Report for PT Mora Telematika Indonesia

Independent telecoms market study

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5th May 2022

Contents

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This market research was completed in February 2022.

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1 Macroeconomic background

Indonesia has experienced strong economic growth in the last five years and is currently South-east Asia's biggest economy. Its nominal gross domestic product (GDP) reached IDR15.4 quadrillion (USD1.1 trillion[1]) in 2020. The economic outlook is expected to remain favourable over the next five years, by virtue of strong government support for infrastructure project investments and supportive economic policies such as a favourable regulatory environment for foreign investors,[2] resulting in a positive trend on private consumption.

Indonesia also has a young population, and its growing working-age population is expected to support increasing adoption of telecoms and data services. Government initiatives to improve telecoms infrastructure in urban and rural areas should drive further adoption of data services and improve economic inclusion and development for the rural population.

1.1 Nominal GDP and real GDP growth

Indonesia has seen robust GDP growth which is expected to continue in the next five years

Nominal GDP in Indonesia grew at a compound annual growth rate (CAGR) of 8.5% from 2016 to 2019, though the Covid-19 pandemic hampered economic growth causing nominal GDP to decline by 2.5% from 2019 to 2020. The Indonesian government implemented emergency fiscal packages equivalent to 3.8% of GDP in 2020 to mitigate the impact of the Covid-19 pandemic, provide relief to firms and households, and facilitate vaccine roll-out.[3] Against the backdrop of the ongoing pandemic, Indonesia is expected to resume its strong economic growth from 2022, with nominal GDP set to grow at a CAGR of 8.5% from 2020 onwards to reach IDR25.2 quadrillion (USD1.7 trillion) in 2026 (see Figure 1.1). This is higher than the expected CAGR of 7.0% for the South-east Asia region across the same period (see Figure 1.2). Nominal GDP per capita is expected to follow a similar trajectory to reach IDR86 million (USD5,900) by 2026, growing at a CAGR of 7.2% from 2020 to 2026. Within Indonesia, there are considerable differences in GDP per capita with that for the Jakarta region significantly higher than that for the rest of the country.

Real GDP and real GDP per capita have largely followed the same trajectory as nominal GDP and nominal GDP per capita, albeit with lower growth levels. Historically, real GDP has grown at a CAGR of 5.1% and growth in the next five years is expected to be at a CAGR of 5.3%. In real GDP terms, Indonesia's growth is expected to be higher than the average for the South-east Asia region.

1 All currency conversions from Indonesian rupiah to US dollar are based on 2020 average currency exchange rate (USD1 to IDR14,582) as published by the World Bank, and are rounded figures.

2 https://www.imf.org/en/Publications/CR/Issues/2021/03/01/Indonesia-2020-Article-IV-Consultation-Press-Release-Staff-Report-and-Statement-by-the-50131

3 https://www.worldbank.org/en/country/indonesia/overview

Figure 1.1: Nominal GDP (IDR quadrillion) and nominal GDP per capita (IDR million) [Source: International Monetary Fund, United Nations, 2021]

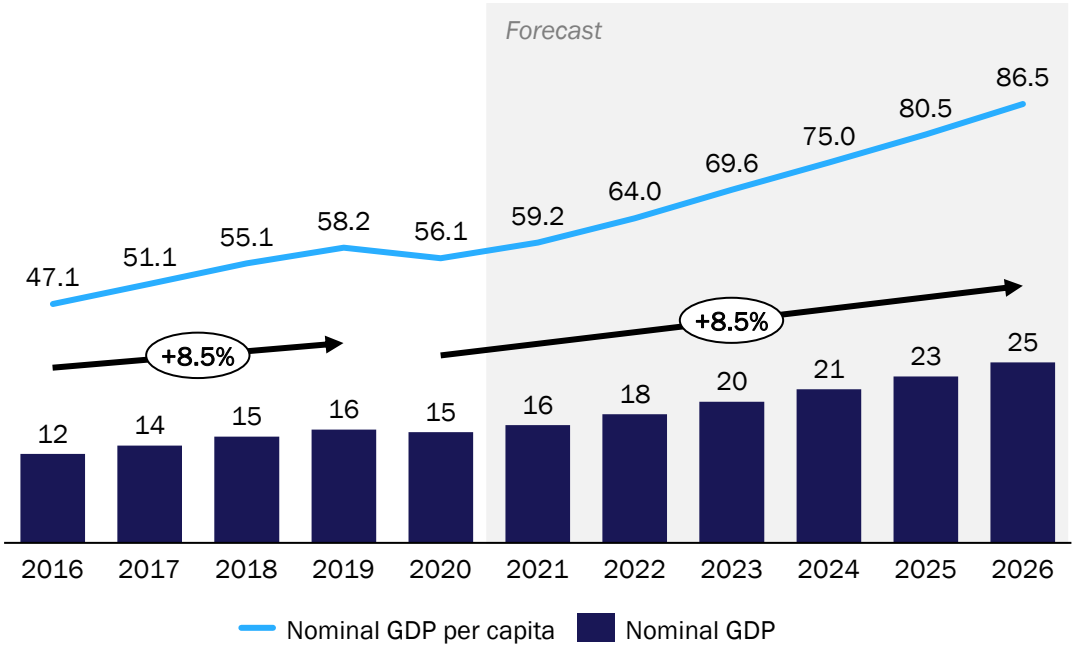


Figure 1.2: Growth in nominal GDP in South-east Asia, CAGR 2020–26 [Source: International Monetary Fund , 2021]

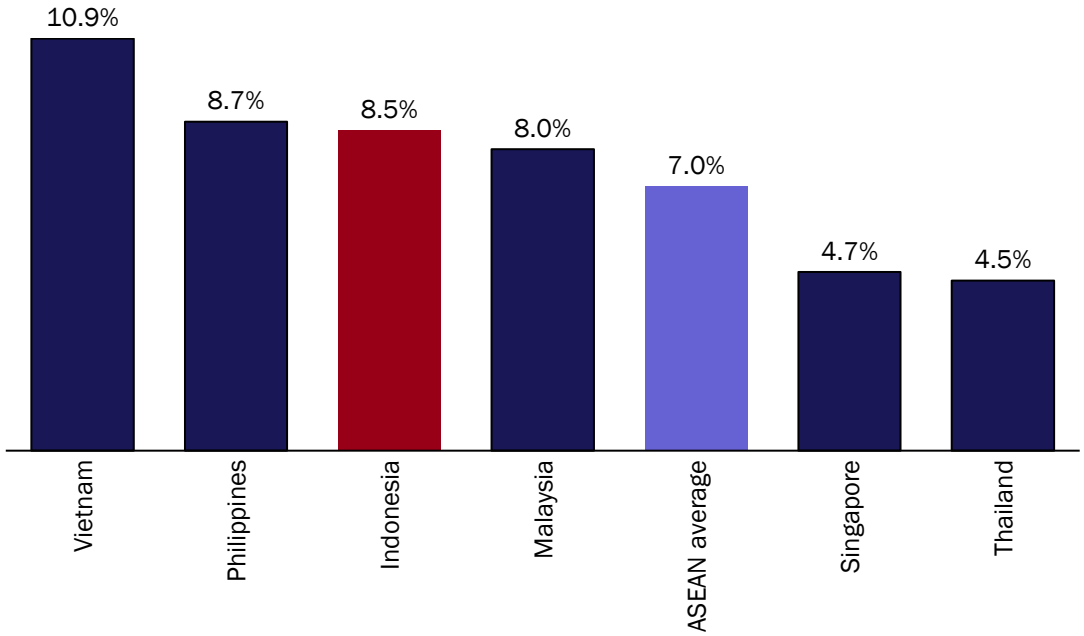


Figure 1.3: Nominal GDP per capita (IDR million) by province, 2020 [Source: BPS, 2022]

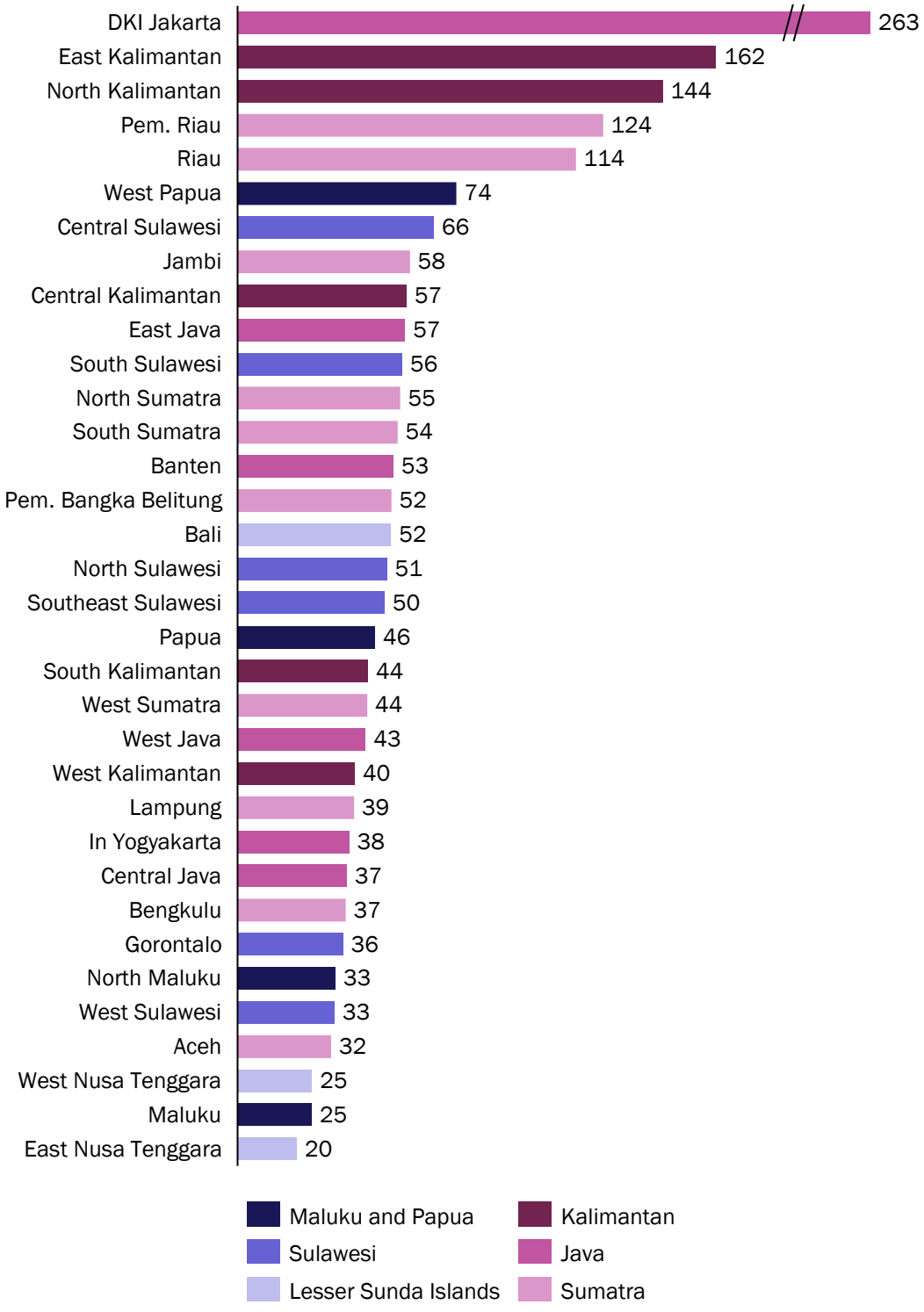


Figure 1.4: Real GDP (IDR quadrillion) and real GDP per capita (IDR million) [Source: International Monetary Fund, United Nations, 2021]

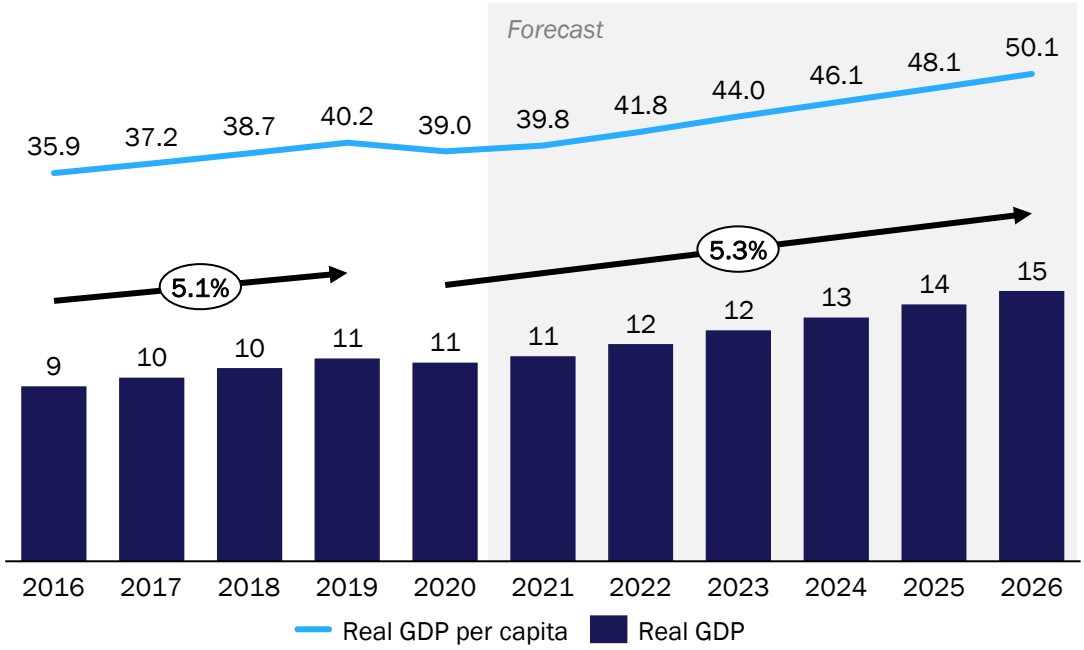
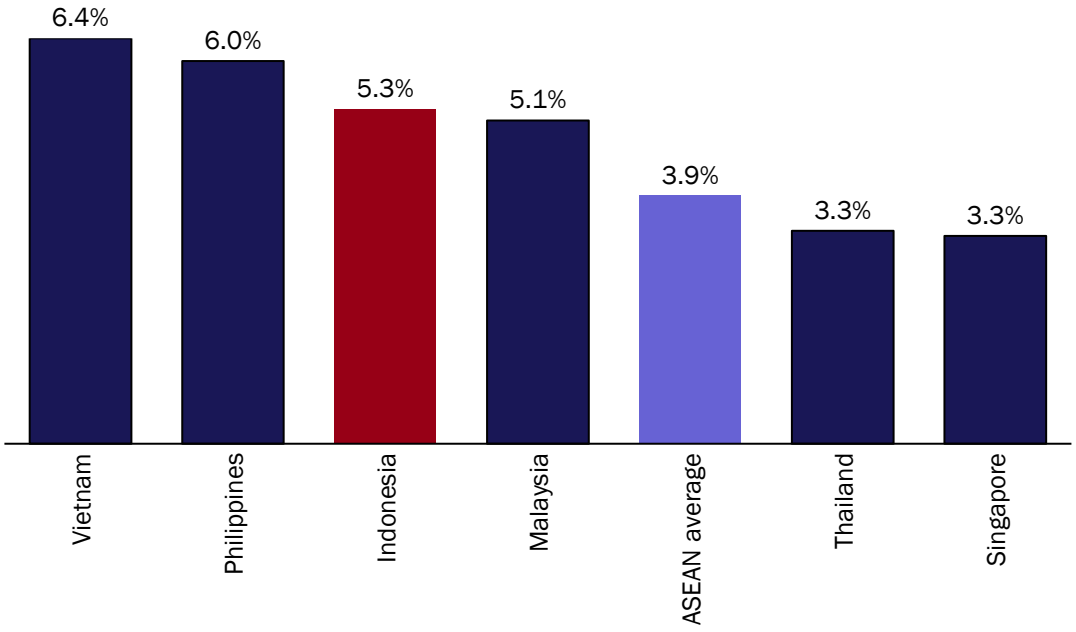


Figure 1.5: Growth in real GDP in South-east Asia, CAGR 2020–26 [Source: International Monetary Fund, 2021]



1.2 Population and population growth

Indonesia has an attractive demographic profile for telecoms services – a large population that is highly urbanised and with a low median age

Indonesia is the fourth most populous country in the world, and the most populous country in South-east Asia. In 2020, it had a population of 274.9 million, and is expected to sustain its past growth rate of 1% CAGR to reach 290.9 million by 2026, according to projections by the United Nations.

