

Fig 2. Compartment Diagram

1. The model of the number of tourists is considered as logistic model in accordance with [8]. Then, increasing of the number of NST destinations and the number of rooms will increase the number of carrying capacity of tourists.
2. The model of hotel rooms is considered as logistic model in accordance with [9]. The development of NST destinations and increasing of the number of tourists could increase the number of carrying capacity of rooms.
3. The NST destinations that discussed in this paper are only 88 areas according to Indonesian government target. When the 88th NSTA has been built, no new NST destinations will be built. The logistic model is chosen to represent the NST destinations growth.
4. Decreasing factors like natural disasters or riot are assumably not significant and could be ignored.

Based on the assumptions above, the relation between number of tourists, rooms, and NST destinations can be depicted as in Fig 2.

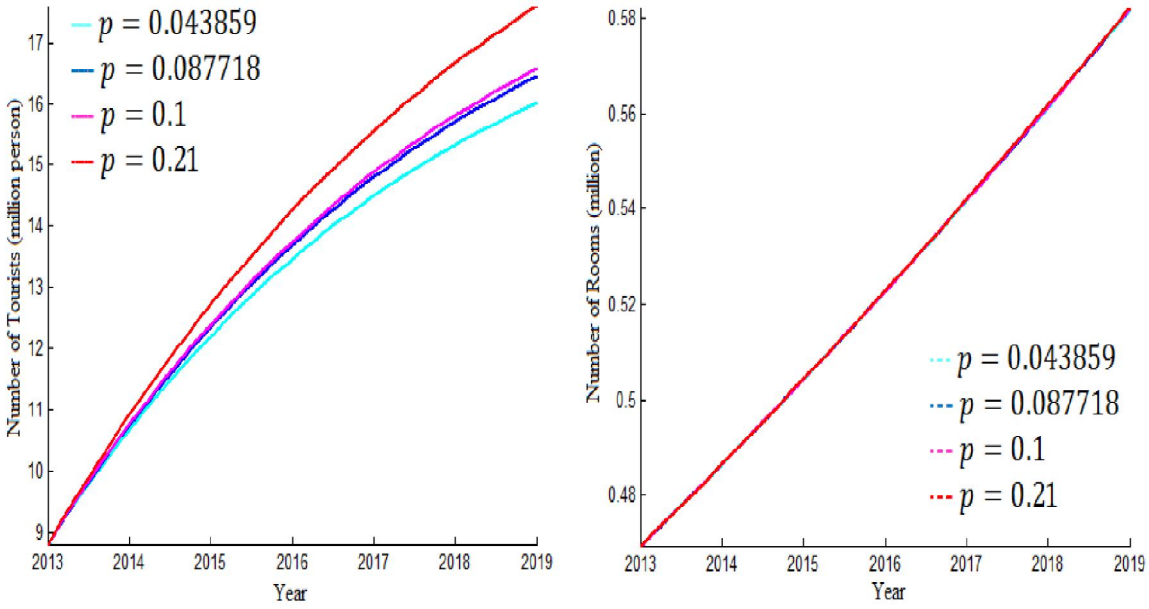

Fig 3. Number of Tourists and Rooms with $\alpha = 0.036364$

Table 1 Parameters Description

Parameters	Description	Baseline Value	Range Value	Dimension
β	Tourists growth rate	0.246765	(0,1)	1 per year
a	Tourists growth rate because of National Strategic Tourism Areas attraction	0.043859	[0,1]	million person per area
b	Tourists growth rate because of rooms attraction	0.043859	[0,1]	million person per room
c	Rooms growth rate because of National Strategic Tourism Areas attraction	0.04544802	[0.01435276 , 0.08019245]	million room per area
d	Rooms growth rate because of the number of tourists	0.04236246331	[0.01435276 , 0.08019245]	room per person
δ	Rooms growth rate	0.04544802	[0.01435276 , 0.08019245]	1 per year
α	National Strategic Tourism Areas growth rate	0.036364	[0.036364 , 0.060606]	1 per year
K_2	Number of tourists carrying capacity	17.5	-	million person
K_3	Number of rooms carrying capacity	1.123543	-	million room
K_1	Number of National Strategic Tourism Areas carrying capacity	88	-	area
γ	Dissatisfaction factor	-	[0,1]	1 per year

