Mobile Cellular Technology Forecast for the Indonesian Telecommunications Industry

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Abstract: Current mobile telecommunications deployment in Indonesia, based on 2G, 3G and 4G technologies, lags behind many other developing countries because of Indonesia's larger territory. This paper presents recent data on revenue growth (%) and the number of Base Transceiver Stations (BTSs) in Indonesia, divided among 2G, 3G and 4G technologies, and forecasts future revenue growth and numbers of BTSs for the next few years. The results show that, while revenue growth from 2G operation is decreasing and 4G deployment is significantly increasing, there are still significant revenues from 2G services and many 2G BTSs in operation at the end of the forecast period, making it difficult to shut down the 2G networks in the near future.

Keywords: Telecommunication, 2G, 3G, 4G, Comparison analysis

Introduction

In Indonesia, the development of mobile telecommunications is growing rapidly because customers need cheaper prices and higher speeds of data transfer. To fulfil customer needs, investors in the mobile telecommunication industry invest in each new generation of technology. Second generation (2G) mobile technology is the oldest generation currently deployed. Customers of 2G are moving to 3G because of cheap prices and ease of content access in 3G technology: 3G technology uses data packets for internet access (Charoenlap & Uthansakul, 2016) and provides good connection speeds (Becona *et al.*, 2017). The newer technology, 4G, also called Long-Term Evolution (LTE), gives even better connection speeds and so will become the primary choice for customers. The effect is that 4G technology is gaining lots of customers (Ezhilarasan & Dinakaran, 2017). Nevertheless, 2G and 3G

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technologies are predicted to last for a long time because these technologies can support *machine-to-machine* (M2M) communication (Labib, Marojevic & Reed, 2016).

Today, mobile phone customers not only send messages (SMSs) via 2G technology but also use data services for sending messages with 3G and 4G technologies. To provide for this opportunity, every operator improves its 2G technology to 3G or 4G technology. The improvement impact of technology on revenue can be seen in Table 1. Below the table is further discussion of the revenue growth for each technology that is used by customers.

Table 1. Revenue growth (%) at the end of a year from each technology in Indonesia (Kominfo, 2017)

Technology	2011	2012	2013	2014	2015	2016
Voice (2G)	45.43	43.15	37.43	35.64	33.78	31.52
SMS (2G)	17.46	16.69	15.45	14.05	12.33	9.58
Data and VAS (3G/4G)	11.86	14.52	18.92	23.90	29.73	36.22
Other	5.25	5.64	8.20	6.41	4.16	2.68

VAS = Value-Added Services

During 2011-2016, as shown in Table 1, revenue growth of 2G technology always decreased because some 2G sites were upgraded in some regions to be 3G or 4G sites. Because of high population in some regions, 2G sites can be upgraded by mobile operators to be 3G or 4G sites to improve service. To upgrade a site, research on market demand in the relevant location should be conducted. There is also a need to source appropriate capital for cellular technology advancements in Indonesia.

In this paper, we describe forecasts to predict future trends among the three generations of technology. The next section outlines the 2G, 3G, 4G technologies and indicates the plans in other countries for switching off 2G technology. The following section describes our research method and results, and discusses our forecasts. The last section provides conclusions and future work.

Cellular Technology Generations

2G technology

2G technology is the 2nd generation of mobile telecommunications using GSM in certain frequency bands: 200MHz, 250MHz, 400MHz, 500MHz, 1000MHz, 1600MHz and 1700MHz (Celik, 2015). A GSM network is built from several functional components, which have specific interface functions. Generally, a GSM network can be divided into three main parts: (1) Radio Sub-System (RSS); (2) Network and Switching Subsystem (NSS); and (3) Operation and Maintenance Subsystem (OMS). GSM uses cellular technology supported on BTSs (Ibrani *et al.*, 2017).

