Analysis of Future Income Forecast for Indonesian Tourism Industry – A Neural Network Research on Tourism Digital Economy

T Hidayat¹, R Mahardiko² and M Alaydrus³

¹ Department of Computer Engineering of Universitas Wiralodra, Jl. Ir. H Juanda KM. 03, Karanganyar, Kabupaten Indramayu, Jawa Barat 45213, Indonesia
² Department of Software Service, Platinumetrix Pte. Ltd, CoHive Menara Prima Kuningan, Setiabudi, South Jakarta 12950, Indonesia
³ Department of Electrical Engineering, Universitas Mercu Buana, Jl. Meruya Selatan, Kebon Jeruk, Jakarta Barat 11650, Indonesia

Email: thidayat.ft@unwir.ac.id¹

Abstract. Information Technology (IT) is an enabler for Indonesian tourism industry. Before Covid-19 pandemic, the industry already felt the effect of IT. The pandemic changes the global industry situation. This paper presents mathematical model on the number of tourism start-up, the number of local and international tourists, and national Gross Domestic Product (GDP). The results of this study show that while there are problems because of Covid-19 pandemic in the following year, the future income of tourism industry shows steady growth. The model can be used by other industry for better analysis.

1. Introduction

In the last decades, Information Technology (IT) development is increasing significantly. The development is already felt by individual, industry, national and international levels. In industry level, IT has already developed well for many industries, such as banking [1], transportation [2], manufacture [3], electricity [4], telecommunication [5], etc. Those industries rely on IT to automate the transaction process, ease communication between internal departments and external relations, fasten the reporting to managerial level, capture better and wider customer, etc [1-3]. The growing benefits of IT will be felt well, if the industry invests more money for IT development [1-5].

The Indonesian tourism felt better Gross Domestic Product (GDP) from tourism activity [6]. The GDP of tourism industry is commonly the result of IT functionality activities [6-7] and business process of certain industry [8]. The IT functionalities for tourism activity is to enhance the transaction process, ease the ticket and hotel reservations, enable easy transportation, etc [6-7]. So, we, the authors, believe and understand that tourism industry relies on the technology deeply. To achieve many mentioned benefits, Indonesian government pushes the development of start-up [9], develop e-marketing to promote local tourism[6] and open up new location of tourism [6], [9] to bridge the national tourism. Table 1 is the Indonesian tourism GDP between 2014 – 2018.
Table 1. Indonesian tourism GDP at the end of the year

|                      | 2014     | 2015     | 2016     | 2017     | 2018     |
|----------------------|----------|----------|----------|----------|----------|
| Total National GDP   | 2,697,695.4 | 2,939,558.7 | 3,195,694.2 | 3,490,608.3 | 3,683,896.2 |
| (IDR billion) [10]   |          |          |          |          |          |
| Tourism Effect (%)   | 9        | 5.8      | 5.47     | 5.8      | 5.2      |
| [11]                 |          |          |          |          |          |
| Tourism GDP (IDR billion) – Total National GDP * Tourism Effect | 242,792.59 | 170,494,40 | 174,804.47 | 202,455.28 | 191,562.60 |

Table 1 is the Indonesian GDP from tourism activity during 2014 – 2018. Even though, the tourism effect is steady, the industry still contributes positively for national GDP. At the end of 2019, the world faced a surprising attack from pandemic of Covid-19 [12-13]. The pandemic hits every nation from Europe, Asia, Africa, America and even Australia [12-15]. The country, USA, Italy, China, England, Malaysia, South Korea, Singapore and even Indonesia, must lock the areas down from the activities [13-14]. Locking down makes that every industrial activity stops the production process [14]. Thus, it creates low demand but high cost resulting higher unemployment [14-15], especially tourism industry [14], [16]. The latest research on Covid-19 for Indonesian tourism developed the comparison analysis among 3 countries (Indonesia, Malaysia, and Singapore) to leverage the national GDP through regulation for better e-commerce [17]. To deeply understand, there is a need of a research to see future Indonesian tourism GDP, so that the government can do suitable action. Our objective is to know the future income of Indonesian tourism GDP. The next section explains our methodology and analyses the prediction then discusses the result. The last section concludes the result and discussion for formulating the future works.