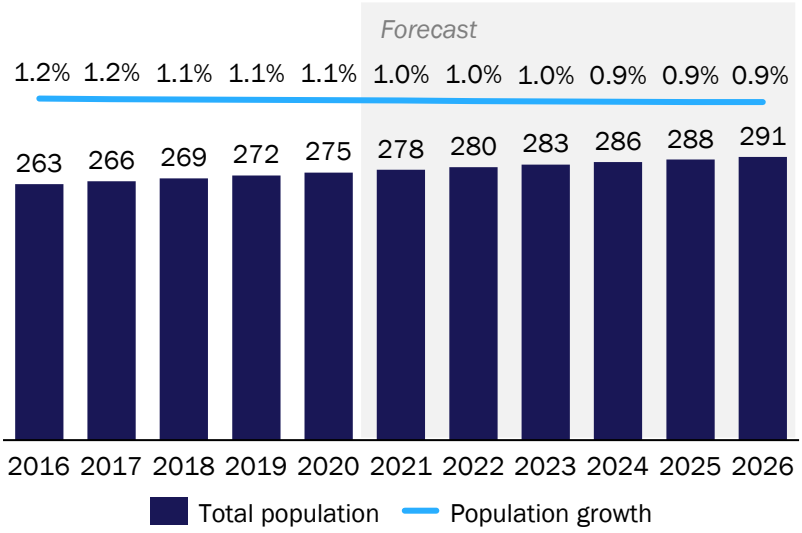


Figure 1.6: Population in Indonesia (million) and growth rate [Source: United Nations, 2021][4]

Despite having the largest population in the South-east Asia region, the growth rate of Indonesia's population has been higher than that of its peers in the region.

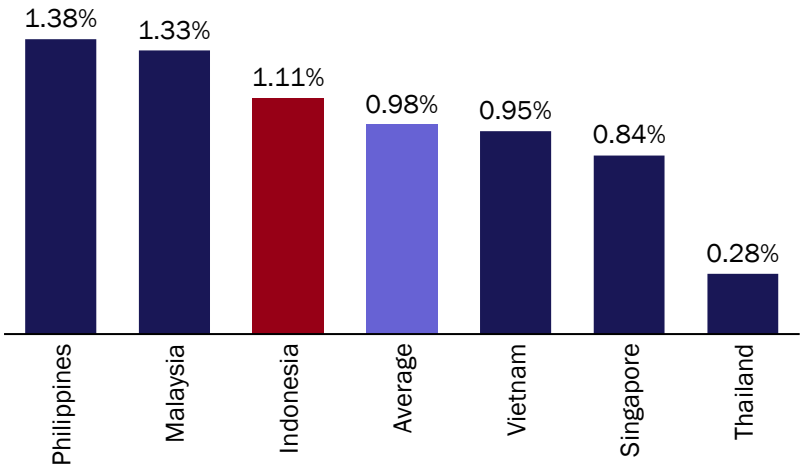


Figure 1.7: Population CAGR (2016–20) in Indonesia and ASEAN countries[5] [Source: United Nations, 2021]

4 Actual population data is available until 2020

5 The average figure represents the average of Indonesia, Malaysia, Philippines, Thailand, Vietnam and Singapore

Over the last five years, the number of households in Indonesia has also witnessed steady growth, which is expected to continue at a 1% CAGR until 2026. This growth in the addressable market is positive for telecoms services that are purchased per household e.g. residential fixed broadband.

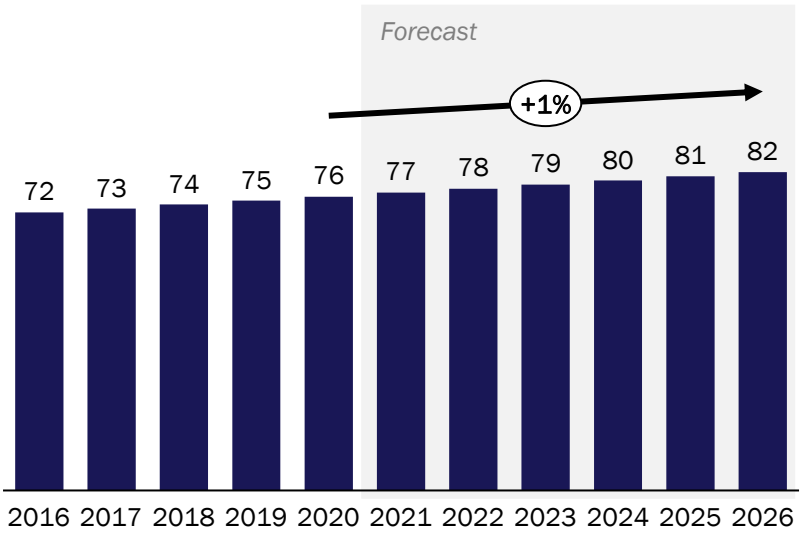


Figure 1.8: Households in Indonesia (million) [Source: Analysys Mason Research, 2021]

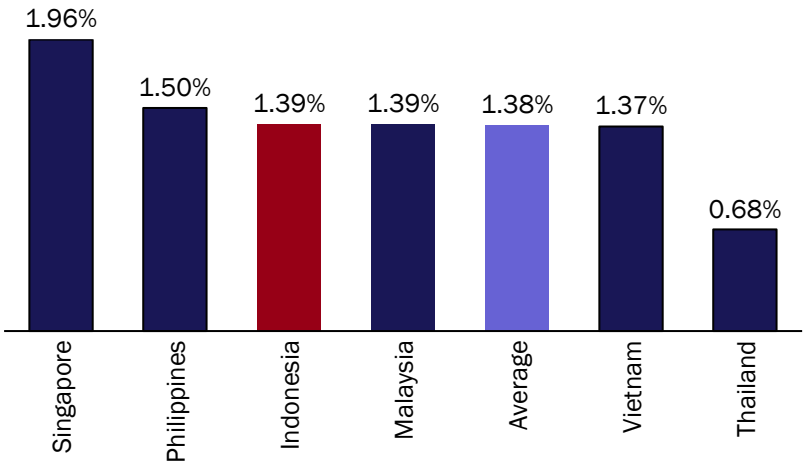


Figure 1.9: Household CAGR (2016–20) in Indonesia and ASEAN countries[6] [Source: Analysys Mason Research, 2021]

Indonesia is also becoming increasingly urbanised, with the total urban population expected to grow from 156 million in 2020 to 176 million in 2026 (a CAGR of 2.1%), which will increase the urban share of the population from 57% in 2020 to 60% in 2026 (see Figure 1.10). This growth will likely be concentrated in the largest urban centres in Indonesia, notably Jakarta, Surabaya, Bekasi, Bandung, Depok and Medan.

6 The average figure represents the average of Indonesia, Malaysia, Philippines, Thailand, Vietnam and Singapore

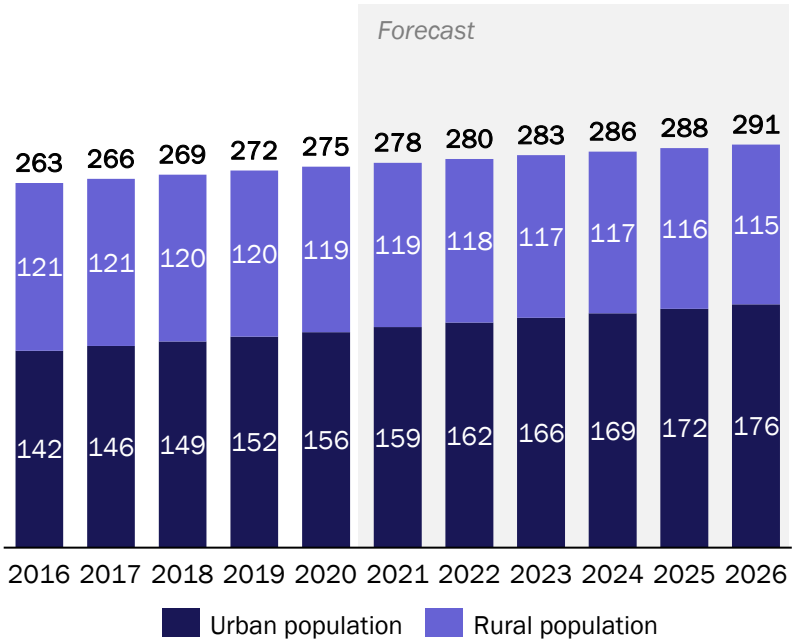
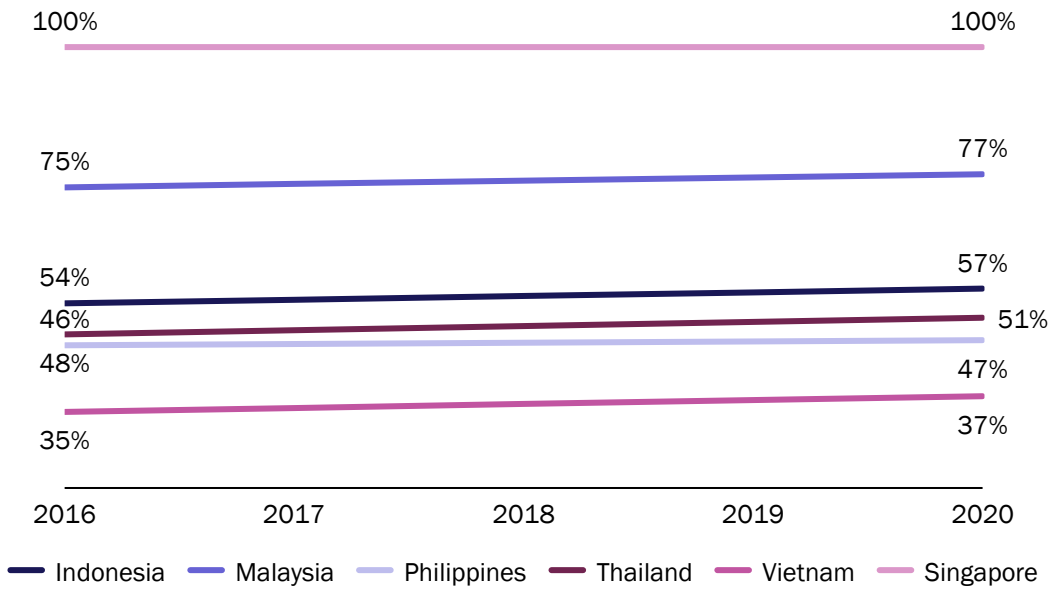


Figure 1.10: Indonesia population split by urban/rural (million) [Source: United Nations 2021]

When compared to its peers in South-east Asia, Indonesia ranks just behind Malaysia and the city state of Singapore in terms of the proportion of population living in urban areas (as shown in Figure 1.11).

Figure 1.11: Urban population percentage (2016–20) [Source: United Nations, 2021]



Indonesia's strong urbanisation trend, coupled with sufficient room for future growth, creates a favourable environment for telecoms services, as urbanisation tends to increase consumer disposable income, making telecoms services more affordable. Operators can achieve significant cost economies when rolling out their networks in dense urban areas. Deployments in densely populated

areas increases the availability of advanced services to a wider audience, which in turn could allow operators to reduce the price of services provided.

Indonesia also has a relatively young population, with 58% being below the age of 35 in 2020. The working-age population, i.e. those aged 15–64, represented 68% of the total in 2020 (see Figure 1.12). It is projected to rise from 190 million in 2020 to 197 million in 2026.

Compared to other South-east Asian countries, Indonesia also has a relatively young population with the national median age of 31 being lower than the South-east Asian average. The high proportion of the young and working age population is expected to drive economic growth and create a favourable market environment for telecoms services.

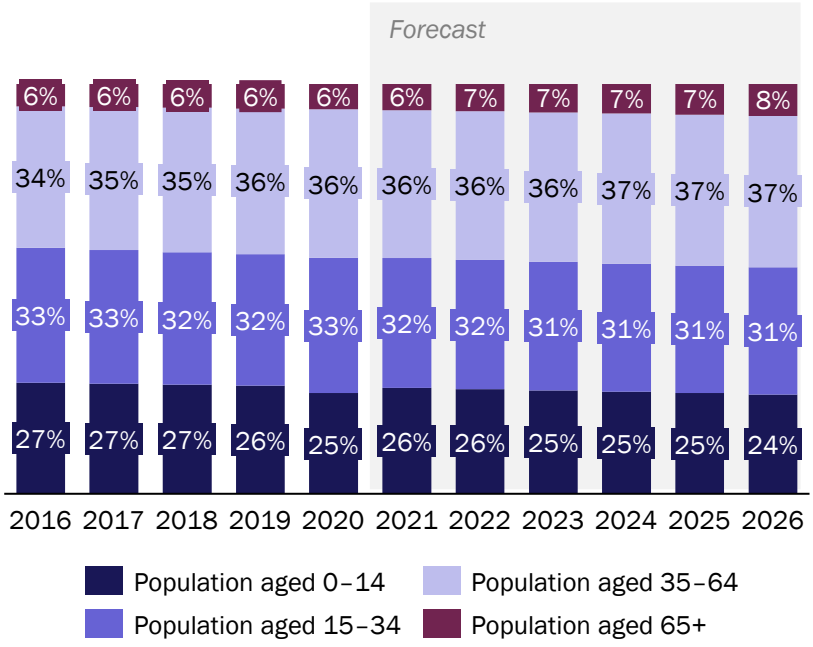
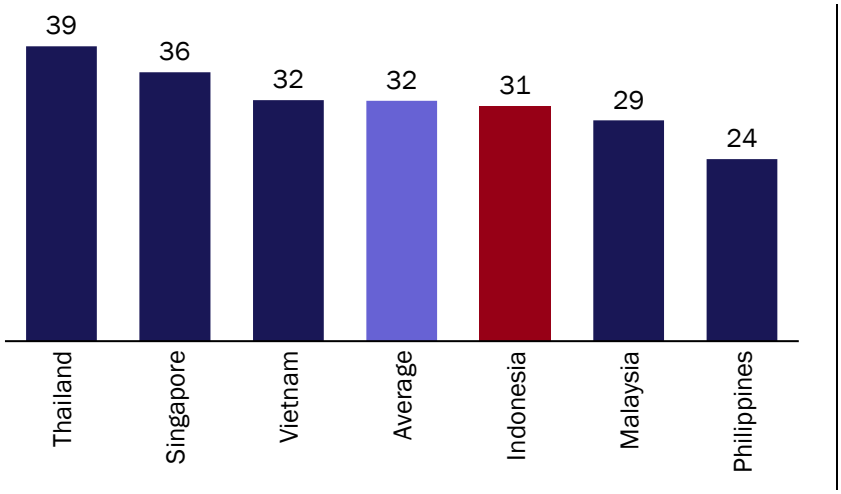


Figure 1.12: Population distribution in Indonesia by age group [Source: BPS, 2021]

Amongst regional peers, Indonesia has a relatively young population (median age of 31, which is lower than the average among the South-east Asian countries (as shown in Figure 1.13). The high proportion of the population being young and of working age is expected to drive economic growth and create a favourable market environment for telecoms services.

Figure 1.13: Median age in Indonesia and ASEAN countries[7], 2021 [Source: World Factbook, 2021]

7 The average figure represents the average of Indonesia, Malaysia, Philippines, Thailand, Vietnam and Singapore



1.3 Disposable income per capita/household

Indonesia is becoming increasingly affluent and per-capita household income has been rising

The proportion of low-income population in Indonesia is also shrinking, with only 18% expected to earn less than USD1,000 per annum by 2026, compared to 31% as of 2020 (see Figure 1.14). A general rise in income level is likely to raise purchasing power, which would likely boost consumption of telecoms services and spur economic growth.

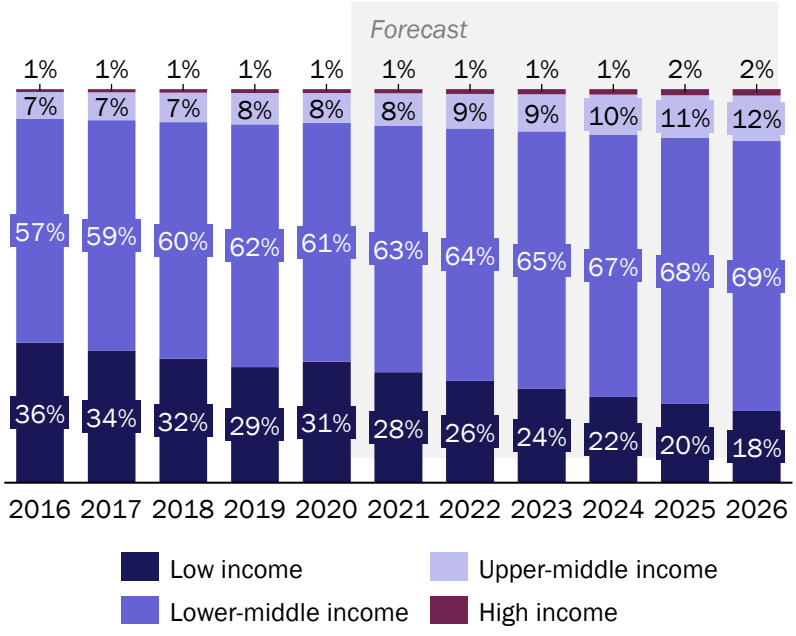


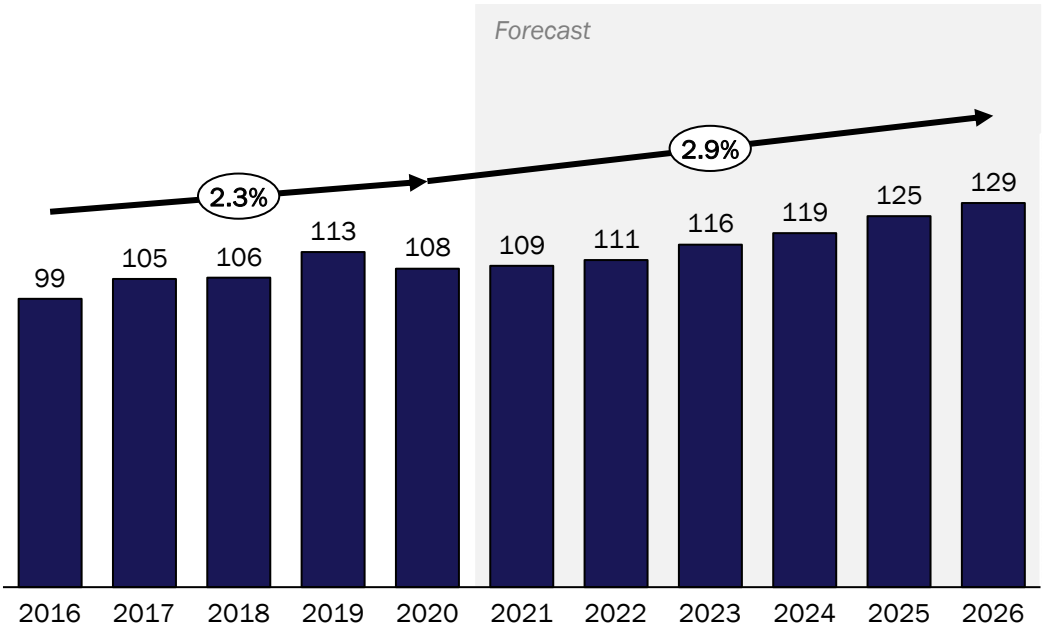
Figure 1.14: Population distribution by income level [Source: Economist Intelligence Unit, 2021]

Note: Number of individuals with annual income within the following bands: low income (USD<1,000), lower-middle income (USD1,000–5,000), upper-middle income (USD5,000–15,000), high income (USD>15,000)

The reduction in the low-income population is also reflected in the growth of the median disposable income over the period 2016–20. This trend is expected to continue into the next five years.