The model can be written as

$$\frac{dx}{dt} = \alpha x(1 \quad \frac{x}{K_1})$$

$$\frac{dy}{dt} = \beta y(1 - \frac{y}{ax + bz + K_2}) \qquad (1)$$

$$\frac{dz}{dt} = \delta z(1 - \frac{z}{cx + dy + K_3})$$

The description of all parameters are given in Table 1. We assume all parameters are non-negative. We state the starting point is year 2013.The parameters β and $K_2$are estimated from equation $I(t)$. Value of β is chosen from $\beta(t) = 0.0254473 - 0.0097064t + 0.0011217t^2$ at $t = 19$ (year 2013) and value of K_2 is chosen to be 17.5.Tourists growth in Indonesia is calculated according to tourists data 1995 – 2013 [7].Baseline value of a is assumed to be the average of tourists' growth. Because there are no data and study on the relationship between tourists and rooms attraction, value of b is assumed to be as same as a. Due to the current number of NST destinations, linear regression between the numbers of tourists and rooms is calculated to estimate the baseline value of d,which is determined as the gradientof the linearequation from this regression.

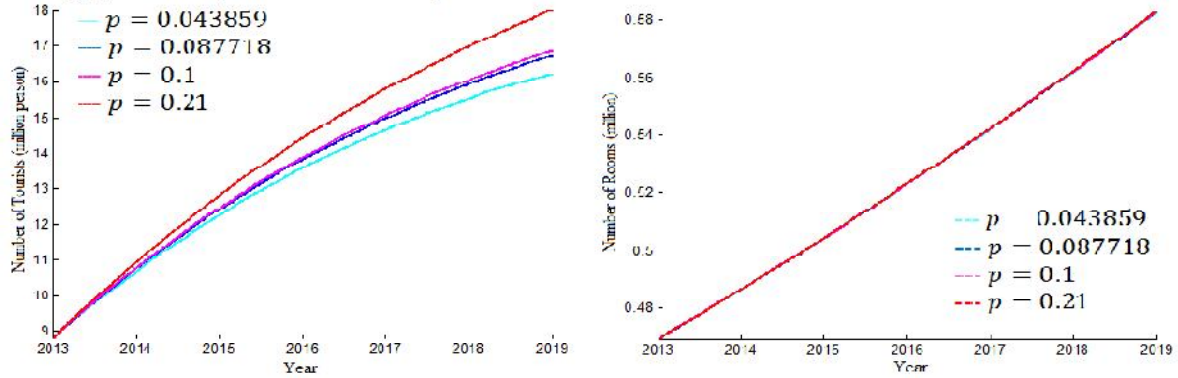

Fig 4. Number of Tourists and Rooms with = 0.060606

The numbers of tourists and rooms data 2000 – 2013 are used for this linear regression. Using Pearl and Reeds equation and least squares method, we calculate the value of K_3. The δ is assumed to be the average of the rooms number's growth. Rooms

number's growth is calculated according to data from from 2000 to 2013. Because there are no data and study on the relationship between rooms number's growth and NST destinations, value of c is assumed to be as same as δ. Baseline value of α is assumed for five years, 16 of 88 NST destinations will be developed. Value of K_1 is target number of National Strategic Tourism destinations that will be built by Indonesian goverment [5], which is 88.The data of the number of rooms are taken from Badan Pusat Statistik [10 – 12].