2. Research Method

2.1. Data Processing with Time Series of Neural Network

Figure 1 displays the process of data analysis of this study. This gives an overview regarding the data collection on tourism industry.

2.2. Time Series Modeling

Time series model is a random variable representation having same time and can be observed in a defined time frame [18]. For an instance, an observation of a tourism industry for at least 2 years. The
collected data is based on the yearly basis [18]. The historical data for time series are collected to predict the future [19]. So that, the results of the future are well explained because of the available past data [20]. This study will use the mathematical model to present the process of time series and then forecast the future [21]. The data for analysis are based on certain identification [19]. The statistical model used is written below [22]:

\[ X_t = A + \varepsilon_t \]  

(1)

\( X_t \) is an observed random variable in time (t). A is a constant level from a model, while \( \varepsilon_t \) is a random deviation in time (t).

2.3. Neural Network Method

Forecasting using Neural Network (NN) [20] depends on variable \( \tilde{y} \), which means the realization of prediction of \( y_{t-n} \), 1 or i is matrix of variable \( X \). Ordinal or nominal is past relational scale \( X_{4x5} \). Therefore, NN processes the freedom degree on prediction design enabling clearly through certain estimation function from \( \tilde{y} = f (X_{1:T}, X_{2:T}, ..., X_{n:T}) \), and transfer model function with time series prediction [19]. After that, this study presents the NN model to predict the time series [23]. The use of NN for time series prediction is a general nonlinear auto aggressive model AR (p) [21]. In time t, prediction is 1 step ahead \( \tilde{y}_{t+n} \) calculated using p=n on observation \( y_T, y_{t-1}, ..., y_{t-n+1} \) where n is previous point in time t, t-1, t-2, ..., t-n+1, where n in input total of NN [22]. The equation of NN model for time series is written below:

\[ \tilde{y}_{t+1} = f(y_T, y_{t-1}, ..., y_{t-n+1}) \]  

(2)

![Figure 2. The architecture of time series [24]](image)

2.4. Source Dataset

This study will employ first dataset in Table 1. This study also will have 3 datasets containing the number of established startup at the end of the year, the number of trips of local and international tourists and the number of total expenditure of local and international tourists. Table 2 explains the number of established startup at the end of the year. Table 3 describes the number of local and international trips at the end of the year, while Table 4 tells the number of total expenditure of local and international tourists at the end of the year.
Table 2. New established start-up at the end of the year [25]

|                          | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|--------------------------|------|------|------|------|------|------|
| Established start-up in  |      |      |      |      |      |      |
| Indonesian tourism       | 8    | 4    | 11   | 10   | 5    | 1    |

Table 3. The number of trips of local and international tourists at the end of the year

| Million times            | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|--------------------------|------|------|------|------|------|------|
| The number of trips by   |      |      |      |      |      |      |
| local tourists [26]      | 250. | 251. | 256. | 264. | 270. | 303. |
| 04                       | 24   | 42   | 34   | 00   | 40   |      |
| The number of trips by   | 8.8  | 9.44 | 10.41| 12.02| 14.04| -    |
| international tourists [11]|      |      |      |      |      |      |

Table 4. The number of total expenditure of local and international tourists at the end of the year

|                          | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|--------------------------|------|------|------|------|------|------|
| The number of total expenditure by local tourists (IDR billion) [26]| 177. | 213. | 224. | 241. | 246. | 291. |
| 84                       | 97   | 69   | 67   | 85   | 02   |      |
| The number of total      | 10.05| 11.17| 12.23| 12.44| 15.24| -    |
| expenditure by           |      |      |      |      |      |      |
| international tourists (USD million) [11] |      |      |      |      |      |      |

3. Result and Discussion

3.1. Analysis Result of new established start-up in the next few years

The use of equation (1) and (2) on Table 2 achieves a predicted of future new established start-up. Table 5 depicts the result.