The strong growth in median disposable income will help to drive household budget expenditure on telecoms services, including broadband. New consumers may sign up to services while existing consumers migrate to higher bandwidth and more expensive packages.

Figure 1.15: Projected median disposable income per household (IDR million), 2016–26 [Source: Economist Intelligence Unit, Analysys Mason, 2022]



1.4 Per-capita annual consumption expenditure

Per-capita annual consumption expenditure has been increasing, although there are regional differences across Indonesia

Telecoms services, while often critical in day-to-day life, do rely on the availability of disposable income for usage. This is especially true for high-bandwidth services that are more economically attractive to the service providers. An average household of four in Indonesia typically spends ~7–8% of its disposable income on telecoms services. Even allowing for a small dip due to the Covid-19 pandemic, consumption expenditure per capita in Indonesia has seen steady growth (5% CAGR over the period 2016–21).

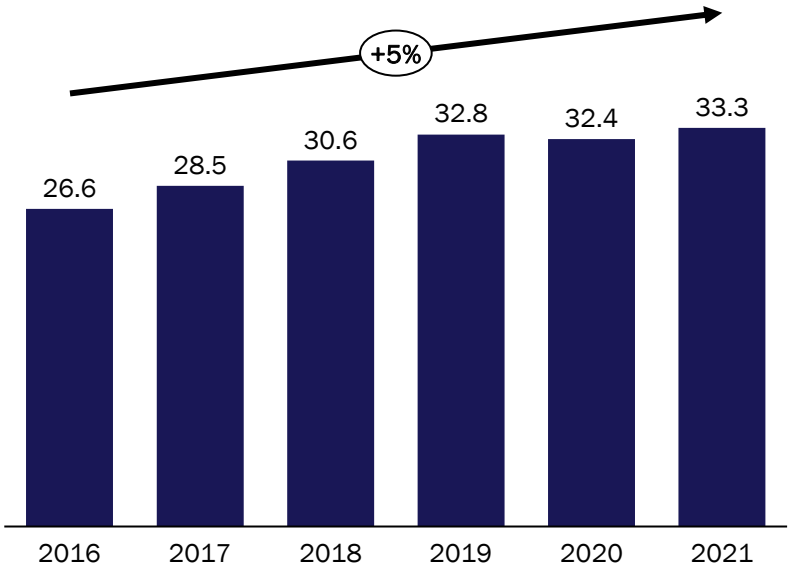
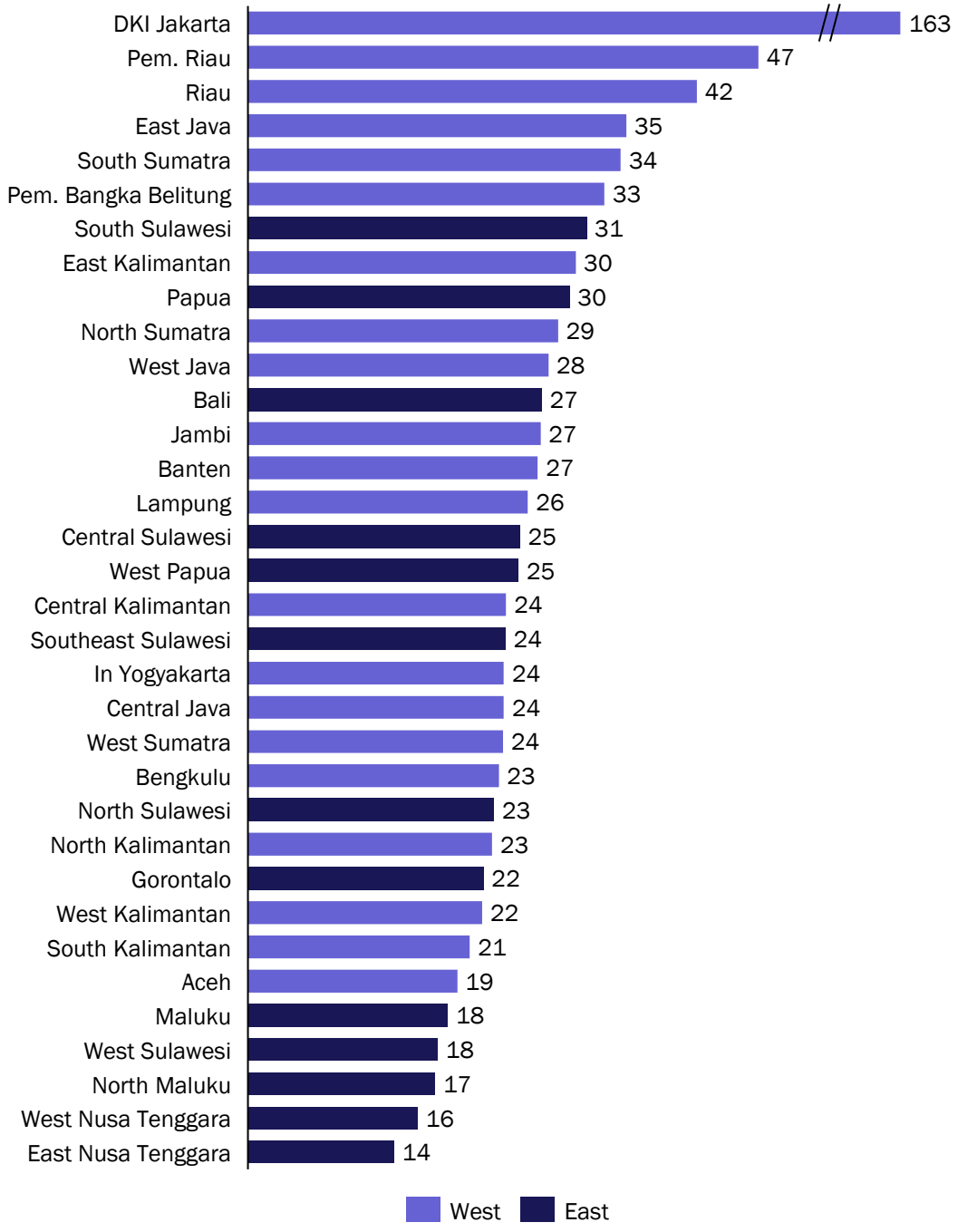


Figure 1.16: Annual consumption expenditure per capita (IDR million), Indonesia [Source: BPS, 2022]

However, there are significant regional differences in consumption trends within Indonesia with the eastern regions typically lagging the wealthier western part of the country; average annual consumption expenditure in Indonesia's western regions, at approximately IDR34 million, is more than 50% higher than that in Indonesia's eastern regions (approximately IDR22 million), as shown in Figure 1.17. Jakarta has a significant lead over the rest of the country in terms of available disposable income.

Figure 1.17: Annual consumption expenditure per capita by province (IDR million), 2020 [Source: BPS, 2022]



1.5 Summary

Indonesia, currently South-east Asia's largest economy, has witnessed robust economic growth that is expected to continue over the next five years. Its population is increasingly urban and has a low median age, all attractive attributes to a telecoms service provider. Affluence is also increasing with rising per-capita household income leading to higher per-capita consumption expenditure. The market is expected to continue to remain attractive for telecoms service providers.

2 Consumer market

2.1 Industry value chain and business model

The mobile network operator (MNO) that provides the service to the customer is the central element in the value chain

To provide telecoms services to the consumer market, a range of different types of players need to work together within the industry value chain. A typical industry value chain is represented below.

Figure 2.1: Traditional industry value chain [Source: Analysys Mason, 2022]

The value chain comprises several types of players:

- Network equipment vendors – they provide the network systems through which telecoms traffic is routed. The exact type of equipment depends on how the telecoms service is being accessed e.g. mobile telecoms requires a radio network that fixed telecoms does not. These vendors typically also provide the IT systems required to provide the telecoms service.
- Transmission and backhaul vendors – they provide the connectivity infrastructure between the network systems. A range of different types of solutions can provide this service. Transmission networks can also be very geographically dispersed ranging from intra-city to between countries.
- Network operators – they are the operators of the telecoms service being provided. For mobile telecoms, these players also own the spectrum used to provide the service.
- Service providers – they provide service provisioning and handle customer engagements. Network operators can provide this service too, although there are companies that only operate in this part of the value chain e.g. mobile virtual network operators (MVNOs).
- Device vendors – they are the manufacturers of the equipment used to access the telecoms service e.g. mobile handset vendors, customer premises equipment (CPE) manufacturers, etc.
- Content providers – this includes content owners and aggregators that supply the content that is provided over the telecoms service.
- Distributors – they provide the customer-facing functions. Service providers can provide these services via stores and online but there are also specialised resellers that operate in this space.

Telecoms services are sold to consumers via the distributors which rely on the marketing efforts of the service providers to attract customers. The service provider works with device vendors and content providers to bring innovative product offerings to the market. The service provider establishes the billing relationship with the customer and is responsible for collecting revenue commensurate to the service subscribed to. To provide the service to the user, the service provider has to establish the network connectivity via business arrangements with network, transmission and backhaul vendors.

The service provider is thus the central party in the industry value chain and the face of the telecoms service being provided. For mobile telecoms services, service providers are typically referred to as MNOs.

2.2 Industry overview

Voice services have seen steady decline while broadband take-up continues to grow

The Indonesian mobile market is expected to grow, catching up with other South-east Asian countries in terms of unique penetration.[8] Mobile average revenue per user (ARPU) is expected to resume gradual growth after 2021 as the country recovers from the Covid-19 pandemic. Driven by increasing connections and ARPU, market revenue is expected to reach IDR173 trillion (USD12 billion) by 2026 based on Analysys Mason Research estimates. The Covid-19 pandemic has also been a catalyst in accelerating digital service consumption (e.g. e-commerce, transport and food, online media and financial services) with ~37% of all digital service consumers being new to these services since 2020.[9]

While legacy voice traffic is expected to continue to decline, Analysys Mason Research projects data traffic in Indonesia to grow significantly at a CAGR of 26% from 2020 to 2026 (see Figure 2.19). Indonesia has one of the most 'mobile-first' populations where data is mainly consumed via mobile networks, with 92% of digital minutes spent on mobile handsets.[10] Indonesia is one of the largest markets for social media (notably Facebook and Instagram) and has one of the highest numbers of mobile app downloads (reaching 7.3 billion in 2021).[11]

The mobile market is currently fragmented with five MNOs – Telkomsel, Indosat, XL, Hutchison 3 and Smart Telecom (Smartfren). The Indosat–Hutchison 3 merger could create a more concentrated four-MNO market with reduced competition. The merger between Indosat and Hutchison 3 would make it the second largest MNO behind Telkomsel and would also put the merged entity in a strong

8 Unique penetration is defined as the number of unique individuals who subscribe to mobile services as a percentage of total market population.

9 Based on e-Conomy SEA 2020 report by Google, Temasek and Bain & Company.

10 https://www.marketingcharts.com/digital/mobile-phone-115616

11 https://datareportal.com/reports/digital-2022-indonesia

position both financially and in terms of spectrum holdings, allowing more aggressive investments into regions outside Java.

The demand for new mobile cell sites is expected to grow, given that MNOs are currently focusing efforts on expanding their networks outside the Java region to catch up with Telkomsel, the incumbent. In the longer term, 5G deployments could drive additional fiberisation of network sites as backhaul capabilities need enhancement to accommodate increasing data traffic.

Based on research from Analysys Mason, fixed voice household penetration in Indonesia grew between 2016 (13%) and 2020 (17%), mainly due to take-up of Telkom's triple-play service plans that bundle fixed voice with fixed broadband and internet protocol TV (IPTV). However, usage has been decreasing as evidenced by the decline in ASPU over the same period, likely driven by increasing prevalence and preference for mobile services.

Similarly, fixed broadband household penetration in Indonesia grew significantly between 2016 (5%) and 2020 (13%),[12] mainly due to investments in fibre roll-out and the IndiHome[13] retail fibre proposition from Telkom, the fixed telecoms incumbent. However, household penetration remains low compared to other countries in the South-east Asia region. This is partly because coverage is more limited in Indonesia than in some other countries in the region due to the archipelagic geographical layout of the country. Fixed broadband retail plans are also relatively expensive in Indonesia compared to elsewhere in the region, which partly reflects the incumbent Telkom's high market share. Generous mobile data allowances have also constrained the growth in the number of fixed broadband subscribers.

Total fixed retail revenue grew to IDR54 trillion (USD3.65 billion) in 2020 based on Analysys Mason Research, thanks to increased take-up of fibre broadband. Indeed, fibre broadband accounted for nearly 64% of total fixed retail revenue as of Q2 2021.

The market has also witnessed recent consolidation as operators look to accelerate network roll-out In January 2022, XL Axiata announced that it will acquire a majority stake (66%) in cable and fibre operator Link Net[14] as it aims to strengthen its position in the fixed broadband and pay-TV[15] markets.

Contributing more than 4% to Indonesia's GDP (USD44 billion) in 2020, the digital economy is expected to continue growing at an unprecedented rate. Following the fourfold increase recorded from 2015 to 2020, the Indonesian digital economy is expected to reach USD124 billion by 2025,[16] driven by aggressive adoption of digital services like social media, digital entertainment, gaming, e-commerce, online food delivery, ride-hailing, productivity apps, mobile payments and digital

12 Analysys Mason Research.

13 IndiHome is Telkom Indonesia's home telephone, broadband internet and IPTV services offering

14 https://www.xlaxiata.co.id/en/news/axiata-and-xlaxiata-sign-conditional-share-purchase-with-link-net

15 Television services for which a fee is payable as opposed to free-to-air broadcast services. IPTV is one mechanism of providing pay-TV services using internet connections

16 https://www.weforum.org/agenda/2021/03/digital-policy-in-indonesia-the-missing-public-sector-link/

banking. Steady increase in the consumption of these services will drive the demand for data services and require MNOs to increase their network capacity.

2.3 Mobile telecom services

Considerable growth opportunity remains in the market with average revenue per user (ARPU) expected to increase driven by data consumption

2.3.1 Cannibalisation by OTT applications is expected to drive further decline in voice traffic

Reflecting global trends, voice traffic in Indonesia has been decreasing due to the increased use of over-the-top (OTT) applications. While this trend is expected to continue, the growth in data traffic is expected to accelerate, driven by increasing consumption of video content, social media and the rapid growth in the digital economy. As a result, MNOs are expected to increase their investments in the capacity of their networks.

Mobile voice traffic in Indonesia has been in sharp decline, falling at an annual rate of 15% from 2016 to 2020 (from 474 billion minutes in 2016 to 249 billion minutes in 2020). Minutes of use (MoU) also follow a similar declining trend, from an average of 124 minutes per month in 2016 to 69 minutes in 2020 (see Figure 2.2).

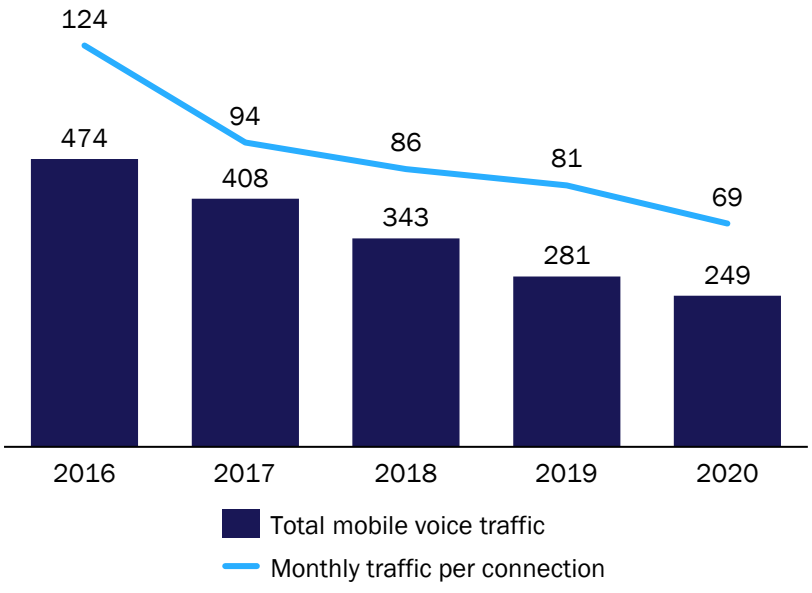


Figure 2.2: Mobile operator voice traffic (billion minutes) and monthly traffic per user in Indonesia (minutes) [Source: Analysys Mason Research, 2021]

The decline in mobile operator voice traffic has largely been due to the prevalence and popularity of OTT applications such as WhatsApp, which allow users to make calls using a data connection instead of using a traditional circuit-switched voice connection. OTT apps have been gaining popularity in Indonesia with voice traffic carried by them growing by almost 50% on an annualised basis from 2016 to 2020 (see Figure 2.3). The shift away from voice traffic to OTT apps is expected to continue, driving further declines in operator voice traffic.

