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RESEARCH ARTICLE

New tourism product forecasting – application of Bass diffusion model and Grey Forecasting Model

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ABSTRACT - Previous researchers usually applied Bass diffusion model (BDM) in forecasting the new product in various areas. This is the first application of BDM to the new tourism product since the model had been developed by Frank M. Bass in 1969. On the other hand, Grey forecasting model able to deal with a limited number of data. Both BDM and grey forecasting model have been used in various areas in the forecasting studies. Taking advantage of both models, the combination of both Bass and grey model, called grey Bass forecasting model is applied in the context of the new tourism product forecasting. The objective of this study is to forecast the new tourism product demand in Malaysia using the developed model. Yearly visitors from two ecotourism resorts in Pahang, Tanah Aina Fahad and Tanah Aina Farrah Soraya from 2014 until 2018 are used. The results show that both BDM and grey Bass forecasting models are suitable in forecasting the new tourism product. The authors also suggest other factors affecting the attendance of visitors to be included in further research to conclude which model performs better in the future.

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1. INTRODUCTION

Forecasting has been an important part in many sectors; not only to predict the future but also for the practitioners to have better planning and attention for upcoming challenges. Athiyaman and Robertson [1] stated that inaccurate forecasts are considerable but accurate ones give an important advantage. Forecasting of new products is popular especially in business sectors as this is the only technique to foresee the future events [2]. Crawford and Benedetto [3] stated that new products are classified into six categories, new-to-the-world, new-to-the-firm, product improvements, additions to current product, repositioning and cost reductions. In the tourism context, a new tourism product can be defined as new facilities and services that are designed for the satisfaction of the visitors. However, a solid product always has a buyer as long as it satisfies the demand. Meanwhile for tourism products, past visitors have a higher probability to not repeat visiting the same place and the customers are changing, then, results in the falling number of visitors to the place. The example of tourism products are natural and geographical attractions such as beaches, highlands, theme parks, shopping malls, museums, and religious or historical buildings. Besides, tourism accommodation such as hotels, resorts and homestays are considered as tourism products and they play important parts in fulfilling the needs of tourists while traveling. Tourism industry involves large investments and supply for infrastructure, equipment and workers. Hence, this is the reason for every country to focus on the tourism industry because not only it has large investments but it gives higher returns to the country's economy if it is managed properly.

1.1 Background

This section presents the literature review about tourism demand forecasting and the application of BDM and grey Bass forecasting model. Most of the literature of tourism demand concentrates on the tourist arrivals into the country or region. This is supported by the review studies from Song and Li [4] and Jiao and Chen [5] where most studies involving tourism demand forecasting use tourist arrivals as a dependent variable even though a decade has passed. For example, Hamzah et al. [6] forecasted tourism demand of Malaysia using Box-Jenkins approach using monthly data from 1998 until 2017. Yang and Zhang [7] applied a spatial-temporal forecasting model for inbound visitors to China. Seasonal tourism demand forecast was studied by Chen et al. [8] by adopting quarterly inbound tourists to Hong Kong.

Based on the literatures, instead of viewing tourism demand at a broad perspective as tourist arrivals, researchers should focus on visitors at a specific tourist attraction. This indirectly helps the management for a better planning at the specific place and affects in boosting the attendance of tourists to the country as a whole.

Bass diffusion model (BDM) had been developed by Frank M. Bass and is usually associated with the forecasting of the new product [9]. Diffusion process measures the level of spread of an innovation among a given set of prospective adopters [10] and Bass classified the theory of diffusion of the new product into two; innovators and imitators [11]. Innovators depend on their independent decision when choosing the product while imitators are influenced by word-of-

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mouth communications and observations of people in the society [12]. BDM had been popular model among researchers in forecasting new product and it had been applied to various areas such as telecommunications, medicine, automobile industry and stocks management [2,13,14,15]. Tourism application using this model is found in Hsiao et al. [16], where the authors focused on the effect to the number of visitors if a festival was held in a theme park. The result shows that the Coffee festival elevated the number of visitors to the theme park. Besides, Kunc [17] applied the same model to forecast wine tourism in Chile. Kunc stated that a lot of effort in infrastructure had been invested for wine tourism but no effect in the increment of number of wine tourists. The forecast finding showed that the number of domestic wine visitors to Chile may reach 200 000 people per year.