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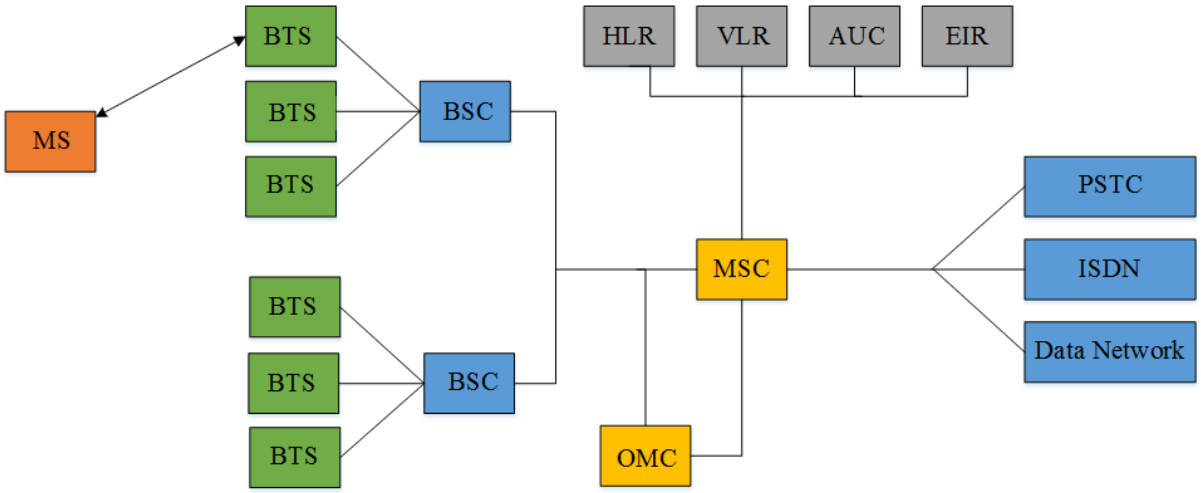

Figure 1. 2G infrastructure (Buchanan *et al.*, 2004)

2G switch-off

Many countries and operators have already switched off 2G technology in order to improve communication quality. Table 2 exhibits the 2G switch-off dates in several countries.

Table 2. 2G switch-off dates by operator and country (Fadrian & Arifin, 2018)

Date of switch	Operator	Country	Technology
2017	Reliance JIO	India	GSM
2019	Airtel	India	GSM
30.06.2015	CTM, Hutchison, Smartone	Macau	GSM
01.08.2019	CTM, Hutchison, Smartone	Macau	GSM
01.04.2018	M1, Singtel, Starhub	Singapore	GSM
2011	KT, LG Uplus, SK Telecom	South Korea	GSM
31.10.2019	DTAC, AIS, TrueMoveH	Thailand	GSM
31.12.2017	Chunghwa, Far East Tone, Taiwan Mobile, Taiwan Star	Taiwan	GSM
01.12.2016	Telstra	Australia	GSM
01.04.2017	Optus	Australia	GSM
30.08.2018	Vodafone	Australia	GSM
15.03.2018	2 Degrees	New Zealand	GSM
01.10.2018	NTT Docomo	Guam & Saipan	GSM
31.12.2016	AT&T	USA	GSM
30.04.2018	Antigua Public Utilities Authority	Antigua and Barbuda	GSM

3G technology

3G technology is the 3rd generation for mobile telecommunications and uses Universal Mobile Telecommunications System (UMTS) (Turniški *et al.*, 2016); 3G works on 1700-2200 MHz frequencies (Letavin, Konovalov & Sychugov, 2018). Based on International Telecommunication Union (ITU) IMT2000 standard, 3G technology is a standard technology for mobile phones that replaces 2G technology. A 3G network enables an operator to give a wider range of services by increasing spectrum utilization (Masmoudi *et al.*, 2017). 3G

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technology supports voice and video calls. Additional facilities include HSPA data transmission, which has the capability to send data with download speeds up to 14.4 Mbps and upload speeds up to 5.8 Mbps. Internet access in a 3G network is slower than in a 4G network (Tamgno, Alidou & Lishou, 2018).