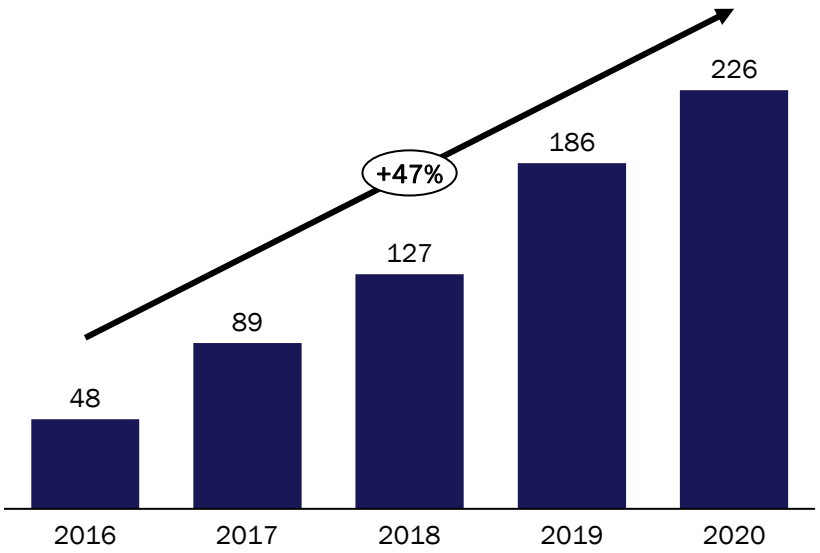


Figure 2.3: OTT voice traffic (billion minutes) [Source: Analysys Mason Research, 2021]

2.3.2 Mobile connections are expected to see steady growth as Indonesia's unique penetration remains relatively low compared to other countries in South-east Asia

The overall mobile connection base in Indonesia declined at a CAGR of 2.8% between 2016 and 2020, largely due to a decline in connections in 2018 associated with enforced SIM re-registration which was aimed to combat the misuse of SIM cards in the country (expected to be a one-off occurrence). Following the SIM re-registration process, mobile connections grew at a CAGR of 3.9% from 2018 to 2020 (see Figure 2.4).

Figure 2.4: Mobile connections (million) and penetration [Source: Operators' reports, Analysys Mason, 2021]

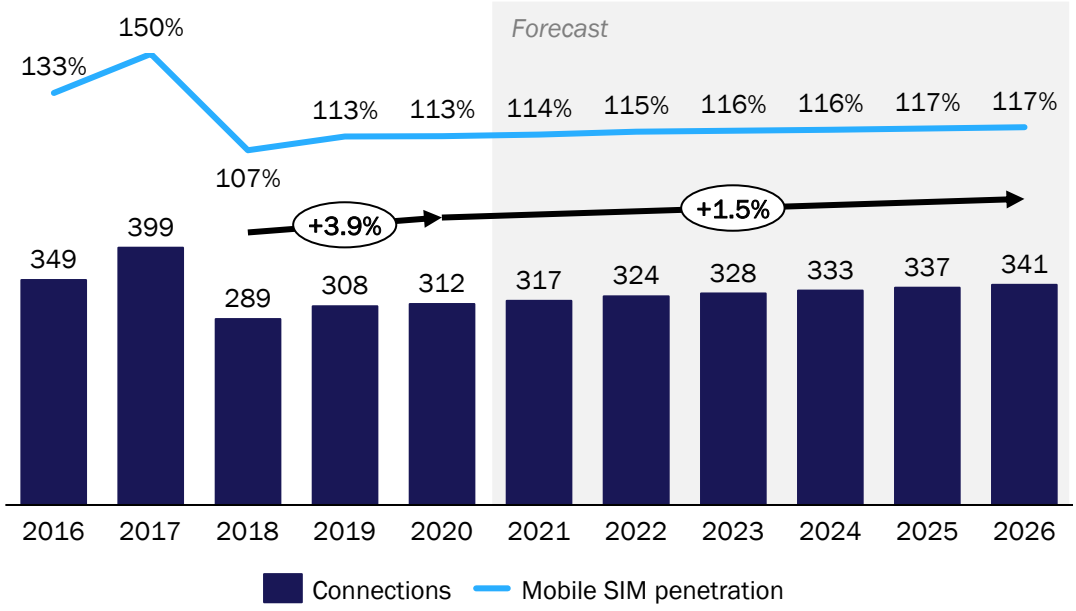
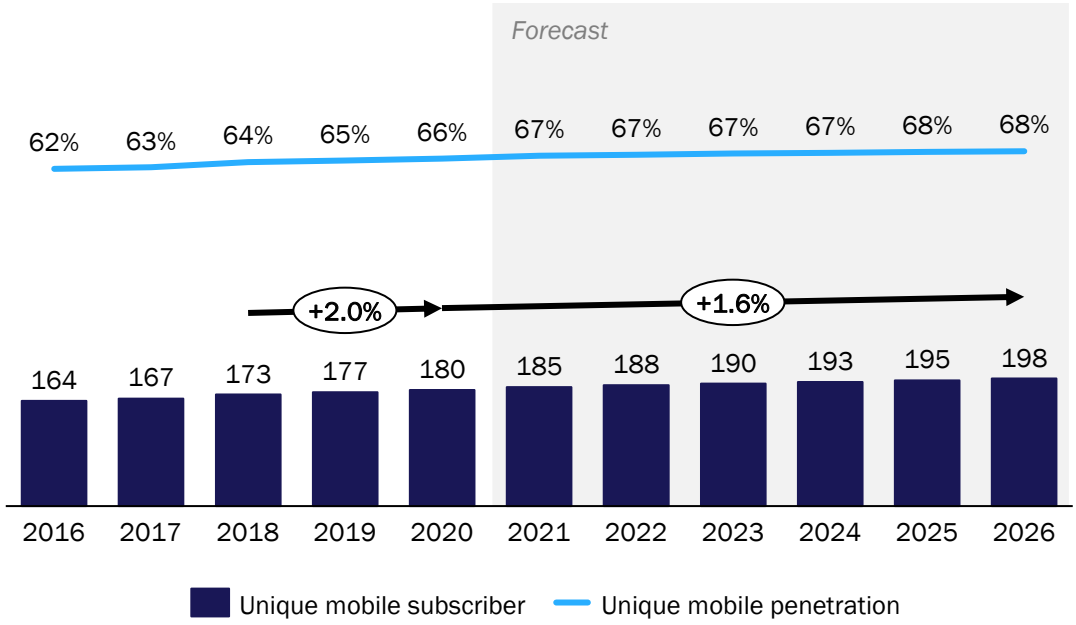


Figure 2.5: Unique mobile subscribers (million) and unique subscriber penetration [Source: GSMA Intelligence, 2022]



While mobile subscriber penetration has been greater than 100% for several years, unique subscriber penetration stands at 66% as of 2020. Indonesia's unique subscriber penetration is currently lower than that of the average across other South-east Asian countries and is indicative of the large growth potential that this market still exhibits.

In the future, the expected steady growth in connections will largely be driven by:

- strong multi-SIM adoption
- improved device affordability
- lack of extensive fixed-line infrastructure.

Strong multi-SIM adoption

Innovative mobile plans and attractive bundled offers have contributed to a 'dual-SIM phenomenon' in Indonesia. While users generally keep a primary SIM to make it easy for their contacts to reach them, they may also have a second SIM that provides more attractive offers on certain services (e.g. unlimited use of certain apps).

Although there were 357 million wireless SIMs in Indonesia in 2020, there were only 180 million unique subscribers according to GSMA Intelligence's estimates.[17] This equates to 66% unique subscriber penetration, with an average of 2.0 SIMs per unique subscriber. Nonetheless, unique

17 https://www.gsmaintelligence.com/

subscriber penetration has also grown steadily at a CAGR of 2.5% between 2016 and 2020, supporting the notion of the increasing affordability and accessibility of mobile services.

Improved device affordability

The emergence of smartphones priced at less than IDR2 million (USD140) has increased device affordability, with varied choices from international (e.g. Xiaomi and Vivo) and local vendors (e.g. Advan and Evercoss). Ongoing price reductions on smartphones are expected to drive further growth of unique mobile users in Indonesia, which currently lags behind that of regional peers like Thailand, Malaysia and Vietnam (as shown in Figure 2.6).

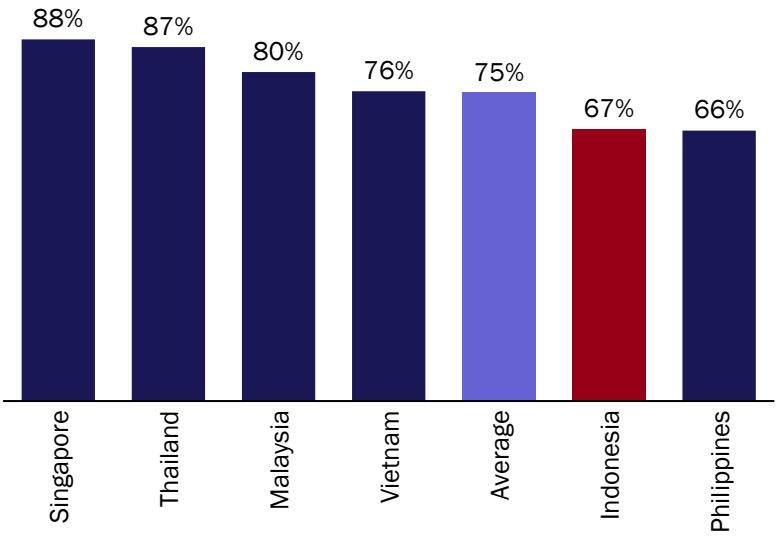


Figure 2.6: Unique subscriber penetration across benchmark countries[18] in 2021 [Source: GSMA Intelligence, 2022]

Lack of extensive fixed-line infrastructure

As shown in Figure 2.7, fixed-line internet penetration in Indonesia is among the lowest in South-east Asia, mainly due to a lack of fixed network coverage in rural areas, especially outside Java. Fixed-line network roll-out has only taken off in key urban areas such as Jabodetabek (Jakarta and the surrounding regions, including Bogor, Depok, Tangerang and Bekasi), whilst rural roll-out, especially outside Java, remains challenging due to the archipelagic nature of the country.

18 The average figure represents the average of Brunei, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, Timor-Lest and Vietnam. The average is calculated by Analysys Mason.

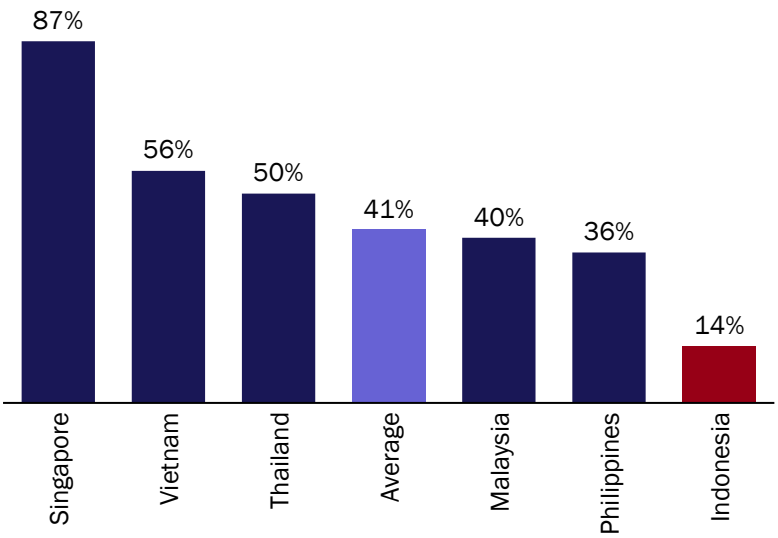


Figure 2.7: Fixed-line internet penetration[19] across benchmark countries[20] in 2020 [Source: Analysys Mason Research, 2021]

Growth in fixed-line broadband penetration over the next five years is expected to be predominantly restricted to urban areas, as deployment of wireline infrastructure to rural areas is often uneconomical. The lack of fixed-line broadband infrastructure is expected to remain a key growth driver for mobile data take-up, leading to a continued surge in mobile data traffic.

2.3.3 Mobile ARPUs are expected to increase, gradually supported by heavy data demand from consumers

Mobile ARPUs were depressed in 2020 after the Covid-19 pandemic due to the surge in unlimited data plans and pandemic relief provided by Indonesia's MNOs in support of the government's data-subsidy programme. The effects of these reduced tariffs are expected to last until 2021, when MNOs should be able to begin raising tariffs gradually to reflect higher data demand from consumers and as Indonesia recovers from the effects of the pandemic. For instance, Indosat and Smartfren made changes in pricing in 2021. Telkomsel also launched unlimited plans into new cities with higher tariffs in 2021.[21] Moreover, the Indosat–Hutchison 3 merger is likely to result in a more rational pricing environment with reduced competition. MNOs are likely to shift focus away from price competition to achieve sustainable business growth in the more consolidated market in future.

Indonesia's mobile ARPU is relatively lower when comparing with other South-east Asian markets, which provides a room for potential growth. Mobile ARPU is expected to reach a CAGR of 3% between 2020 and 2026, higher than the average of 1%.

19 Fixed-line internet refers to fixed broadband in both the residential and enterprise segments.

20 The average figure represents the average of Indonesia, Malaysia, Philippines, Thailand, Vietnam, Cambodia and Singapore

21 UBS Indonesia Telecom Sector analyst report May 2021.

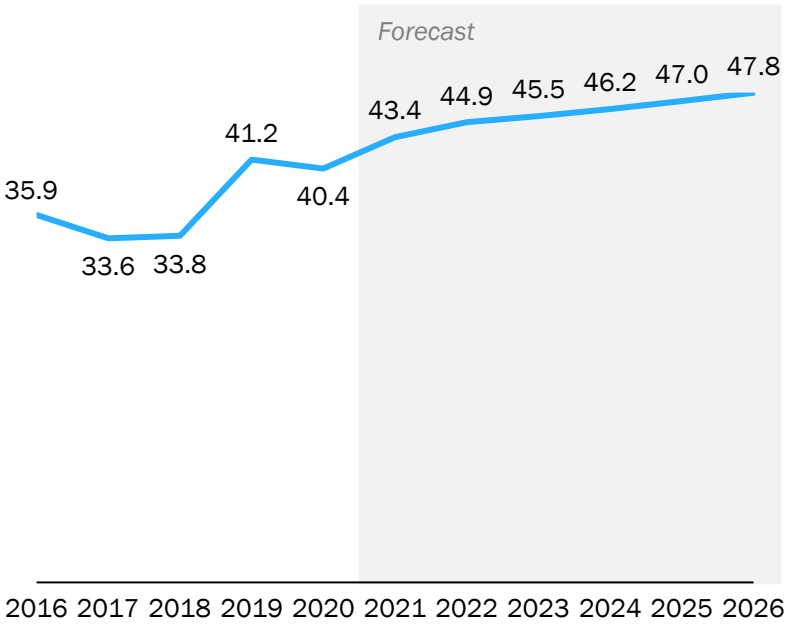


Figure 2.8: Mobile ARPU in Indonesia (IDR thousand/month) [Source: Analysys Mason Research, 2021]

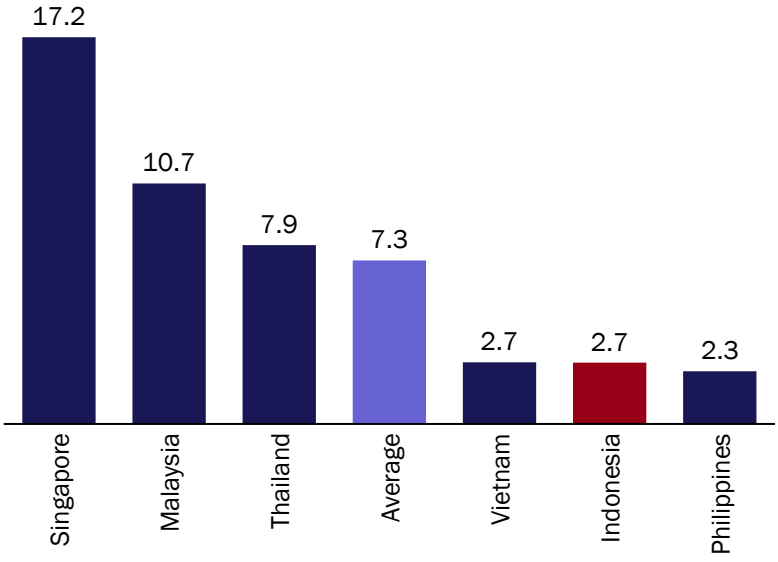


Figure 2.9: Mobile ARPU (USD/month) across benchmark countries[22] in 2020 [Source: Analysys Mason Research, 2022]

22 The average figure represents the average of Indonesia, Malaysia, Philippines, Thailand, Vietnam and Singapore

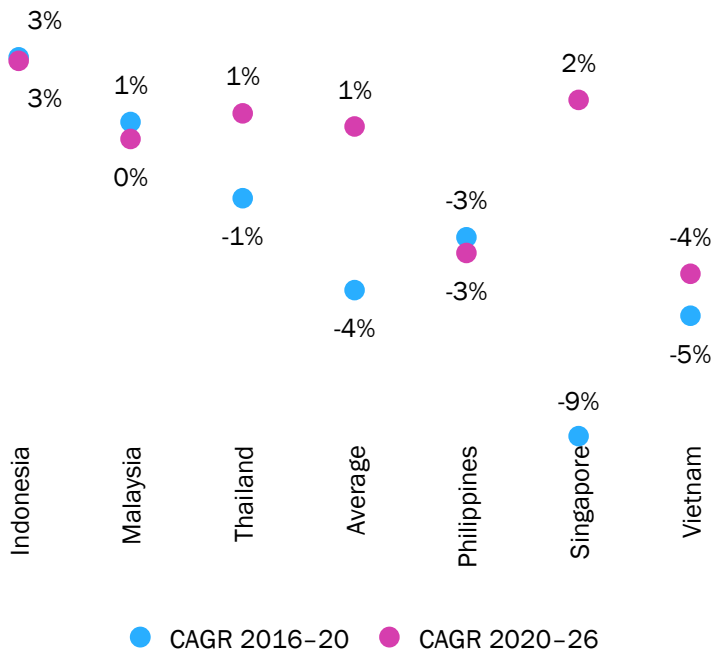


Figure 2.10: Mobile ARPU CAGR % across benchmark countries[23] [Source: Analysys Mason Research, 2022]

2.4 Fixed telecoms services

Residential fixed voice has witnessed steady decline in usage while residential fixed broadband has witnessed steady growth

The archipelagic nature of Indonesia's geography leads to technical difficulties and higher costs when deploying fibre networks for fixed services.