Another model, grey forecasting model, which is an outstanding model when working with the presence of limited data, is combined with BDM to produce a new model called grey Bass forecasting model. The data is defined as limited data when there is four to 30 data available. No data is defined when there is below than three data available [11]. Other than in tourism area, the literature that seems relevant to reflect the application of this model is in Abu and Ismail [18]. They forecast the sales of new automobile in Malaysia and are concerned about the limited data available. Results found that the proposed combination of both models performed better than the basic BDM.

The aim of this paper is to forecast new tourism product demand in Malaysia using the proposed model by taking advantages of both BDM and grey Bass forecasting model in forecasting the new product with limited presence of data. Since this is the first application of the proposed model in the tourism product context, this study will fill the gap in the literature by narrowing the subject of forecast which is the new tourism product instead of tourist arrivals to the country. Besides, this study will help the management end to expect the number of visitors in the future. If the forecast number of visitors decline in ten years, proper developments in terms of infrastructure improvements can be planned earlier.

1.2 Case study

Pahang is the largest state in Peninsular Malaysia. It is rich of its nature from islands, beaches to highlands and have plenty of tourism places to be offered to the tourists. The launching of tourism slogan using local slang “Hogoh Pahang” in 2017 reflected that Tourism Pahang had put an effort in attracting visitors to visit the state with its unique culture. This study focuses on ecotourism resort named Tanah Aina Glamping Resort. Tanah Aina, a resort which have 10 locations in Pahang, Johor and Selangor overall, which each of them carries its theme of holiday retreat in the nature. This study concentrates on two of the branches as the tourism product, Tanah Aina Fahad and Tanah Aina Farrah Soraya, which are located in Raub, Pahang. It can accommodate families or couples on holiday and for large group of visitors and it is perfect place for business trips and meetings. Yearly number of visitors to Tanah Aina Fahad and Tanah Aina Farrah Soraya are collected from 2014 until 2018 and analyzed using BDM and grey Bass forecasting model. Yearly data is used because this study will forecast the number of visitors to the new tourism product without considering other seasonality factors. In addition, since there are only five data available, these case studies are considered as limited data.

Next section points the methodology of BDM and grey Bass forecasting model and the analysis from the models, respectively. The last section concludes the study.

2. METHODOLOGY

2.1 Bass diffusion model (BDM)

Frank M. Bass assumed that the theory of diffusion of new products are classified into two: innovators and imitators. When new product is introduced to the market, the number of innovators decline as time passes due to low potential innovators. Meanwhile the number of imitators increase because of external influences. The formulation of the model is written as:

$$P(t) = p + \left(\frac{q}{m}\right) Y(t) \tag{1}$$

where $P(t)$ is the probability of purchase at time $t, Y(t)$ is the number of previous buyers, m is the total number of buyers, p is the coefficient of innovators and q is the coefficient of imitators. According to Bass, this formulation is according to the assumption and theory of “the probability that an initial purchase will be made at t given that no purchase has yet been made is a linear function of the number of previous buyers” [9]. After several algebraic process, (1) gives the number of purchasing at time t as:

$$S(t) = pm + (q - p)Y(t) - \frac{q}{m}[Y(t)]^2 \tag{2}$$

where $S(t)$ is the sales at time t and pm is the total number of buyers begin by innovators as when $t = 0, S(0) = pm$.

This study considers yearly data compared to the data with seasonality such as monthly or quarterly data due to this basic BDM might produce biased forecast when considering seasonal data [19]. The author in [19] also suggests considering the model with seasonality if seasonal data is used in the study.

2.2 Parameter estimation of BDM

The three parameters listed in BDM are p (innovators), q (imitators) and m (potential market). The diffusion of the product is considered successful if $p \leq q$ as the adopting curve will reach its peak points as shown in Figure 1. In the opposite case of $p > q$, no peak point will be reached. Hence, the sales will remain to grow. Bass [9] also mentioned that as the time increases, the number of adopters decreases as there is no new purchase if there is no development made. The parameters of *p, q* and *m* are identified using ordinary least square methods and the analogue is used as in the equation of $S(t) = a + bY(t-1) + cY(t-1)^2$, where $t = 2, 3, \ldots$ and $S(t)$ is the sales at time $t, Y(t-1)$ is the cumulative sales through period $t-1$. The parameters are estimated such that $a = pm, b = q - p$ and $c = -\frac{q}{m}$. Hence, $-mc = q, \frac{a}{m} = p$, and $b = q - p = -mc - \left(\frac{a}{m}\right)$. The author have that $cm^2 + bm + a = 0$, where m can be estimated using the formula of $\frac{-b \pm \sqrt{b^2 - 4ac}}{2c}$.