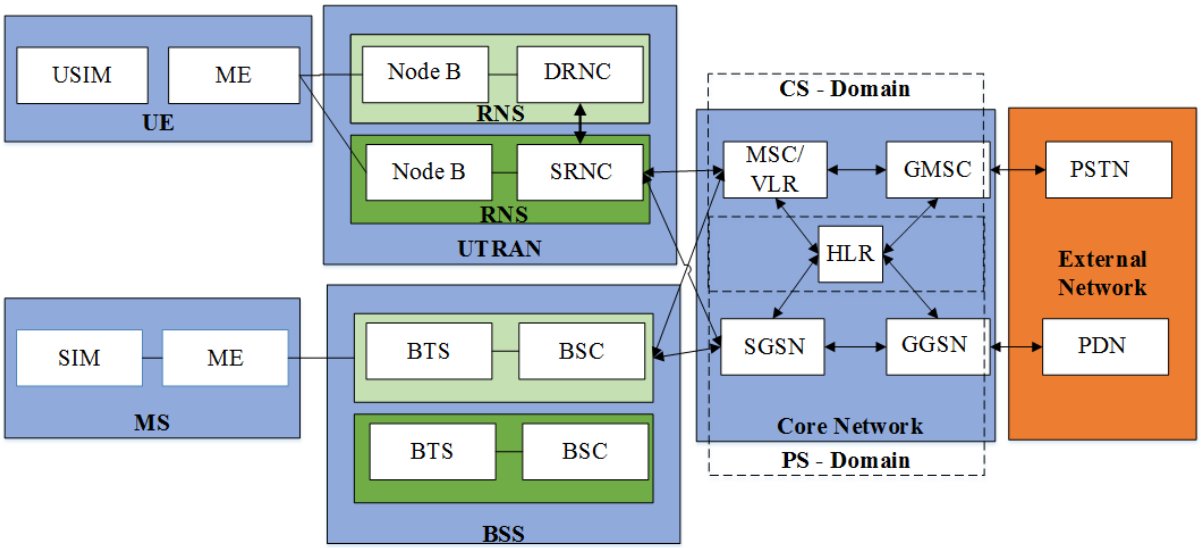

Figure 2. 3G infrastructure (Jung & Kwon, 2015)

4G technology

LTE technology is the 4th generation of mobile telecommunication. LTE has been developed by the 3rd Generation Partnership Project (3GPP) (Choi *et al.*, 2015). This technology is based on Internet Protocol (IP). The wireless communication system of 4G technology uses Orthogonal Frequency Division Multiplexing (OFDM). OFDM has good noise performance characteristics and can support high quality wireless data services (Jia, 2017).