2.4.1 Falling fixed voice revenue

Indonesia has seen an increase in both total residential fixed voice connections and household penetration, mainly driven by take-up of Telkom's triple-play service plans (fixed voice bundled with fixed broadband and IPTV services). According to Analysys Mason Research, residential fixed voice connections grew at a CAGR of 7.0% between 2016 and 2020, reaching 17% household penetration in 2020.

23 The average figure represents the average of Indonesia, Malaysia, Philippines, Thailand, Vietnam and Singapore

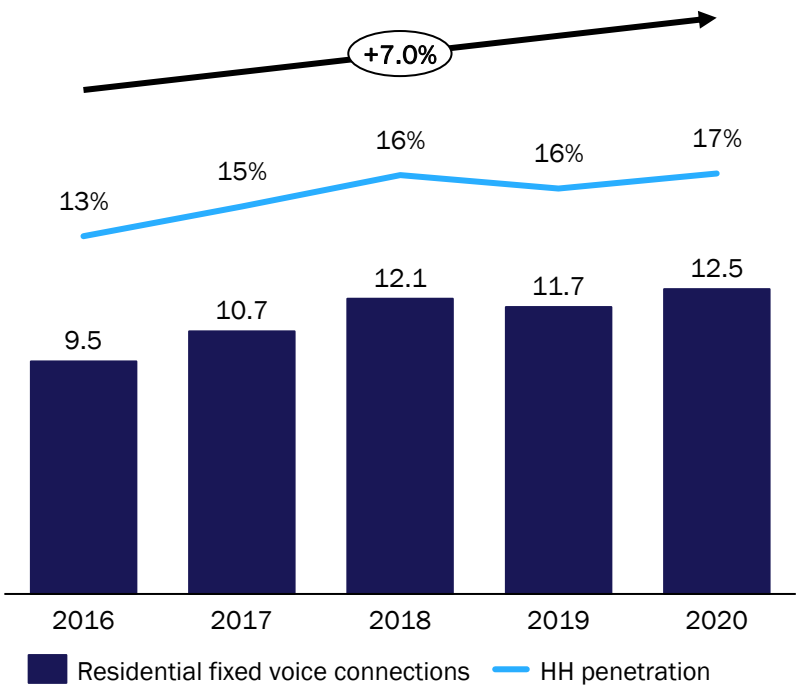


Figure 2.11: Residential fixed voice connections (million) and household penetration [Source: Analysys Mason Research, 2022]

However, despite the growing penetration, fixed voice usage has been in decline, likely driven by increasing prevalence and preference for mobile services. This is reflected in the sharp decline in average spend per user (ASPU) over the same period.

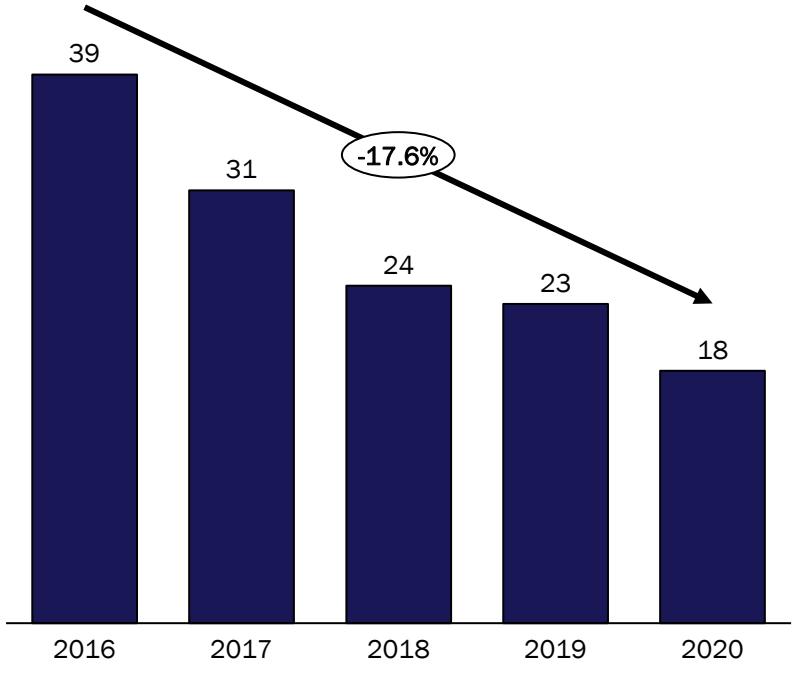


Figure 2.12: Residential fixed voice ASPU (IDR thousand/month) [Source: Analysys Mason Research, 2022]

2.4.2 Steadily growing fixed broadband revenue

The archipelagic nature of Indonesia's geography leads to technical difficulties and higher costs when deploying fibre networks for fixed broadband. As a result, current fixed broadband penetration in the country is significantly lower when compared to other South-east Asian countries, as seen in Figure 2.14. Situation is comparable to that in the Philippines, another archipelagic country, although penetration in Indonesia is lower than that in the Philippines as of 2020.

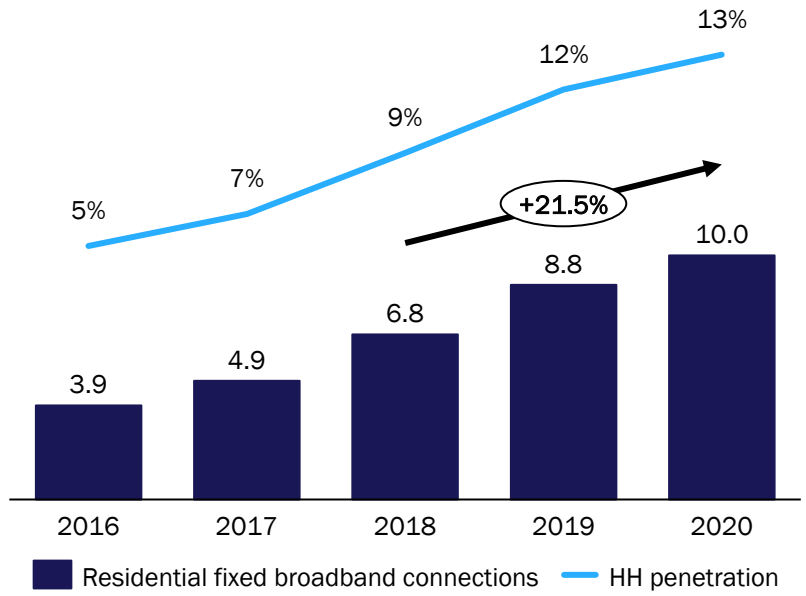


Figure 2.13: Residential fixed broadband connections (million) and household penetration [Source: Analysys Mason Research, 2022]

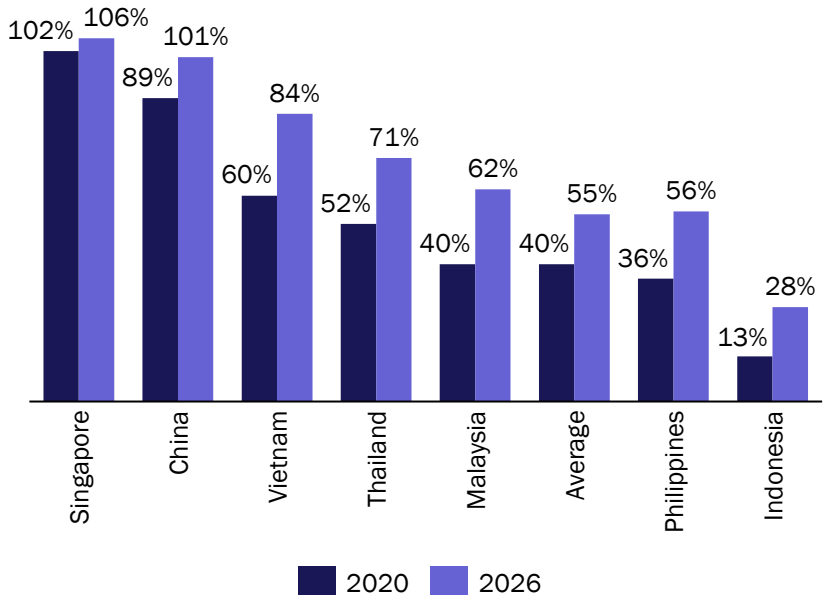


Figure 2.14: Benchmarks of household fixed broadband penetration[24] in 2020 and 2026 [Source: Analysys Mason Research, 2022]

24 Refers to the number of residential fixed broadband connections as a share of total number of households. The average figure represents the average of Indonesia, Malaysia, Philippines, Thailand, Vietnam, Cambodia, Myanmar and Singapore

Despite the low penetration rate, growth in the number of connections has been significant over the last five years. This has been driven by extensive roll-outs by many of the service providers as well as the need for high-speed connections at home given the restrictions imposed by the Covid-19 pandemic. However, ASPU has seen modest growth over the same period.

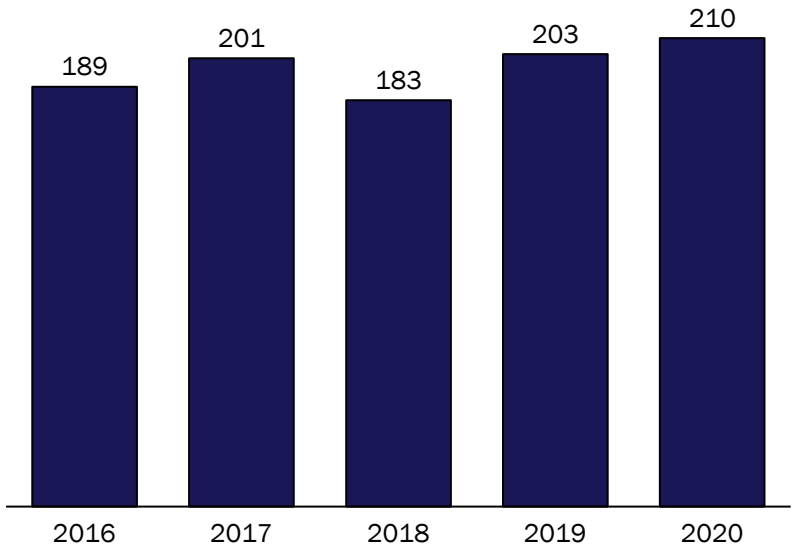


Figure 2.15: Residential fixed broadband ASPU (IDR thousand per month) [Source: Analysys Mason Research, 2022]

2.5 Internet services

Data traffic has witnessed steep growth, driven by demand for video content, social media usage and growth of the digital economy

Indonesia's internet user base has increased at a CAGR of 22% to reach 148 million in 2020. Increasingly affordable smartphones and mobile data plans are expected to continue driving the growth of internet take-up.

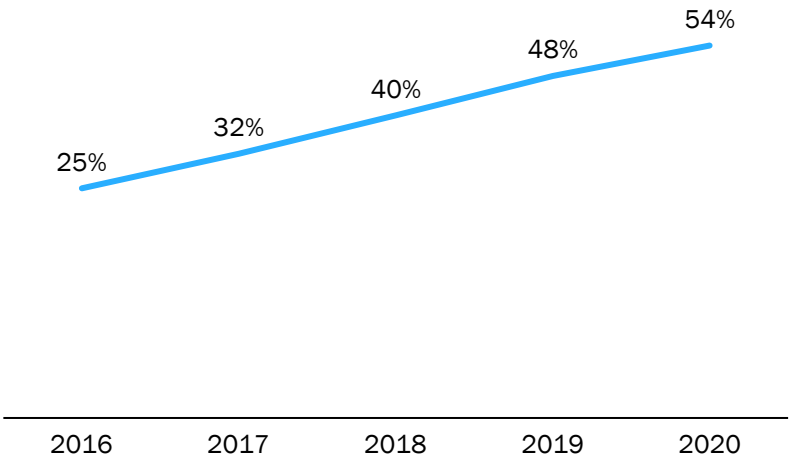


Figure 2.16: Indonesia internet penetration (%) [Source: ITU, 2021]

In general, Indonesians are relatively internet literate, and spend a considerable amount of time online engaging in activities such as social media, video streaming, e-commerce and gaming. Specifically, social media platforms such as YouTube, WhatsApp, Instagram and Facebook are particularly popular. Increasing penetration rates are also observed for newer apps such as TikTok and Pinterest. Internet usage patterns in the country suggest increasing reliance on high-speed internet to support activities that require low-latency connectivity.

Figure 2.17: Key activities for internet users in Indonesia [Source: Analysys Mason, 2022]

Activities	Description
Social media	As of 2020, 92% of internet users have social media accounts. The average internet user has ~10 social media accounts
Online videos	99% of internet users consume online video content. Youtube is by far the most popular video content platform; it is used by ~80% of Indonesian internet users
E-commerce	88% of internet users have made an online purchase, the highest e-commerce adoption in the world

Indonesia, together with the Philippines, Malaysia and Thailand, ranked amongst the top 10 countries globally in terms of average daily time spent on the internet in 2021. Indonesians spend an average of 8.6 hours on the internet daily, trailing closely behind the Philippines (10.5 hours), Malaysia (9.2 hours) and Thailand (9.1 hours).

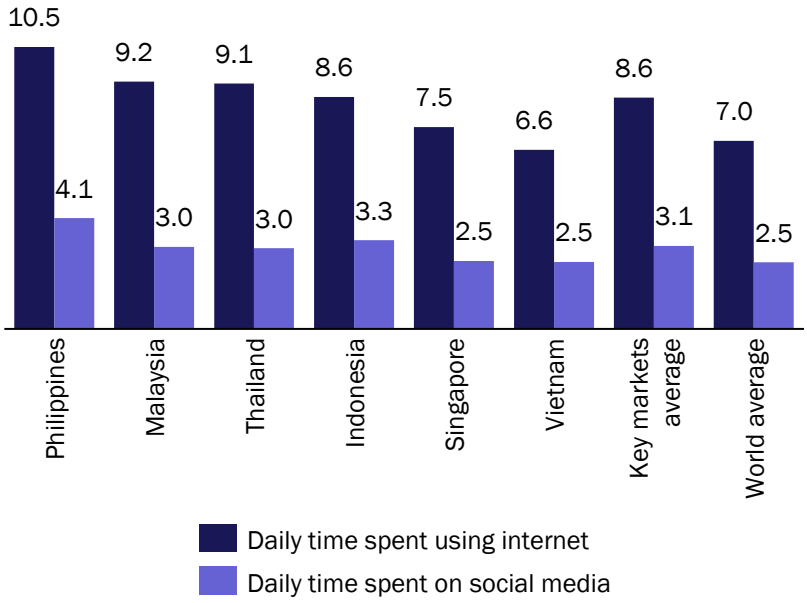


Figure 2.18: Average time spent daily on the internet and social media (hours) in 2021[25] [Source: Statista,[26] 2021]

Average mobile data usage per connection has grown strongly over the last five years, from 0.6GB/month in 2016 to 7.2GB/month in 2020, driven by a significant increase in intrinsic internet demand and smartphone penetration. This trend is forecast to continue, at a CAGR of 21%, to reach around 22GB/month by 2026, as shown in Figure 2.19. Supported by increasing mobile penetration, corresponding total mobile data traffic is expected to enjoy higher growth at a CAGR of 24%, to reach over 104EB of data in 2026 from 29EB in 2020.