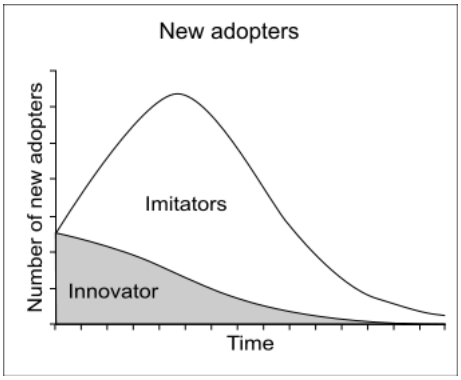

Figure 1. Growth of the number of new adopters

2.3 Grey Bass forecasting model

Grey model was introduced by Deng [20] in 1982 and it is popular of its ability in handling insufficient data. Then, Wang [21] proposed grey Bass forecasting model which has an advantage in terms of forecasting new product with limited data. The grey Bass forecasting model procedures are as follow:

The list of data is given by

$$x^{(0)} = \left(x^{(0)}(1), x^{(0)}(2), \ldots, x^{(0)}(n)\right) \tag{3}$$

Next, performing AGO as

$$x^{(1)}(k) = \sum_{i=1}^{k} \quad x^{(0)}(i), k = 1,2, \ldots, n \tag{4}$$

and average creating of blog accumulative number by using

$$z^{(1)}(k) = MEAN\left(x^{(1)}(k)\right) = 0.5\left(x^{(1)}(k) + x^{(1)}(k-1)\right) \tag{5}$$

Besides, Wang stated that the parameter of potential market, *m* is estimated manually by the researcher. Then, the authors will subtitute the same value of *m* from BDM in this model for a better comparison. Parameters p and q are defined using least square method as follows:

If $\hat{a} = [p, q]^T$ is a sequence of parameters, then,

$$\begin{aligned} B = \Bigg(& m - z^{(1)}(2)\, z^{(1)}(2)\left(1 - \frac{z^{(1)}(2)}{m}\right)\, m - z^{(1)}(3)\, z^{(1)}(3)\left(1 - \frac{z^{(1)}(3)}{m}\right) \vdots \\ & \vdots\ m - z^{(1)}(n)\, z^{(1)}(n)\left(1 - \frac{z^{(1)}(n)}{m}\right)\Bigg), Y = \left(x^{(0)}(2)\, x^{(0)}(3)\ \vdots\ x^{(0)}(n)\right) \end{aligned} \tag{6}$$

The least square estimates sequence of the grey Bass differential equation

$$x^{(0)}(k) = p\left(m - z^{(1)}(k)\right) + qz^{(1)}(k)\left(1 - \frac{z^{(1)}(k)}{m}\right) \tag{7}$$

Satisfies

$$\hat{a} = [B^T B]^{-1} B^T Y = [p, q]^T \tag{8}$$

3. RESULTS AND DISCUSSION

The parameters of BDM in both Tanah Aina Fahad and Tanah Aina Farrah Soraya are estimated using regression analysis. For Tanah Aina Fahad, the regression equation is given by $S(t) = 81 + 0.926Y(t) - 0.00016Y(t)^2$and the parameters $p, q,$ and m are estimated to be 0.0138, 0.9397 and 5891, respectively. The value of $p \leq q$ satisfies the prerequisite of the diffusion of the new product to be successful. Hence, these parameters are substituted into BDM equation to get forecast results of BDM. The same step is repeated using Tanah Aina Farrah Soraya, with regression equation of $S(t) = 781 + 0.867\,Y(t) - 0.000026Y(t)^2$. The parameters $p, q,$ and m are estimated as 0.0229, 0.8860 and 34076, respectively.

For grey Bass forecasting model, the parameter of potential market m is estimated using prediction of researchers [19]. Therefore, $m = 5891$ is chosen and $m = 34076$, the same values used in BDM because better comparison of which model perform the best in forecasting Tanah Aina Fahad and Tanah Aina Farrah Soraya resorts can be made. The values of p and q are estimated using ordinary least square method as explained before. For Tanah Aina Fahad, the values of $p = 0.1681$ and $q = 0.5397$. Besides, for Tanah Aina Farrah Soraya, p and q are estimated to be 0.1986 and 0.4406. In both new tourism products, the parameters $p \leq q$. Then, these values of parameters can be used and are substituted in (6) to get the forecasted values. The values of parameters estimated of Tanah Aina Fahad and Tanah Aina Farrah Soraya are listed in Table 1 and Table 2 respectively. The forecast results of BDM and grey Bass forecasting model together with the actual number of visitors are illustrated as shown in Figure 2 for Tanah Aina Fahad and Figure 3 for Tanah Aina Farrah Soraya.