Table 5. Predicted future of new established start-up

|                          | 2017 | 2018 | 2019 | 2020 | 2021 |
|--------------------------|------|------|------|------|------|
| Established start-up in  |      |      |      |      |      |
| Indonesian tourism       | 5    | 1    | 0    | 0    | 2    |

Table 5 explains that in 2019 and 2020, there is no new established start-up for Indonesian tourism. This indicates that the global situation on global pandemic affects Indonesian tourism industry. However, in 2021, there will be 2 new established start-ups. The new start-up will improve the Indonesian tourism situation for ticket and hotel reservations.

3.2. Analysis Result of the number of trips by local and international tourists

The use of equation (1) and (2) on Table 3 results a predicted of future the number of trips. Table 6 depicts the result.

Table 6. Predicted future of the number of trips by local and international tourists at the end of the year

| Million times          | 2017 | 2018 | 2019 | 2020 | 2021 |
|------------------------|------|------|------|------|------|
| The number of trips by |      |      |      |      |      |
| local tourists         | 270. | 303. | 325. | 413. | 517. |
| 00                     | 40   | 00   | 00   | 00   | 00   |
The number of trips by international tourists

|                | 14.04 |    | 15.00 | 17.00 | 10.00 |
|----------------|-------|----|-------|-------|-------|

Table 6 explains that the number of trips by local tourists will significantly grow in 2021. While, the positive trend is shown in the number of trips by local tourists, the number of trips by international tourists shows otherwise. This indicates that global pandemic will eventually affect international tourists to arrive to Indonesia.

3.3. Analysis Result of the number of total expenditure by local and international tourists

The use of equation (1) and (2) on Table 4 results a predicted of future the number of total expenditure. Table 7 depicts the result.

|                | 2017  | 2018  | 2019  | 2020  | 2021  |
|----------------|-------|-------|-------|-------|-------|
| The number of total expenditure by local tourists (IDR billion) | 246.85 | 291.02 | 311.00 | 361.00 | 206.00 |
| The number of total expenditure by international tourists (USD million) | 15.24 | -     | 17.00 | 21.00 | 12.00 |

Table 7 explains that the number of total expenditure by local and international tourists will significantly grow in 2019 and 2020. In fact, the positive growth will end in 2020 and decrease in 2021. Overall, the decreasing trend is nearly double in 2021.

3.4. Analysis Result of the Indonesian tourism GDP for the next few years

The use of equation (1) and (2) on Table 1 results a predicted of future Indonesian tourism GDP. Table 8 depicts the result.

|                | 2017  | 2018  | 2019  | 2020  | 2021  |
|----------------|-------|-------|-------|-------|-------|
| Tourism GDP (IDR Billion) | 202,455.28 | 191,562.60 | 171,663.00 | 156,822.00 | 200,798.00 |

Table 8 describes the Indonesian tourism GDP for the next few years. During 2019 and 2020, the downtrend is shown, but it will rise in 2021. Overall, the uptrend is shown until 2021.

4. Discussion on the Results

Analysis of prediction has been done in several terms. First term, forecast was done for some methods, such as: moving average [27], Markov Chain [28] and etc. Second term, prediction was done for some industries, such as: telecommunications [27], retail [29] and etc. Third term, forecast was done for some purposes, such as: revenue prediction [27], [30], operational and strategic decisions [31], Virtual Machine (VM) migration [32], security [33] and etc. This research was done to prove that near future income of Indonesian tourism will still have the real revenue for GDP. Table 9 describes how tourism GDP is affected by tourism start-up.
Table 9. Relation table on tourism GDP from tourism start-up