25 The key markets average represents the average of Indonesia, Malaysia, Philippines, Thailand, Vietnam and Singapore

26 Source: DataReportal, & Hootsuite, & We Are Social. (January 26, 2022). In Statista: https://www.statista.com/statistics/1258232/daily-time-spent-online-worldwide/; source: DataReportal (February 15, 2022) in Statista. https://www.statista.com/statistics/1128147/apac-daily-time-spent-using-social-media-by-country-or-region/

Figure 2.19: Mobile and fixed data usage[27] per connection (GB/month) [Source: Analysys Mason Research, 2022]

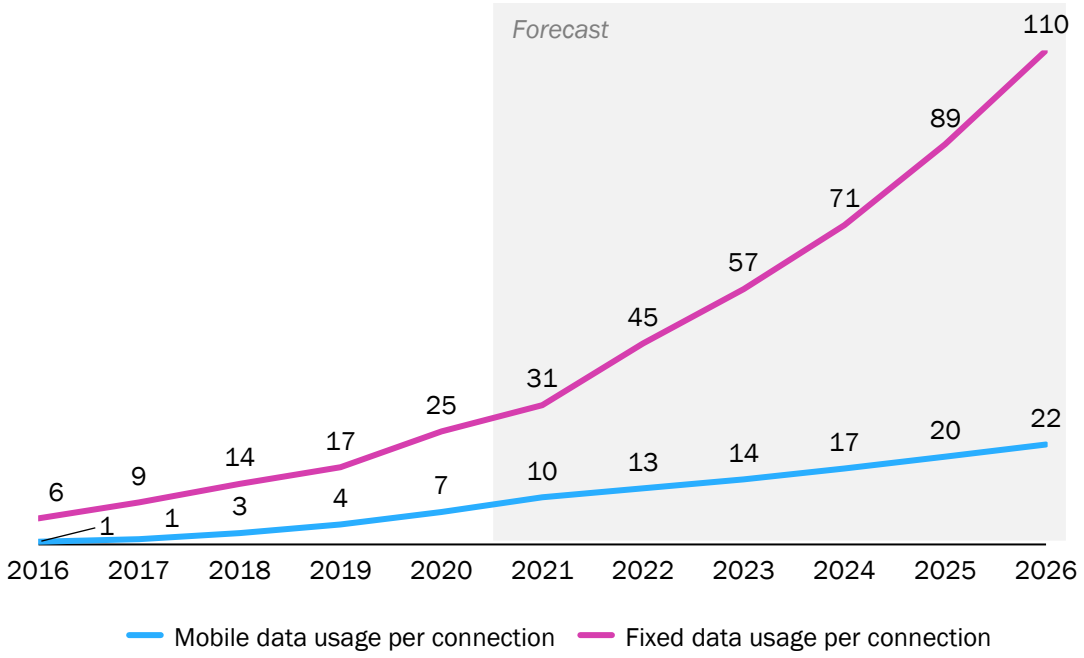
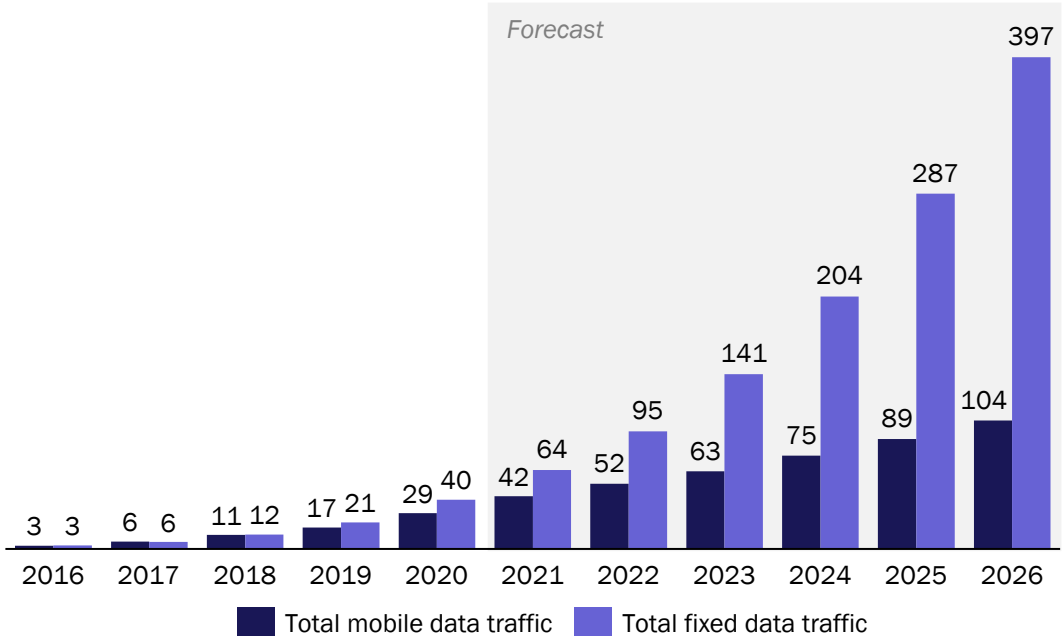


Figure 2.20: Total mobile and fixed data traffic (EB[28]/year) [Source: Analysys Mason Research, 2021]



27 Mobile data traffic is defined as total cellular data traffic (downstream and upstream) generated by all cellular devices; fixed data traffic is defined as the total annual traffic from best-efforts IP data that traverses the public internet (downstream and upstream). Includes traffic cached on CDNs and traffic that comes through bilateral paid-for interconnections, so long as the path over the end user's network is not prioritised.

28 Exabyte; equals to 1,000 Petabyte

Average fixed data usage per connection has also grown strongly over the last five years, from 5.8GB/month in 2016 to 25.2GB/month in 2020, driven by a significant increase in intrinsic internet demand and the availability of fibre networks. This trend is expected to continue to reach around 110GB/month by 2026, as shown in Figure 2.19. Supported by increasing broadband penetration, corresponding total fixed data traffic is expected to reach 397EB of data in 2026 from 40EB in 2020.

Strong data traffic growth is expected to continue in the coming years supported by the following factors:

- Increasing consumption of video content (particularly OTT services) at higher quality (e.g. full HD, 4K video). Notably the collaboration between Disney + Hotstar and Telkomsel to offer OTT video streaming on connected devices and smartphones has reduced the barrier to premium Disney content previously available only through traditional pay-TV platforms. As the OTT sector is expected to be increasingly competitive with other key providers like Vidio and iflix investing heavily in local content, consumers may increasingly substitute pay-TV with on-demand video streaming, further boosting data consumption.

- Popularity of social media, particularly platforms which involve posting photos and videos, has driven data usage (e.g. Indonesia registered almost 180 million downloads of the popular app TikTok as of August 2020[29]).

- Rapid growth in the digital economy, led by the popularity of the technology 'unicorns'[30] (e.g. Go-To, Grab, Traveloka and Bukalapak) and the resulting growth in related transactions (e.g. e-commerce, ride-hailing, digital payment and online food delivery).

2.6 Digital adoption

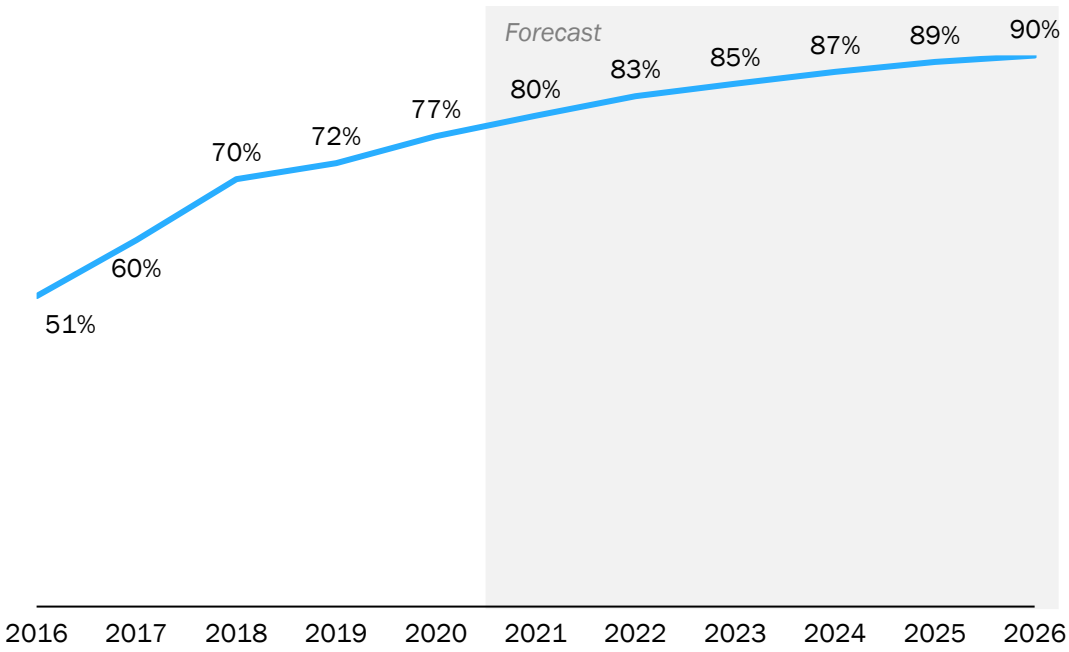
Smartphone penetration and app downloads have steadily increased

Smartphone penetration has risen because of the increasing affordability of devices, reaching 77% of total mobile connections in 2020. With China being one of the leading countries in terms of 5G adoption, affordable 5G devices from Chinese manufacturers are expected to be available in Indonesia as 5G is deployed in the short to medium term. This trend is expected to continue, with smartphone penetration as a percentage of all mobile connections projected to exceed 88% by 2025 (see Figure 2.21).

29 https://www.thejakartapost.com/news/2020/08/28/tiktok-booms-in-southeast-asia-as-it-picks-path-through-political-minefields.html

30 Unicorns are privately held start-up companies that have achieved a valuation of USD1 billion.

Figure 2.21: Growth in smartphone take-up as a proportion of connections [Source: GSMA Intelligence, 2022]



High app downloads in Indonesia have contributed to the long hours spent on the internet daily. App downloads grew at a CAGR of 16% from 3.5 billion downloads in 2016 to 6.3 billion in 2020 (see Figure 2.22), which is substantially higher than the global average of 11%.[31] With a greater proportion of the population embracing a digital lifestyle – using mobile apps for social networking, gaming, entertainment, shopping, payment, productivity and various other emerging digital services – Indonesians are expected to continue spending a substantial (and growing) amount of time on the internet.

31 https://datareportal.com/reports/digital-2021-indonesia; https://www.appannie.com/en/go/state-of-mobile-2020/

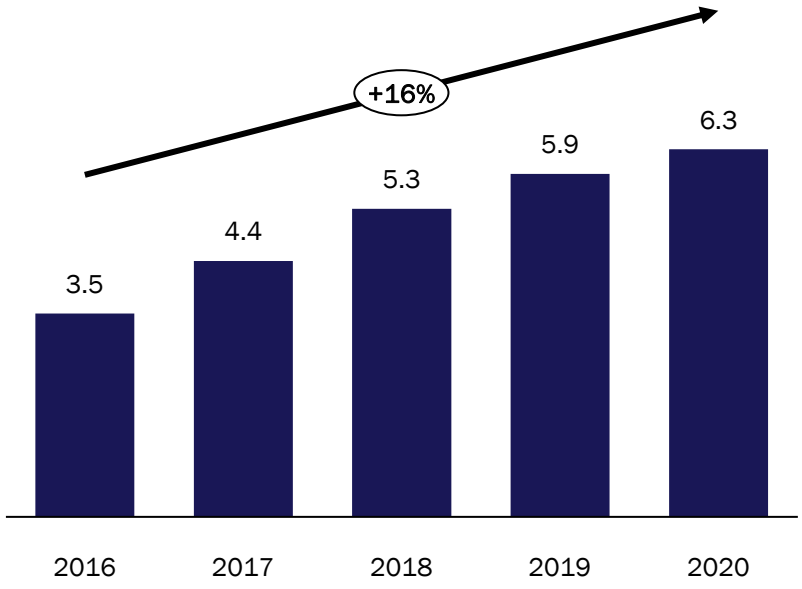


Figure 2.22: Historical app downloads in Indonesia (billion) [Source: data.ai Intelligence[32], 2021]

2.7 Technology roadmap overview

The trajectory of 5G take-up uncertain

Over the period 2016–20, the combined 4G and 5G share of mobile connections rose from 15% to 65%. Growth in smartphone penetration has driven strong migration to 4G, which will continue as the use of legacy 2G/3G devices and basic phones wanes. Nonetheless, Indonesia is still behind most other South-east Asian nations in terms of adoption of 4G and advanced 5G mobile technologies (see Figure 2.23).

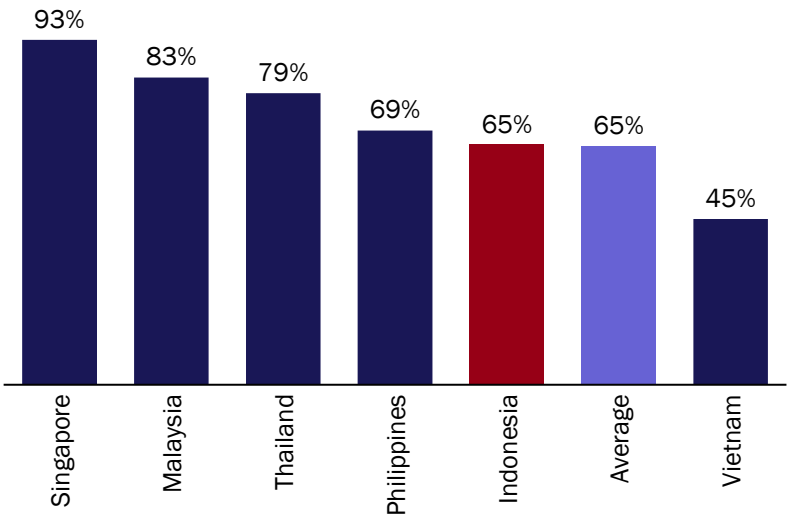


Figure 2.23: Share of 4G/5G as a proportion of total mobile connections in 2020[33] [Source: Analysys Mason Research, 2022]

32 https://www.data.ai/top/

33 The average represents the average of Indonesia, Malaysia, Philippines, Thailand, Vietnam, Cambodia, Myanmar and Singapore

Since 2019, several MNOs have announced plans to scale back/shut down 2G/3G networks to focus on 4G:

- XL Axiata announced that it was looking to refarm 2G spectrum for 4G[34]
- Hutchison 3 started to shut down parts of its 2G network in 2019[35]
- Indosat announced plans to phase out its 3G network.[36]

These developments are expected to accelerate the shift towards 4G/5G, which will likely account for 91% of connections by 2026 (see Figure 2.24). However, there is a high degree of uncertainty relating to 5G launch and take-up. Currently, only Telkomsel and Smartfren have sufficient spectrum to be able to launch full-scale 5G networks, but both will need to contend with competing uses of the spectrum to serve their 4G subscribers. As such, deployments to date have been limited, with only Telkomsel offering 5G services in limited areas.

While Indosat also launched 5G in June 2021, it provides only a limited 5G service using existing 4G spectrum (i.e. using part of its 2×20MHz of 1.8GHz[37]). Due to limited availability of 5G spectrum, the performance on the 5G network is expected to be equivalent to, or poorer than, the existing 4G network (due to limited carrier aggregation opportunities available), limiting take-up of its services. Until additional spectrum can be made available to allow operators to provide high throughput (i.e. more than 1Gbit/s) services, 5G take-up is expected to remain muted.

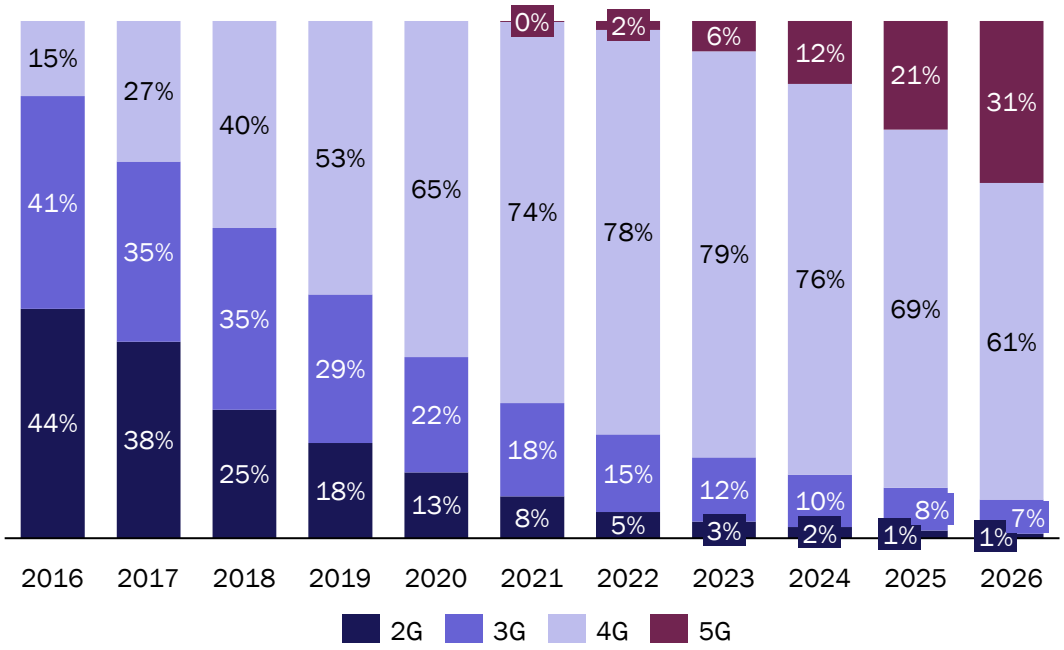
34 https://www.commsupdate.com/articles/2019/02/20/xl-axiata-cutting-2g-network-usage-amid-focus-on-data/

35 https://www.cnnindonesia.com/teknologi/20190507203821-213-392854/tri-matikan-jaringan-2g-di-beberapa-kota-besar

36 https://developingtelecoms.com/telecom-technology/wireless-networks/11631-indosat-unveils-phased-3g-network-shutdown.html

37 https://indosatooredoo.com/portal/id/5g

Figure 2.24: Evolution of mobile subscriber connections by technology [Source: Analysys Mason Research, 2021]



Several technology trends could potentially have an impact on the businesses of telecoms infrastructure providers.