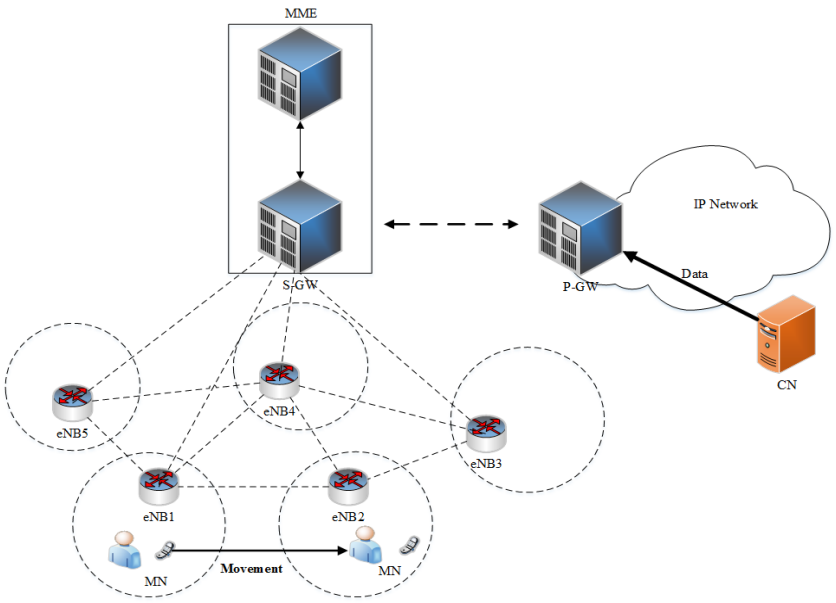

Figure 3. LTE/4G infrastructure (McLaurin ***et al.***, 2018)

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A major purpose of LTE is to improve the capacity of data transfer by using previously unused spectrum. This reduces data transfer cost and simplifies network architecture (Campos, 2017). The simplified network architecture means that every node connected in an LTE network will be at lesser cost than in a 3G network (Jha & Saha, 2019).

Forecasting Analysis

Forecasting analysis is a tool for predicting certain conditions in the future. Many practical circumstances are predicted by forecasting analysis to help us make important decisions. For example, based on the data obtained by the forecasting of daily payments in retail stores, daily operational decisions in the stores can be executed (Ma & Fildes, 2020). In electric power systems, a model based on a higher-order Markov chain and the Gaussian mixture method has been developed for forecasting the power generated by photovoltaic systems (Sanjari & Gooi, 2017). A review of different forecasting models applied in telecommunication and ICT is given in Meade & Islam (2015).

Forecasting analysis in this paper is implemented in the form of a time series analysis (Berk, 2015) by use of a regression analysis as given in equation (1):

$$y = a + bx \tag{1}$$

where y the new prediction, a the actual prediction, b the direction coefficient of inclination and x the time period calculated through time deviation.

In order to determine the unknown coefficients, a and b, from the data, the moving average method is used. The method provides a simple calculation for smoothing historical data. Additionally, the method is useful to forecast when there is no trend and can work with different estimation methods for better analysis.

The method takes a set of observed values and then calculates the average amount from the set. The average value of the data amount is used to calculate the actual prediction a, as shown in equation (2):

$$a = \frac{\sum_{n=1}^{N} y_n}{N} \tag{2}$$

y_n is the available data. It can be annual, monthly, or quarterly data. Meanwhile, the direction coefficient of inclination can be calculated with equation (3):

$$b = \frac{\sum_{n=1}^{N} x_n \sum_{n=1}^{N} y_n - N \sum_{n=1}^{N} x_n y_n}{(\sum_{n=1}^{N} x_n)^2 - N \sum_{n=1}^{N} x_n^2} \tag{3}$$

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Research Method

Data analysis by using forecasting

Figure 4 shows the data analysis process by using forecasting method. This gives us the ability to do trend comparisons for each potential technology in Indonesia.