|                      | 2017       | 2018       | 2019       | 2020       | 2021       |
|----------------------|------------|------------|------------|------------|------------|
| New established start-up | 5          | 1          | 0          | 0          | 2          |
| The number of local tourists trips | 270.00     | 303.40     | 325.00     | 413.00     | 517.00     |
| The number of local tourists expenditure | 246.85     | 291.02     | 311.00     | 361.00     | 206.00     |
| The number of international tourist trips | 14.04      | -          | 15.00      | 17.00      | 10.00      |
| The number of international tourist expenditure | 15.24      | -          | 17.00      | 21.00      | 12.00      |
| Tourism GDP           | 202,455.28 | 191,562.60 | 171,663.00 | 156,822.00 | 200,798.00 |

Table 9 explains that while there is no new established start-up in 2019 and 2020, the trips of local and international tourists still significantly grow from 2017 – 2020. The number of local tourist trips grows by 52.96 percentage points and the number of international tourists rises 21.08 percent. Even though the new established start-up in 2021 is significantly increasing by 200%, the reduction of the number of international tourist trips is seen in 2021 by -41.18 percentage point and the number of local tourist trips shows otherwise. It indicates that during 2019 – 2020, local and international tourists still have trips in the middle of Covid-19 pandemic, but international tourist has less trips in 2021 in the middle of Covid-19.

The growing trips also give positive growth on total expenditure in 2019 and 2020 for local and international tourists. During 2017 – 2020, the number of total expenditure of local and international tourists grows by 46.24% and 37.80% respectively. But, the reduction is shown in 2021 for the number of total expenditure of local and international tourists. It indicates that though the number of trips of local tourists is increasing in 2021, the total number of local tourist expenditure will decrease. Local tourist will eventually do the trips without any spending during the trips. The result shows otherwise for international tourist. The effect of lower number of international tourist trips gives less expenditure. It indicates that international tourist will not do the trips in 2021.

The Indonesian GDP of tourism industry says that the downturn is happening between 2017 – 2020, but the uptrend will happen in 2021. It indicates that the expenditure of local and international tourists does not give significant result on tourism GDP, but it gives positive result on 2021.

5. Conclusions and Future Works

This study gives some positive results. First result, there is no new established start-up in 2019 and 2020, but the existing established start-ups give positive growth of trips for local and international tourists. Second result, the effect of trips gives positive trend on total expenditure of local and international tourists in 2019 and 2020. Third result, even though the uptrend is shown for total expenditure, the tourism GDP says otherwise. Fourth result, in 2021, the downturn of total expenditure for local and international tourists gives positive result on tourism GDP. All the results indicate that pandemic of Covid-19 still gives an effect on tourism industry.

There are some limitations on this study. First limitation, this study only discovers Indonesian tourism. Second limitation, newer datasets can be done. Third limitation, this study only discovers established start-up, the trips, the expenditure and the GDP as variables. Fourth limitation, comparison research on this study can be done. From the defined limitations, there will be future works.
6. References

[1] E.H. Abualsauod, A.M. Othman. A study of the effects of online banking quality gaps on customers’ perception in Saudi Arabia. Journal of King Saud University - Engineering Sciences (2019) 1–7. doi.org/10.1016/j.jksues.2019.09.001

[2] R. Mahardiko. IT value analysis: Case study of PT. express transindo utama. in Proc. 2014 International Conference on Information Technology Systems and Innovation (ICITSI) (2014) 224–229. doi.org/10.1109/ICITSI.2014.7048268

[3] D. Grant, B. Yeo. A global perspective on tech investment, financing, and ICT on manufacturing and service industry performance. International Journal of Information Management. 43 (2018) 130–145. doi.org/10.1016/j.ijinfomgt.2018.06.007

[4] R.A. Susilo, Suhardi. IT value analysis by resource-based view theory: The case study of PT. PLN (Persero) Indonesia. in Proc. 2014 International Conference on Information Technology Systems and Innovation (ICITSI) (2014) 213–218. doi.org/10.1109/ICITSI.2014.7048266