5G mmWave/small cells

Millimeter wave (mmWave) refers to higher-frequency radio bands ranging from 24GHz to 40GHz, with the 26GHz and 28GHz bands being the most widely licensed/deployed 5G spectrum ranges to date. Higher bandwidths (i.e. blocks of spectrum) available in the mmWave bands are expected to result in much higher mobile speeds and lower latency. However, technical challenges such as poor propagation and the need for additional handset antennas are expected to impede wide-scale mmWave deployment in Indonesia. As such, the impact of this technology on the demand for infrastructure is likely to be limited in the immediate future.

Fiberisation/fibre to the tower (FTTT)

Microwave backhaul was commonly used in traditional mobile networks (2G to 4G). However, with 5G, average data usage is expected to increase site capacity requirements exponentially and backhaul capacity requirements per site is also expected to increase by the same magnitude, as shown in the figure below.

Figure 2.25: Backhaul capacity per site in distributed RAN[38] [Source: Analysys Mason, 2021]

Type of site	Backhaul capacity per site		
	2018	2022	Towards 2025
Urban	150Mbit/s–1Gbit/s	450Mbit/s–10Gbit/s	600Mbit/s–20Gbit/s
Suburban	100–350Mbit/s	200Mbit/s–2Gbit/s	300Mbit/s–5Gbit/s
Rural	50–150Mbit/s	75–350Mbit/s	100–600Mbit/s

As such, access to fibre backhaul will be key for the deployment of 5G, since fibre offers high capacity and has no line-of-sight issues that restrict microwave backhaul deployments.

In Indonesia, MNOs typically own and lease fibre deployed for backhaul use and have been increasingly 'fiberising' their sites. The impact of this development provides significant opportunities to infrastructure providers.

5G fixed-wireless access (FWA)

MNOs in Indonesia (e.g. XL Axiata) have previously indicated an interest in using 5G as an alternative to fibre broadband. FWA-only operators could potentially create increased demand for sites, as they would have to deploy standalone 5G FWA networks. FWA has the potential to significantly improve speed-to-market since deployment does not require the permission of local authorities, which typically is very time consuming.

To date, there has been no indication of any pure 5G FWA player that could potentially enter the Indonesian market. Furthermore, the past failures of Indonesian 4G FWA-only players (Bolt and Jasnita) and the limited deployment by existing 4G FWA-only operators (Hinet and Net1) may deter potential 5G FWA-only operators from entering the market.

Indonesia is a relatively spectrum-constrained market and the timing for the release of 5G spectrum is uncertain. With key 5G bands still allocated to other uses (e.g. broadcasting, satellite), it may take several years before the existing users and services are migrated; after the migration the bands can then be allocated to operators for mobile use. There are also four MNOs fighting for scarce 5G spectrum, which could limit network capacity available for FWA.

Most of the fibre/cable deployment in Indonesia is aerial, which carries significantly lower deployment costs than buried fibre/cable. The rapid deployment of fibre/cable in high-/mid-value regions by multiple fixed broadband providers also creates a strong barrier to entry, as the business case for a FWA provider, as a late entrant, can be weak.

In the early phases, MNOs are likely to focus 5G deployment in key cities and are unlikely to expand coverage into remote areas due to low return on investment (ROI). 5G is likely more suited for network capacity enhancement in cities (assuming sufficient spectrum is available), serving as an

38 Each range represents low- to high-capacity sites.

alternative to fibre to the premises (FTTP)/cable, especially for price-sensitive users. Thus, usage of 5G for FWA is likely to be limited.

5G FWA deployment is thus expected to be relatively slow in the short term, as the 2.6GHz and 3.5GHz spectrum bands have not been freed up for mobile use. And it is unlikely that these bands will be available in full before 2024. As such, fibre-based infrastructure is expected to continue to be in demand specially for economically viable deployments.

Low Earth orbit satellite internet service

Low Earth orbit (LEO) satellite internet service (e.g. Starlink by SpaceX) is an alternative technology that can be used to fill mobile coverage gaps in rural areas.

Despite wide global coverage, the slower speeds and higher service costs of LEO satellites make them an attractive option only for rural populations with no access to terrestrial networks. Furthermore, the cost of end-user terminals is likely to be a significant factor that will limit take-up of this service (as they are unlikely to be available at mass-market prices), and installation and maintenance (especially in rural areas) will be challenging.

Thus, the impact of LEO satellite services on the demand for fibre infrastructure is likely to be small in the immediate future.

2.8 Summary

Consumer telecoms markets have witnessed considerable growth historically, and that growth trajectory is expected to continue in the near future. This market outlook makes it attractive for telecoms infrastructure providers that provide the critical network on which these services are provided. The mobile communications market, with low unique subscriber penetration and average data usage per user compared to regional peers, has considerable room to grow. Fixed telecoms services, with current penetration levels lower than those in other South-east Asian markets, are still relatively immature but witnessing considerable growth in network deployment. Digitally literate Indonesian users, who consume significant amounts of data, will play a key role in future take-up of these services. As data demand keeps on increasing, networks will also have to be further fiberised thus providing further opportunities for fibre infrastructure providers in Indonesia.

3 Enterprise market

3.1 Industry value chain and business model

Like that for consumer services although providing infrastructure only with no direct retail services is more prevalent

The value chain to provide telecoms services to enterprises is largely like that used to provide telecoms services to consumers. However, certain parts of the value chain have differences given the different ways in which services are provided and how enterprises purchase and consume telecoms services.

The following section highlights the differences in the enterprise value chain compared to the one for consumer telecoms services:

- Network operators – they can fulfil multiple roles from being only the infrastructure provider to being the service provider to the customer. For fixed telecoms services, the model of network operators just providing access to the infrastructure to service providers is more prevalent than for mobile telecoms services. This arrangement, titled wholesale access, can reduce the duplication of network assets and is mandated by regulation in certain cases e.g. when there is a dominant or monopolistic network operator in a particular geography.
- Distributors – they provide the customer-facing functions. Enterprise telecoms services are often sold via "value-added distributors" that bundle the telecoms service with services of their own and sell to customers. These distributors are supplemented by sales teams from the service provider whose composition depends on the customer segment the service provider targets e.g. key account management for large customers with customised requirements, etc.

Like in the case of consumer telecoms services, the service provider is the central party in the industry value chain and the face of the telecoms service being provided.

3.2 Industry overview

Steadily growing industry is poised for further growth as economic development continues and hyperscalers enter the market

Enterprises typically use a range of solutions supplied by telecoms service providers – dedicated connections for sites that require non-contested bandwidth, broadband services as well as facilities to co-locate IT equipment in data centres. Some may even provide the infrastructure to run cloud workloads. Dedicated connections provide connectivity for virtual private networks (VPNs), public internet access, or access to a cloud service. Fixed broadband services offer a range of connectivity options via digital subscriber line (DSL), fibre-to-the-home (FTTH), cable, etc. to business sites.

Cloud/data-centre services provide hosting and access to enterprise-owned servers within data centres or leased IT infrastructure (e.g. servers).

Overall, the enterprise market in Indonesia has shown steady growth across all service lines between 2016 and 2020. Dedicated connections have seen a steady migration towards higher-speed circuits while the growth of fixed broadband has been driven by the increasing demand from the small and medium-sized enterprise segment. As the digital economy has boomed, demand for hosting and cloud services has also been robust. However, this segment is still in its nascent stage and demand is expected to get a bigger uplift as 'hyperscalers' enter and establish their businesses in Indonesia. At the same time, disruptive technologies like software-defined wide-area network (SD-WAN) which allow the use of broadband over dedicated connections while still providing strong performance and security, are in their early stages of deployment in Indonesia.

3.3 Enterprise dedicated connections

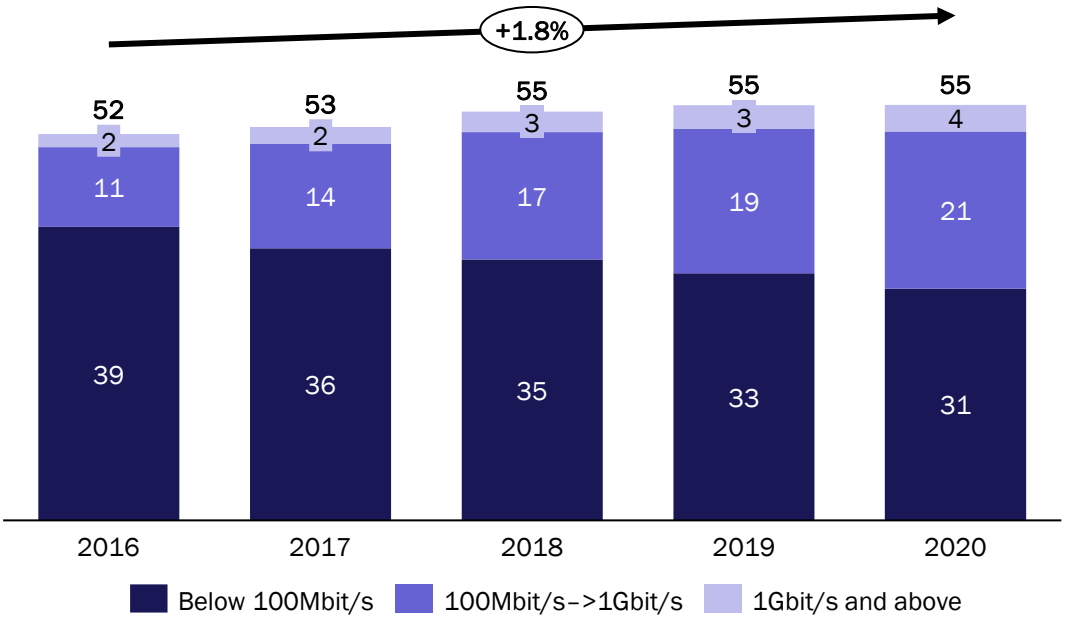
Demand is moving to high-speed connections with disruptive technologies yet to witness considerable demand

Demand for dedicated connections has grown moderately in recent years, supported by enterprise digitalisation and the entry of cloud providers in the market (i.e. Alibaba Cloud in 2019 and Google Cloud in 2020) which created demand for private connectivity to cloud services.

Demand for high-speed dedicated connections (>100Mbit/s) has increased at the expense of low-bandwidth dedicated connections over the last few years. This is expected to continue as data demand from companies increases due to higher consumption of multimedia content. At the same time, the growth of cloud-based services and the entry of the cloud service providers (e.g. Amazon plans to launch a cloud region in Jakarta in 2022, while Microsoft Azure has also announced intention to invest) have affected this market.

We expect SD-WAN and other technologies to become increasingly mature as more network providers start to offer this service in Indonesia, causing some 'trading down' of dedicated connections for broadband connections. However, some demand will still be protected due to customers' 'stickiness' and reluctance to switch and there may be some specific (essential) services on current dedicated circuits that cannot be supported by SD-WAN.

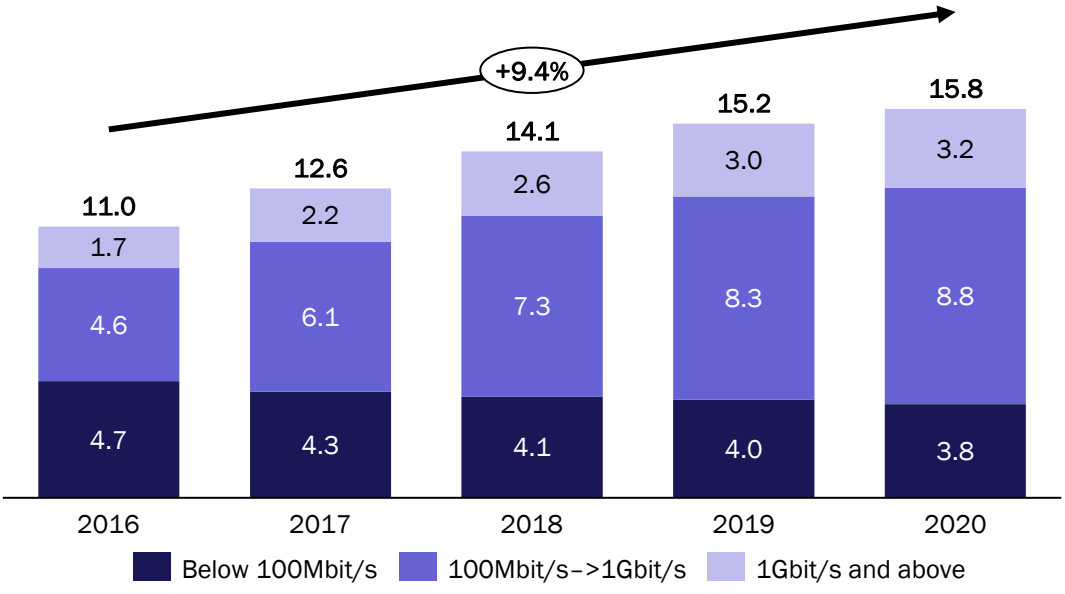
Figure 3.1: Indonesia dedicated connections by type (thousand) [Source: Analysys Mason Research, 2022]



Revenue from dedicated connections has also experienced steady growth in line with the growth in the number of connections.

Compared to other countries in the South-east Asia region, dedicated connection market revenue has experienced the strongest growth in Indonesia.

Figure 3.2: Indonesia dedicated connection market revenue (IDR trillion) [Source: Analysys Mason Research, 2022]



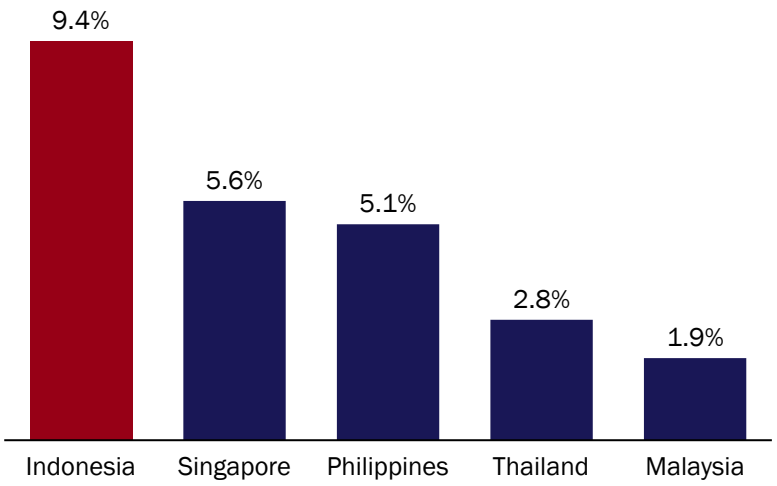


Figure 3.3: CAGR for dedicated connection market revenue 2016–20 [Source: Analysys Mason Research, 2022]

3.4 Enterprise fixed broadband

Robust growth is driven by adoption from the micro/small/medium-sized enterprise (MSME) segment

Enterprise fixed broadband demand has grown strongly in recent years because of increasing operator investment in rolling out the required network infrastructure. The Covid-19 pandemic has also had a direct impact on demand because of working-from-home arrangements that rely on the availability of high-bandwidth connections.

MSME represents an outsized share of enterprise broadband connections and has seen strong growth at 12% CAGR over the last five years. However, as of 2019, only ~2 million out of a total of ~64 million MSMEs in Indonesia have adopted fixed broadband, which signals ample room for growth in fixed broadband connections as the nation moves towards digitalisation.

Enterprise connections of large businesses have grown at a CAGR of 10% over the last five years as more business premises connect to fibre broadband. Some impact from SD-WAN migration could be expected in the future, although this is likely to affect large enterprises with multi-site requirements first.

Enterprise fixed broadband revenue has also experienced steady growth in line with the growth in the number of connections.