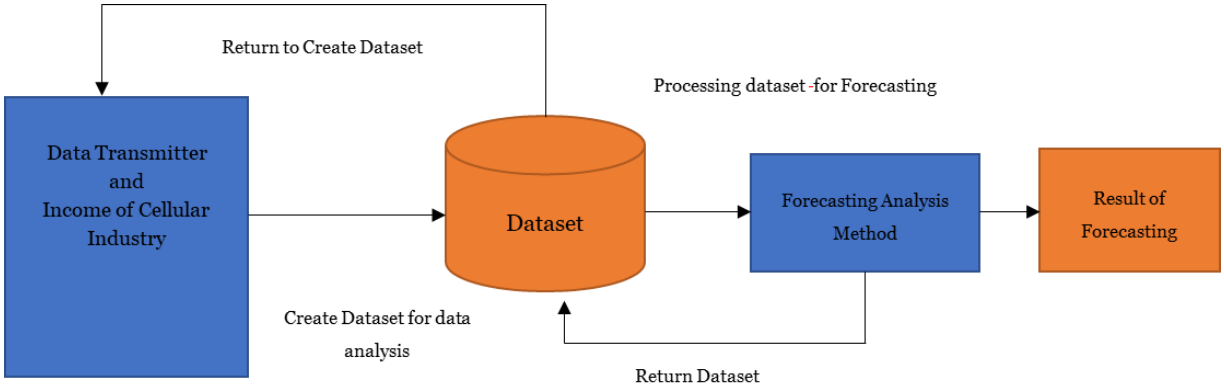

Figure 4. Dataset processing

Data sources

The first sample data source for this research is in Table 1. The other data source used in this paper is the number of BTSs for each technology. Table 3 exhibits the number of BTSs in each quarter from Q3 2015 – Q2 2018.

Table 3. The number of BTS at the end of each quarter from Q3-2015 – Q2-2018 (Kominfo, 2018)

Period	2G Sites	Growth (%)	3G Sites	Growth (%)	4G Sites	Growth (%)
Q3-2015	130,146	-	110,482	-	965	-
Q4-2015	129,847	-0.23	114,300	3.46	5,600	480,31
Q1-2016	130,624	0.60	118,858	3.99	10,269	83.38
Q2-2016	131,794	0.90	138,095	16.18	12,040	17.25
Q3-2016	132,469	0.51	148,639	7.63	20,935	73.88
Q4-2016	132,579	0.08	158,702	6.77	24,997	19.40
Q1-2017	128,374	-3.17	162,334	2.29	42,318	69.29
Q2-2017	132,903	3.53	170,007	4.73	54,701	29.26
Q3-2017	132,865	-0.03	174,796	2.82	61,291	12.05
Q4-2017	132,496	-0.28	175,708	0.52	72,045	17.55
Q1-2018	132,405	-0.07	178,492	1.58	83,646	16.1
Q2-2018	123,663	-6.60	161,769	-9.37	96,449	15.31

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Results and Discussion

Analysis result of industry revenue growth

A predicted future trend for revenue growth was achieved by utilizing the data from Table 1 and equations (1) to (3). Table 4 depicts industry revenue growth. The data from Table 4 is shown graphically in Figure 5.

Table 4. Trend of industry revenue growth

Technology	Industry Revenue Growth (%)				
	2017	2018	2019	2020	2021
Voice (2G)	33	31	27	22	20
SMS (2G)	14	13	10	8	7
Data and VAS (3G/4G)	42	46	53	60	63
Other	11	10	10	10	10