[5] L. Abdurrahman. Hybrid configuration in information technology value model. IEEE Systems Journal (Early Access) (2020) 1–8. doi.org/10.1109/JSYST.2020.2968415

[6] C.J. Jonathan, R.E. Tarigan. The effects of e-tourism to the development of tourism sector in Indonesia. CommIT (Communication & Information Technology) Journal 10(2) (2016) 59–62. doi.org/10.21512/commit.v10i2.1669

[7] N.W. Htet, B. Dimitry, Z. Irina. Information data structure for Myanmar tourism system. in Proc. 2017 IEEE Conference of Russian Young Researchers in Electrical and Electronic Engineering (ElConRus) (2017) 510–512. doi.org/10.1109/ElConRus.2017.7910603

[8] Ö. Peksatici, H.S. Ergun. The gap between academy and industry - A qualitative study in Turkish aviation context. Journal of Air Management Transport 79 (2019). doi.org/10.1016/j.jairtraman.2019.101687

[9] B. Pamungkas, S. Rohajawati, D. Fitrianah, I Nurhaida, H.H. Wachyu. Proposing a key model e-commerce towards digital economy for coastal areas in Indonesia. In: Kim K., Kim H., Baek N. (eds) IT Convergence and Security 2017 (2018) 98–105. doi.org/10.1007/978-981-10-6454-8_14

[10] BPS. Quarterly Indonesian gross domestic product 2014–2018 (Central Bureau of Statistics, 2018) 1–118. (in Indonesian: Produk Domestik Bruto Indonesia Triwulanan 2014-2018)

[11] LPEM FEB UI. A study of the impact of the tourism sector on the Indonesian economy (Institute of Economic and Community Inquiry, 2018) 1–142. (in Indonesian: Laporan Akhir: Kajian Dampak Sektor Pariwisata Terhadap Perekonomian Indonesia)

[12] M. Nicola, Z. Alsafi, C. Sohrabi, A. Kerwan, A. Al-Jabir, C. Iosifidis, M. Agha, R. Agha. The socio-economic implications of the coronavirus pandemic (COVID-19): A review. International Journal of Surgery 78 (2020) 185–193. doi.org/10.1016/j.ijsu.2020.04.018

[13] S. Gössling, D. Scott, C. M. Hall. Pandemics, tourism and global change: a rapid assessment of COVID-19. Journal of Sustainable Tourism (2020) 1–20. doi.org/10.1080/09669582.2020.1758708

[14] J. Sarkis, M.J. Cohen, P. Dewick, P. Schröder. A brave new world: Lessons from the COVID-19 pandemic for transitioning to sustainable supply and production. Resources, Conservation and Recycling 159 (2020) 1–4. doi.org/10.1016/j.resconrec.2020.104894

[15] S. Wellman, J. Moskal, C.L. Barnes, J. Parvizi. Business unusual: COVID-19 ramifications for arthroplasty. The Journal of Arthroplasty 35 (2020) S1–S2. doi.org/10.1016/j.arth.2020.04.062

[16] N.A. Bakar, S. Rosbi. Effect of coronavirus disease (COVID-19) to tourism industry. International Journal of Advanced Engineering Research and Science 7(4) (2020) 189–193. doi.org/10.22161/ijaers.74.23

[17] I.S. Permana, T. Hidayat, R. Mahardiko. An analysis to set the regulation up for tourism industry in new normal pandemic of Covid-19. in Proc. International Conference on Cultural Heritage, Education, Sustainable Tourism, and Innovative Technologies (CESIT) (2020) In Press
[18] F. Ambrosino, C. Sabbarese, V. Roca, F. Giudicepietro, G. Chiodini. Analysis of 7-years radon time series at campi flegrei area (Naples, Italy) using artificial neural network method. Applied Radiation and Isotopes 163 (2020). doi.org/10.1016/j.apradiso.2020.109239