Table 1. Parameters for BDM and grey Bass forecasting model for Tanah Aina Fahad

Model/Parameters	m	p	q
BDM	5891	0.0138	0.9397
Grey Bass forecasting model	5891	0.1681	0.5397

Table 2. Parameters for BDM and grey Bass forecasting model for Tanah Aina Farrah Soraya

Model/Parameters	m	p	q
BDM	34076	0.0229	0.8860
Grey Bass forecasting model	34076	0.1986	0.4406

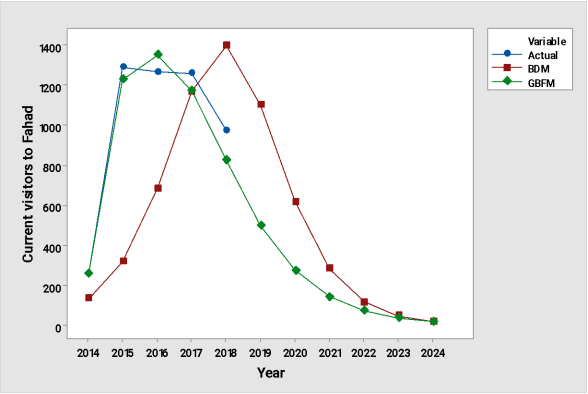

Figure 2. Actual and forecasted current visitors for Tanah Aina Fahad

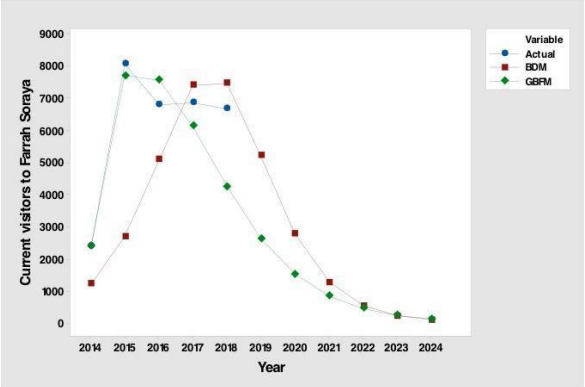

Figure 3. Actual and forecasted current visitors for Tanah Aina Farrah Soraya

Based on Figure 2, BDM forecasts lower number of visitors to Fahad in its early year of opening and the number increases gradually by year until 2018. The number of visitors reach the maximum in 2018 and start to decrease after four years of opening year. Unlike BDM, the number of visitors to Fahad from the forecast using grey Bass forecasting model elevated faster after a year. The forecast reaches maximum visitors in 2016 and the visitors start to decrease in 2017. This shows that the forecast follows the growth of the number of new adopters as shown in Figure 1.

For Tanah Aina Farrah Soraya, the same diffusion patttern of new adopters is expected for both models as shown in green and red line in Figure 3. Number of visitors forecasted using grey Bass forecasting model (green line) follows closely the actual value (blue line) except for in year 2018. The number of visitors for Tanah Aina Farrah Soraya reaches its peak in 2015 and starts to decline in 2016. From the management and planners viewpoint, the new development and advertisement are fundamental to attract visitors in the future based on the long-term forecast. However, negligence from management in taking action will results in the decreasing of the number of visitors. The performance of both models are compared using mean absolute percentage error (MAPE) in the next section.

3.1 Model comparison

This study uses mean absolute percentage error (MAPE) to measure the forecast accuracy and it is important in decision making of which model perform best in forecasting. The formula of MAPE [16] is given as

$$MAPE = \left(\frac{1}{n}\right)\left(\sum_{t=1}^{n} \left|\frac{A_t - F_t}{A_t}\right|\right) \times 100, A \neq 0 \tag{9}$$

where A is actual value and F is forecasted value. MAPE gives the value in terms of percentage. Hence, it is easier to make comparison between the two models as the higher value of percentage error shows that the model is lack of performance. The data of 2014 until 2017 is regarded as in-sample data and 2018 as out-sample data. The model with the lowest value of percentage for MAPE is considered as the best forecasting model.