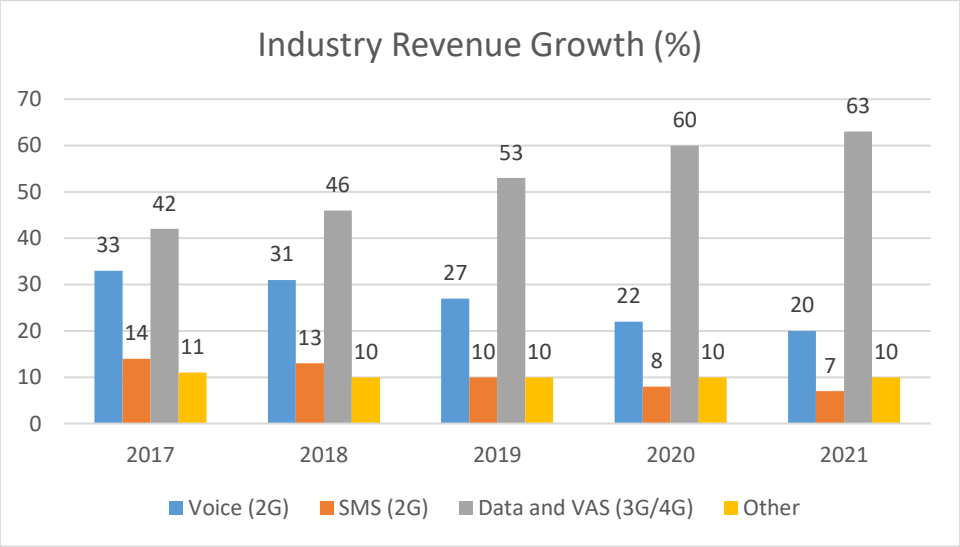

Figure 5. Industry revenue growth from 2017 to 2021

Figure 5 shows the industry revenue growth among the three technologies from 2017 to 2021. There is a significant decrease in SMS revenue growth by 7 percentage points between 2017 and 2021. A significant reduction is also predicted for voice by 13 percentage points between 2017 and 2021. Meanwhile, there is a significant increment for data and VAS by 21 percentage points between 2017 and 2021.

Analysis result of the number of BTS

Based on total operator requirements, positive and negative trends are found for the number of BTS of 2G, 3G and 4G technologies. Table 5 presents the forecast of the number of BTS. Figure 6 presents this result graphically.

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Table 5. Trend of the number of BTS for 2G, 3G and 4G at each quarter in Indonesia

Period	2G Sites	Growth (%)	3G Sites	Growth (%)	4G Sites	Growth (%)
Q3-2018	131,103	-	192,721	-	99,394	-
Q4-2018	130,989	-0.087	198,984	3.25	108,310	8.97
Q1-2019	130,874	-0.088	205,246	3.15	117,226	8.23
Q2-2019	130,760	-0.087	211,509	3.05	126,142	7.60
Q3-2019	130,645	-0.088	217,771	2.96	135,058	7.07
Q4-2019	130,531	-0.087	224,034	2.87	143,975	6.60
Q1-2020	130,416	-0.088	230,296	2.80	152,891	6.19
Q2-2020	130,302	-0.087	236,559	2.72	161,807	5.83
Q3-2020	130,187	-0.088	242,821	2.65	170,723	5.51
Q4-2020	130,073	-0.088	249,084	2.58	179,640	5.22
Q1-2021	129,958	-0.088	255,346	2.51	188,556	4.96
Q2-2021	129,844	-0.088	261,609	2.45	197,472	4.73
Q3-2021	129,730	-0.088	267,871	2.39	206,388	4.52
Q4-2021	129,615	-0.088	274,134	2.39	215,305	4.32