[19] M.B. Wagena, D. Goering, A.S. Collick, E. Bock, D.R. Fuka, A. Buda, Z.M. Easton. Comparison of short-term streamflow forecasting using stochastic time series, neural networks, process-based, and Bayesian models. Environmental Modelling & Software 126 (2020). doi.org/10.1016/j.envsoft.2020.104669

[20] B.K. Iwana, V. Frinken, S. Uchida. DTW-NN: A novel neural network for time series recognition using dynamic alignment between inputs and weights. Knowledge-Based System 188 (2020). doi.org/10.1016/j.knosys.2019.104971

[21] X. Wei, L. Zhang, H.-Q. Yang, L. Zhang, Y.-P. Yao. Machine learning for pore-water pressure time-series prediction: Application of recurrent neural networks. Geoscience Frontiers (2020). doi.org/10.1016/j.gsfn.2019.03.017

[22] R.de A. Araújo, N. Nedjah, A.L.I. Oliveira, S.R.de L. Meira. A deep increasing–decreasing-linear neural network for financial time series prediction. Neurocomputing 347 (2019) 59–81. doi.org/10.1016/j.neucom.2019.03.017

[23] C. Zhang, H. Tang, Z. Duan. Time series analysis of volleyball spiking posture based on quality-guided cyclic neural network. Journal of Visual Communication and Image Representation (2019). doi.org/10.1016/j.jvcir.2019.102681

[24] F. Weissenberger, F. Meier, J. Lengler, H. Einarsson, A. Steger. Long synfire chains emerge by spike-timing dependent plasticity modulated by population activity. International Journal of Neural Systems 27(8) (2017). doi.org/ 10.1142/S0129065717500447

[25] Bekraf, Mapping & database startup Indonesia 2018 (Indonesian Digital Creative Industry Society, 2018) 1–202

[26] BPS, Domestic tourism statistics (Central Bureau of Statistics, 2018) 1–280. (in Indonesian: Statistik Wisatawan Nusantara)

[27] T. Hidayat, R. Mahardiko, M. Alaydrus. Mobile cellular technology forecast for the Indonesian telecommunications industry. Journal of Telecommunications and the Digital Economy 8(1) (2020) 37–48. doi.org/10.18080/itde.v8n1.226

[28] J. Schoenfisch, C. Meilicke, J. von Stülpnagel, J. Ortmann, H. Stuckenschmidt. Root cause analysis in IT infrastructures using ontologies and abduction in markov logic networks. Information Systems 74(2) (2018) 103–116. doi.org/10.1016/j.is.2017.11.003

[29] S. Ma, R. Fildes. Forecasting third-party mobile payments with implications for customer flow prediction. International Journal of Forecasting, 36(3) (2020) 739–760. doi.org/10.1016/j.ijforecast.2019.08.012

[30] T. Hidayat, R. Mahardiko. Mathematical Model to Forecast Future Banking Income. International Journal of Mathematics and Operational Research. In Press (2020). doi.org/10.1504/IJMOR.2020.10032545

[31] R. Fildes, S. Ma, S. Kolassa. Retail forecasting: Research and practice. International Journal of Forecasting (2019). doi.org/10.1016/j.ijforecast.2019.06.004

[32] T. Hidayat, M. Alaydrus. Performance analysis and mitigation of virtual machine by using naïve bayes classification. in Proc. 2019 Fourth International Conference on Informatics and Computing (ICIC) (2019), pp. 1–5. doi.org/10.1109/ICIC47613.2019.8985932

[33] T. Hidayat, D. Sianturi Tigor Franky, R. Mahardiko. Forecast Analysis of Research Chance on AES Algorithm to Encrypt during Data Transmission on Cloud Computing, in Proc. 2020 2nd International Conference on Broadband Communications, Wireless Sensors and Powering (BCWSP) (2020), pp. 163–166. doi.org/10.1109/BCWSP50066.2020.9249478

Acknowledgments
The authors would like to thank Department of Computer Engineering Universitas Wiralodra for support of this research.