III. MATHEMATICAL ANALYSIS

In the case of the absence of dissatisfaction effect due to the growing crowd of tourists we have eight different equilibrium points :

$$x^* = 0, y^* = 0, z^* = 0 \quad (2)$$

$$x^* = 0, y^* = 0, z^* = K_3 \quad (3)$$

$$x^* = 0, y^* = K_2, z^* = 0 \quad (4)$$

$$x^* = 0, y^* = \frac{bK_3 + K_2}{1 - bd}, z^* = \frac{dK_2 + K_3}{1 - bd} \quad (5)$$

$$x^* = K_1, y^* = 0, z^* = 0 \quad (6)$$

$$x^* = K_1, y^* = 0, z^* = cK_1 + K_3 \quad (7)$$

$$x^* = K_1, y^* = aK_1 + K_2, z^* = 0 \quad (8)$$

$$x^* = K_1, y^* = \frac{(a + bc)K_1 + bK_3 + K_2}{1 - bd}, \quad z^* = \frac{(ad + c)K_1 + dK_2 + K_3}{1 - bd} \quad (9)$$

Equilibrium point (2) is a condition when there are no tourists, rooms, and developed National Strategic Tourism destinations.Equilibrium point (3) is a condition as same as (2) but the number of rooms are still increasing until it reaches its carrying capacity.Equilibrium point (4) is a condition as same as (2) but the number of tourists are still increasing until it reaches its carrying capacity.Equilibrium point (5) is a condition when the number of tourists and rooms are increasing not because the impact of developed NST destinations.Equilibrium point (6) is a condition when developed NST destinations reach its target but give negative impact and cause no tourists and rooms.Equilibrium point (7) is a condition when there are no tourists but the NST destinations and rooms are developed until they reach their carrying capacity.

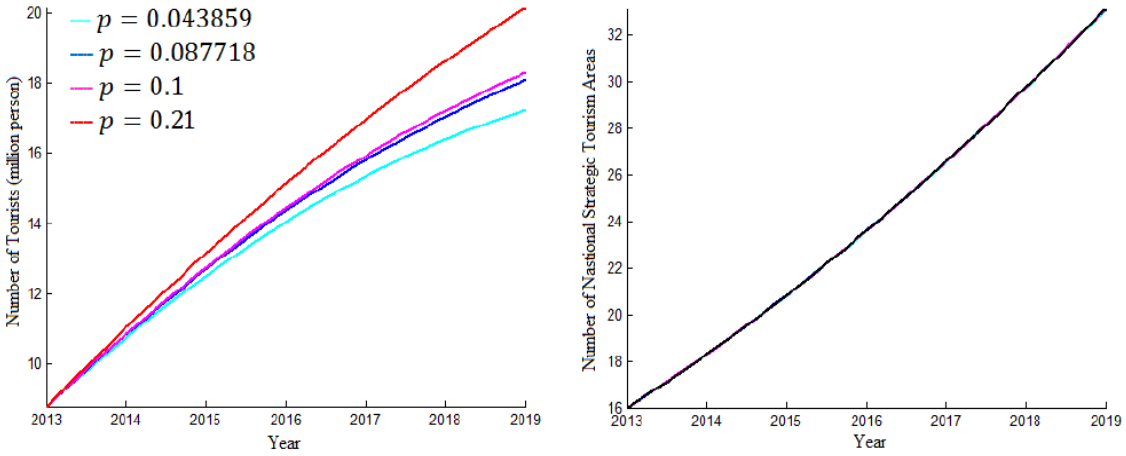

Fig 5. Number of Tourists and National Strategic Tourism destinations with □ = 1/6

Equilibrium point (8) is a condition when developed NST destinations reach its target and the number of tourists increases but no rooms are built. Equilibrium point (9) is a condition when the developed NST destinations give a positive impact on tourists and rooms and cause increasing in the number of tourists and rooms.

In order to check stability for each equilibrium, we find eigen values from Jacobian matrix for each equilibrium. We find that for (2) – (8), there always exist positive eigen values. Hence, (2) – (8) will not stable for every given non-negative parameters. Equilibrium point (9) always stable because it gives negative eigen values for every non-negative parameters. Existence condition for (5) and (9) is bd < 1.