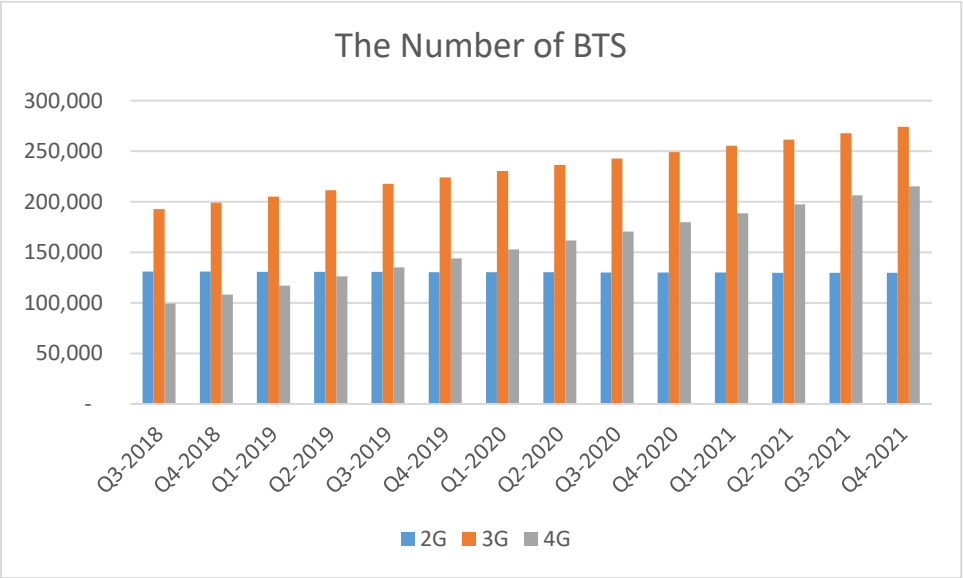

Figure 6. The number of BTS at the end of each quarter from Q3-2018 to Q4-2021

For 3G and 4G technologies, there is an uptrend from Q3-2018 to Q4-2021. For 3G sites, there is significant increment by 42.24% between Q3-2018 and Q4-2021. In addition, a positive trend also occurs for 4G sites, an increase of 116.62% between Q3-2018 and Q2-2021. Otherwise, 2G technology is on a downtrend from Q3-2018 to Q2-2021, declining 1.13% between Q3-2018 and Q2-2021. 2G technology is on a downtrend because it is entering a critical phase, where traffic and subscriber numbers continue to degrade while spectrum allocation for data services is made larger (Fadrian & Arifin, 2018).

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Discussion

In related forecasting, retailers use forecast analysis to support operational, tactical and strategic decisions (Fildes, Ma & Kolassa, 2019). Based on historical data for 2014-2017, retailers forecasted retail demand between 2018 and 2020 in online shares, with a positive trend during 2018-2020. In addition, forecasting customer flow by using third-party mobile payments is key for retailers in making daily operational decisions (Ma & Fildes, 2020). That research used many time series and a thousand stores from a variety of categories. The result was that a general solution for forecasting should be based on Gradient Boosting Regression Tree (GBRT). The same result on forecasting is found for the characteristics of 3G and 4G mobile broadband diffusion in India for 2016-2026 (Jha & Saha, 2020). For those reasons, we then do a comparative analysis of 2G, 3G and 4G technologies. The table below describes how revenue growth is affected by the number of BTS.

Table 6. Relation table on revenue growth and the number of BTS

Period	2G Sites	Revenue Growth of SMS (2G)	Revenue Growth of Voice (2G)	3G Sites	4G Sites	Revenue Growth of Data and Vas (3G/4G)
2017	132,496	14	33	175,708	72,045	42
2018	130,989	13	31	198,984	108,310	46
2019	130,531	10	27	224,034	143,975	53
2020	130,073	8	22	249,084	179,640	60
2021	129,615	7	20	274,134	215,305	63

The table suggests that a reduction of 2G sites by 2.17% will decrease revenue growth of SMS by 7 percentage points and of voice by 13 percentage points during 2017-2021. Otherwise, increasing 3G sites by 56.02% and 4G sites by 198.85% will increase revenue growth of data and VAS by 21 percentage points for the same period. Reduction or addition of sites will affect the number of subscribers that can join a cellular network for revenue generation (Fadrian & Arifin, 2018). The effect of the number of BTS on revenue growth can be discussed in terms of maturity. Companies do not continue to add base station endlessly. As they add new base stations in lower value regions with smaller numbers of subscribers, this affects revenue growth.

Previous mobile technology (2G, 3G and 4G) was mainly for carrying human-to-human traffic with a limited number of services types. The next generation, 5G, will have a much higher number of service, traffic and user types (Akkari & Dimitrou, 2019). The authors concur that 5G will be the future of mobile technology.

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Conclusions

This research has shown the application of moving averages for forecasting analysis. We have compared revenue growth and the number of BTS for each generation of mobile technology in Indonesia. We have noted that a reduction or addition of sites will impact on the number of subscribers that can join a mobile network for generating income. This relationship helps to explain the positive trend that customers in Indonesia tend to use data rather than voice and SMS.

Limitation and Future Research

This research only compares the three mobile telecommunication technologies for the number of BTS and revenue growth. A limitation of the study is that it does not take account of the large area of Indonesia. Future research will be needed to plan for the 2G switch-off in Indonesia.

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