Table 3. Comparison of MAPE for BDM and grey Bass forecasting model for Tanah Aina Fahad

Model	MAPE(%)	
	In-sample	Out-sample
BDM	44	44
GBFM	5	15

Table 4. Comparison of MAPE for BDM and grey Bass forecasting model for Tanah Aina Farrah Soraya

Model	MAPE(%)	
	In-sample	Out-sample
BDM	37	12
GBFM	7	36

Forecast accuracy results of MAPE for forecasting using both models are given in Table 3 and Table 4 for Tanah Aina and Tanah Aina Farrah Soraya, respectively. The result of forecast for Tanah Aina Fahad, MAPE shows a noticeable high value of MAPE for BDM compared to grey Bass forecasting model in Table 3. Out-of-sample's MAPE value for grey Bass forecasting model gives the value of 15% which is lower than out-sample value for BDM, 44%. From the MAPE value, grey Bass forecasting model has a better performance than BDM. However, for Tanah Aina Farrah Soraya, out-sample MAPE value for grey Bass forecasting model is higher than BDM, which means BDM performs better than grey Bass forecasting model for this case study. Based on Figure 2, the green line of forecasted value from grey Bass forecasting model shows it follows closely the actual values. The results from Table 3 and Figure 2 show that the proposed model of grey Bass forecasting model has an accurate forecast on the number of visitors to Tanah Aina Fahad Resort compared to classical BDM.

For the case of Tanah Aina Farrah Soraya, BDM shows a better performance compared to grey Bass forecasting model. With 36% of out-sample MAPE and 12% for BDM, the forecast has a better performance when using BDM compared to grey Bass forecasting model. The inconsistency in which model performed better than the other is probably affected by the values of the parameters, $m, p,$ and q. In this study, the three values in both models are estimated using the least square method in MATLAB software. Looking at the value of m, the estimated value is 5891 which is still acceptable when compared to the actual value of number of visitors ranging from 150 to 1400 for Tanah Aina Fahad. However, for the case of Tanah Aina Farrah Soraya, 34076 is a high estimate of potential market with the actual number of visitors which range between 1000 to 9000 people. While the argument of the choice of potential market affects the forecast might be true, this study uses only one method; ordinary least square estimation to estimate m. Besides, the objective of this study is to forecast the new tourism products. Therefore, for Tanah Aina Fahad, it can be concluded that grey Bass forecasting model has a better forecast than BDM and vice versa for Tanah Aina Farrah Soraya.

In overall, both models are suitable to forecast the new tourism product but further improvements on the study by considering other factors such as the choice of the parameters, need to be made. Based on the forecast, both resort shows that they will receive an increasing number of visitors during early years of their openings. After reaching the peak number of visitors, the trends will start to decrease. This forecast's impact gains the managers' concern that if there is no planning for the facilities or introduction of a new attraction to the place, the number of visitors will decline in the future. Other than that, the management needs to collaborate with the government or other private sectors to advertise the resort to the public.

4. CONCLUSIONS

The higher returns from tourism industry to the country's economy makes it important for governments and other tourism practitioners to have a strategic planning and marketing to ensure the continuity of tourists to the country or to the specific attractions. In this paper, the purpose is to forecast the number of visitors to the new tourism product demand in Malaysia. Thus, two models, BDM and the proposed model of grey Bass forecasting model are used to forecast ecotourism resorts in Pahang named Tanah Aina Fahad and Tanah Aina Farrah Soraya. New product is known to have limited number of data. In order to overcome this, grey Bass forecasting model is applied.

The authors acknowledge the limitation in this study that could be resolved with further research. For example, yearly data from Tanah Aina Fahad is employed. Seasonality in tourism plays an important role in forecasting tourism demand. Even though Malaysia has tropical weather all year round, the effect of school holidays and its rainy season at the end of the year especially in the east region of Peninsular Malaysia possibly affected the number of visitors to the resort. If the data is collected as quarterly or monthly, the peak and minimum number of visitors in the year can be seen clearly. Therefore, future research should consider monthly or quarterly data compared to annual data.

This study uses only one method to estimate parameters, which is ordinary least square method. Further work using other method such as genetic algorithm can be applied to estimate the parameters. Apart from that, variants of parameter m (potential market) can be employed by considering the number of visitors to Pahang.

Overall, based on the analysis, both BDM and grey Bass forecasting model is acceptable for forecasting the new tourism product. The researchers can forecast and help the management for a better planning to meet the visitors' expectations when visiting the place. The result shows that both Tanah Aina Fahad and Tanah Aina Farrah Soraya are expected to face declination in the number of accommodators after several years of opening. Therefore, planning of the tourism product's developments are required to sustain the continuity of the visitors. Other than the development, taking advantage of social network, advertising through mass media or using ambassadors can be considered as an initiative to notice the public about its existence and indirectly attract the locals to visit the place.

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DECLARATION OF ORIGINALITY

The authors declare no conflict of interest to report regarding this study conducted.

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