IV. NUMERICAL RESULTS

In this section, we simulate the dynamic of the model (1) with several variations of parameters. Fig 3 and Fig 4 show the number of tourists and rooms from different α. It can be seen both from the figure, the larger value of a will increase the number of tourists but not affects the number of rooms. The larger value of α will increase the number of tourists. By the end of 2019, increasing of parameter a by 100% from its

baseline value will increase the number of tourists by 2.7% – 3.09%. Increasing of parameter a by 128% will increase the number of tourists by 3.5% - 3.9%. Increasing parameter a by 378% will increase the number of tourists by 9.9% - 11%. Increasing parameter α by 66.67% will increase the number of tourists by 1.45% - 2.42%.

Due to the increment of the number of new NST destinations and rooms, the number of tourists may exceed the initial carrying capacity (K_2). Furthermore, the large number of tourists makes crowds in the tourist destination and causes a decrease in the number of tourists in the future [13]. Therefore, we modify equation (1) for the number of tourists considering the dissatisfaction factor.

The equation is written as

$$\frac{dy}{dt} = \beta y\left(1 - \frac{y}{ax + bz + K_2}\right) - \gamma(y - K_2)$$

In Fig 7 we simulate the impact of dissatisfaction factor due to crowds in the tourism destinations. The large value of γ (dissatisfaction factor) causes decreased the number of tourists.

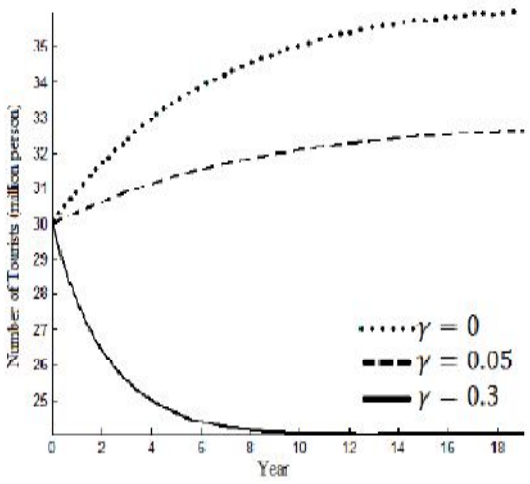

Fig 7. Number of Tourists Because of Dissatisfaction Factor (γ)

V. DISCUSSIONS

We have shown a mathematical model for tourism, between number of tourists, rooms, and National Strategic Tourism destinations. The simulations show the growth of number of tourists and rooms for six years (since 2013 until 2019). Due to Indonesian's government target which is by the end of 2019, 20 million tourists will visit Indonesia. Indonesian government should have a target numbers for tourists that will visit Indonesia, especially the NST destinations. From Fig 5, we suggest the government should build minimum thirty three NST destinations and target 210 thousand tourists will visit the NST destinations each year. If this condition is satisfied, 20 million tourists will be reached. Larger number of tourists who visit the thirty three NST destinations (or larger value of a), less time is needed to reach 20 million tourists.

In the beginning, we have shown predicted number of tourists who visit Indonesia is below Singapore. But, from the simulation between number of tourists and NST destinations in Fig 6, we get number of tourists who visit Indonesia can exceed number of tourists who visit Singapore in the end of 2022. To achieve this number of tourists, Indonesian government should build twenty four NST destinations and target 210 thousand tourists will visit NST destinations each year.

From this model, we could see the potential of NST destinations. Now, the NST destinations is still in development. When the NST destinations are ready, Indonesian government must arranges a strategy to campaign the NST destinations and achieve its annual target of tourists who visit the NST destinations. The increment of the number of tourists may cause crowds in the tourist destinations in the future. The government needs to pay attention to this situation that possibly occur in the future.

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