Figure 3.4: Indonesia enterprise fixed broadband connections by enterprise type (million) [Source: Analysys Mason, 2022]

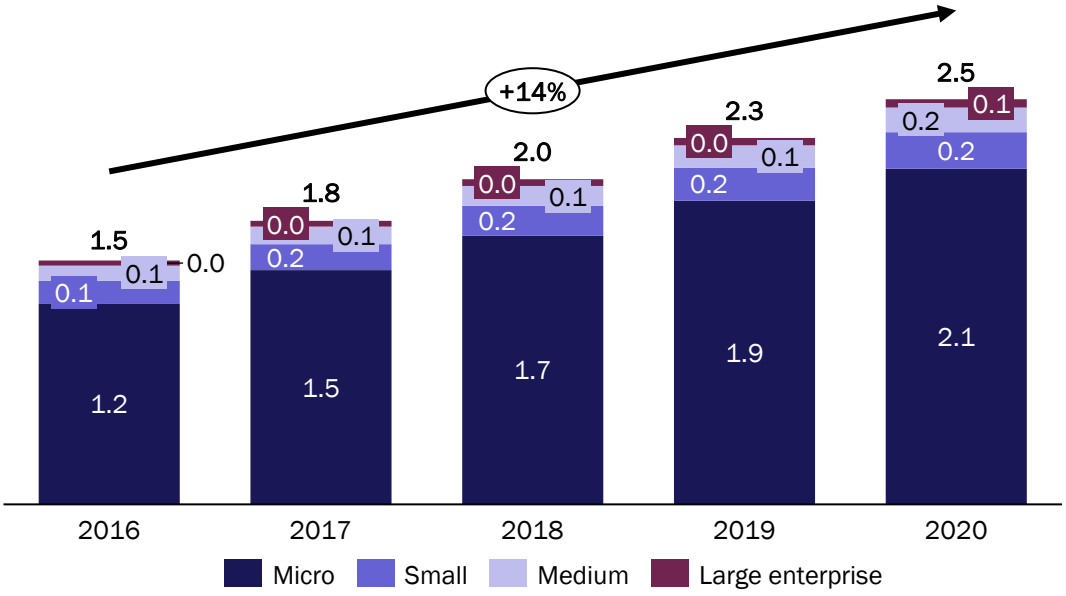
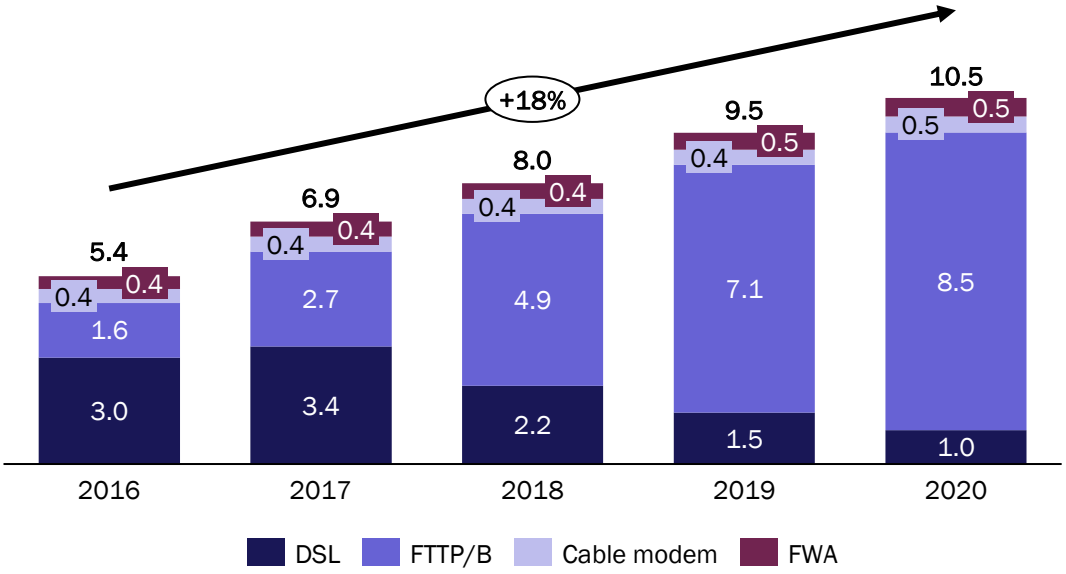


Figure 3.5: Indonesia enterprise fixed broadband market revenue (IDR trillion) by technology [Source: Analysys Mason Research, 2022]



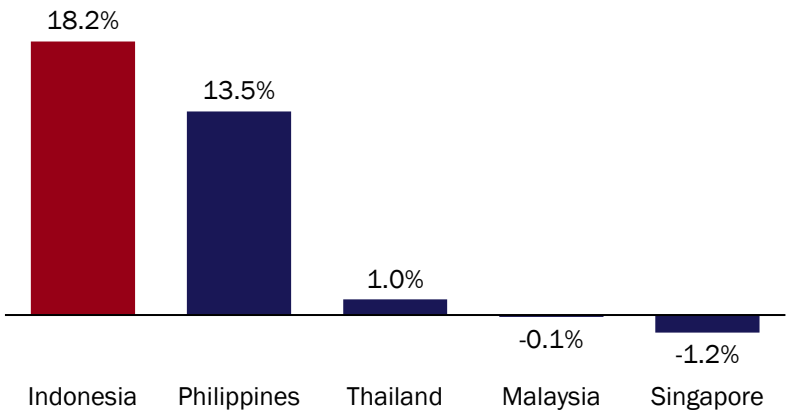


Figure 3.6: CAGR for enterprise fixed broadband revenue, 2016–20 [Source: Analysys Mason Research, 2022]

3.5 Data-centre capacity

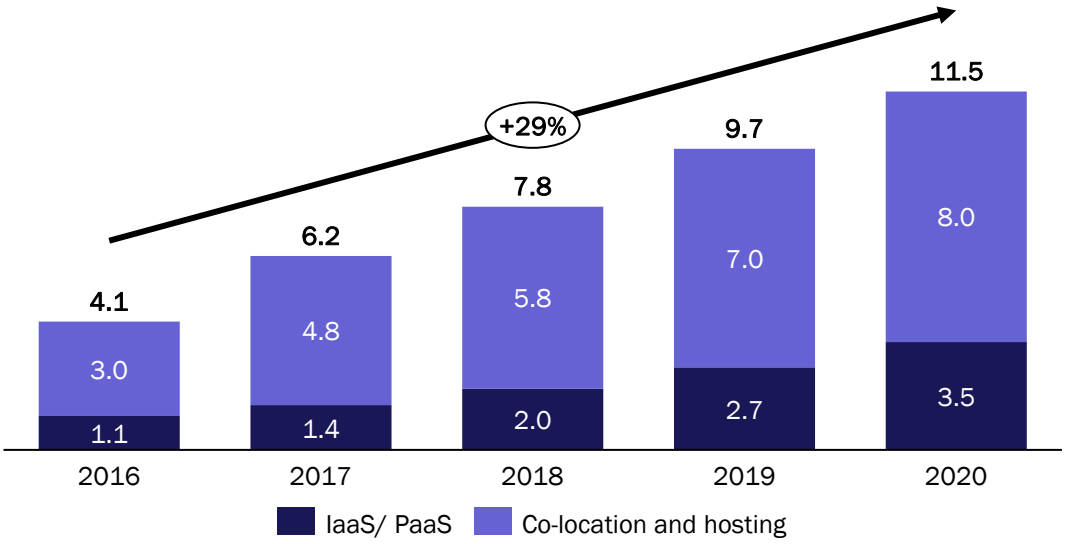
Both co-location and cloud services have witnessed steep growth in demand although the market is not yet mature

The supply of data-centre capacity in Indonesia is expected to increase exponentially, driven by the rapidly growing internet economy and the popularity of cloud services among internet companies. As Indonesia's data-centre market is not yet mature, many new entrants over the past two years (e.g. Keppel, PDG and STT) have been looking to capture the growing demand.

Traditional operators have also expanded their capabilities to address the growing hyperscale opportunity and have deployed hyperscale-capable facilities (e.g. NTT and TelkomSigma). Hyperscale capacity was limited in 2020 as data-centre operators faced significant delays in the construction and launch of their facilities due to the Covid-19 pandemic, thus resulting in very high utilisation levels. A significant amount of capacity came online in 2021 and should be able to satisfy some of the pent-up market demand.

New data-centre clusters may emerge as demand continues to grow in other parts of the country. Some data-centre operators are exploring options to enter Surabaya, the second-largest city in Indonesia. The demand in the market as well as the increasing infrastructure availability have led to a steady growth in services provided from data centres e.g. co-location/hosting and cloud infrastructure services like infrastructure as a service (IaaS)/platform as a service (PaaS).

Figure 3.7: Indonesia IaaS/PaaS, co-location and hosting market revenue (IDR trillion) [Source: Analysys Mason Research, 2022]



3.6 Technology roadmap overview

Disruptive technologies like SD-WAN are in their early stages of deployment in Indonesia

Enterprise connectivity solutions can be provided using a range of different technologies. Connectivity solutions are typically configured as local area networks (LANs) or wide-area networks (WANs). LAN deployments interconnect systems within a small geographical area e.g. a building, whereas WAN deployments can span multiple buildings and even different geographies. Connectivity within the network can be provided using different types of solutions.

Figure 3.8: Overview of connectivity option [Source: Analysys Mason, 2022]

Option	Description
Dark fibre	Unlit fibre provided for enterprises to establish their own active network
Metro Ethernet/MPLS	Secure connections but expensive to deploy
Direct internet access (DIA)	Dedicated direct access connections
Enterprise broadband	Best-effort connectivity, although QoS guarantees via some SLAs can be provided

New technologies like SD-WAN are in the early stages of adoption; more widespread adoption is unlikely in the next two to three years

Traditional WANs use dedicated connections that route traffic between branches and data centres. This is a reliable and secure solution but can be costly and complex to manage since backhauling traffic to data centres is expensive, inefficient and could have implications for service latency.

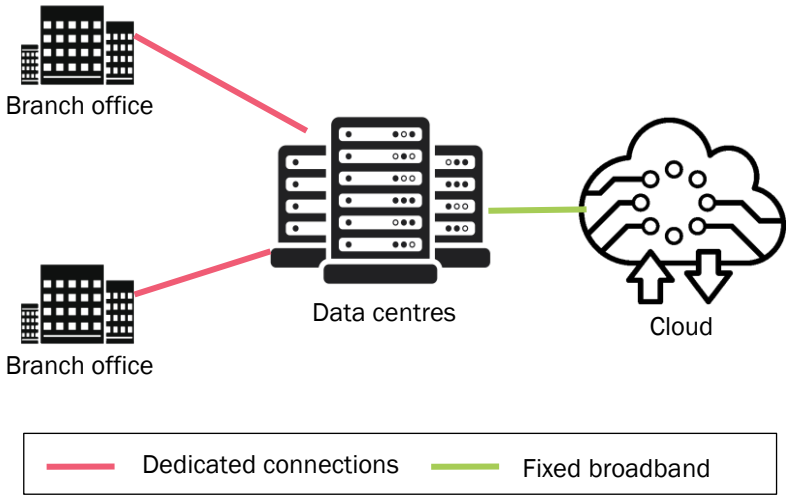


Figure 3.9: Illustration of traditional WAN architecture [Source: Analysys Mason, 2022]

SD-WAN is an alternative to traditional WANs which allows the use of broadband over dedicated connections while still providing strong performance and security.

New technologies like SD-WAN are increasingly being evaluated by enterprises due to their ability to reduce operating costs and boost operating margins. SD-WAN provides cost savings, permits business continuity, and provides visibility into network and application performance. SD-WAN also enables centralised provisioning and ongoing management of network services across cloud, data centres, WAN, and wired and wireless LAN. The simplified management reduces the number of hours needed to manage configuration, roll-out of new sites, updates and ongoing management.

Instead of requiring dedicated connections, SD-WAN can use broadband connections (e.g. fibre or mobile) to route traffic. These broadband connections are significantly cheaper than dedicated connections and thus reduce network costs.

SD-WANs also increase the competitive intensity on the supply side since multiple types of service providers can provide this service. The following describes the potential different types of suppliers:

- **systems integrators** – typically help enterprises implement third-party technology solutions and usually have partnerships with software vendors for reselling/distribution
- **managed services providers** (e.g. data-centre operators) – typically offer a range of IT services for enterprise customers
- **international telecoms operators** – provide international backbone connectivity to multi-national corporations (MNCs) in procuring connectivity services across multiple countries of operation
- **technology vendors** – can sell direct-to-customer.

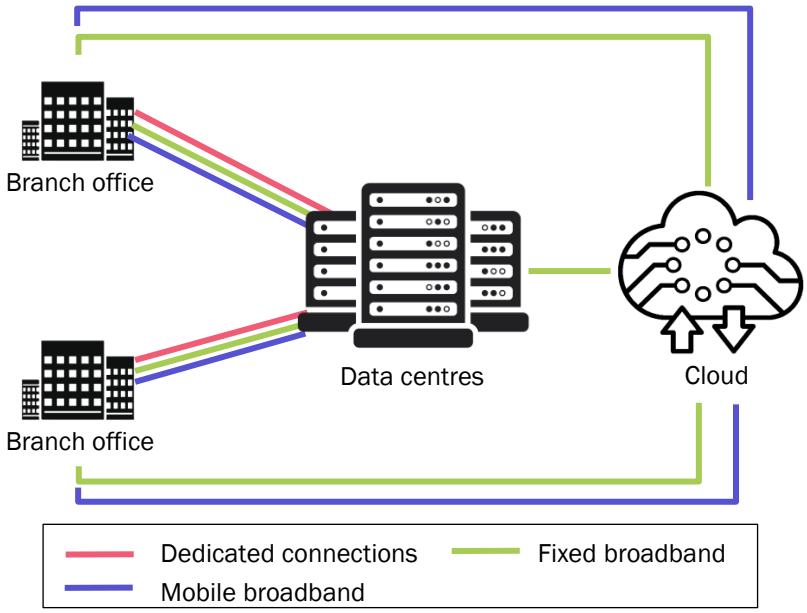


Figure 3.10: Illustration of SD-WAN architecture [Source: Analysys Mason, 2022]

Telkom, Indosat/Lintasarta and XL are the few domestic fixed connectivity providers with SD-WAN offerings, mainly targeted at large enterprises.

Figure 3.11: Telecoms operators' SD-WAN launches in Indonesia [Source: Operator reports, Analysys Mason, 2022]

Provider	Launch date
NTT Comm	Jun 2017
Telkom	Jul 2018
Indosat/ Lintasarta	May 2019
XL Axiata	Dec 2020

At the same time, SD-WAN technology vendors have largely elected to partner with key telecoms operators to offer SD-WAN solutions in Indonesia, leveraging the latter's established customer relationships.

Figure 3.12: SD-WAN adoption in Indonesia[39] [Source: Analysys Mason, 2022]

Sector	Known # of SD-WAN	Example
Financial services	PoC: 7 / Implement: 5	Central Bank of Indonesia selected Telkomtelstra to implement PoC of Cisco Viptela SD-WAN
Energy	PoC: 1 / Implement: 3	Chevron selected Telkomtelstra to implement PoC of Citrix SD-WAN
Healthcare	PoC: 0 / Implement: 2	Dexa Medica selected XL Axiata to implement VMWare's VeloCloud SD-WAN across the organisation

39 PoC = Proof of concept.

Sector	Known # of SD-WAN	Example
ICT	PoC: 1 / Implement: 1	PT. TeleNet selected Telkomtelstra to implement PoC of VMWare VeloCloud SD-WAN
Others	PoC: 2 / Implement: 2	Alfamart selected Telkomtelstra to implement VMWare's VeloCloud SD-WAN and optimise branch office network performance in existing cloud ecosystem

Indonesia is still a nascent market for SD-WAN, with around half of publicly announced SD-WAN projects are at the pilot stage as opposed to being implemented. More widespread adoption is expected in the next two to three years, after enterprises are more educated on the potential benefits of SD-WAN.

3.7 Summary

While Indonesia's terrain makes deployments of fixed networks challenging, there has been considerable growth in the recent past as new networks are rolled out across the country. Demand for high-capacity connections and adoption by the under-penetrated MSME segment will be the key drivers behind the growth in the enterprise market. At the same time, new disruptive technologies like SD-WAN are at an early stage in terms of adoption, having a limited impact on the demand for dedicated connections. As businesses require higher speeds and lower-latency services, demand for fibre services is expected to remain robust.

The growth of the internet economy and the adoption of cloud services will drive steady growth in services that can be provided from a data centre. Co-location and cloud infrastructure services are expected to benefit from this demand.

4 Fibre infrastructure market

Fibre demand typically comes from a range of sources – telecoms operators that use the fibre to connect network sites, internet service providers that lease fibre to provide connectivity services, as well as enterprise and residential customers that use a fibre connection for their own high-speed connectivity needs.

In this section we cover the first two types of uses only which is typically called the wholesale market.

4.1 Revenue, capex and cost structure

Revenue is generated from leasing fibre which is mostly deployed aerially

Fibre deployment starts with location selection. Location is selected based on demand and local competitive situation. Once location has been selected, the service provider can decide to either deploy the infrastructure itself or lease capacity from infrastructure available in the area. Leasing typically tends to be much more economically attractive than deploying the infrastructure and thus there is often a preference to lease unless there are strategic reasons to own the fibre.

Fibre deployment requires community permits and fee payments via a largely informal and administrative process. A community permit, together with an associated fee, is required from a local community and there are no standardised policies or guidelines applicable for these discussions. As such, their outcome is dependent on the negotiations between the community and the fibre deploying operator.

Fibre is generally deployed aerially in Indonesia, particularly within cities. MNOs and fibre players generally have 80–90% of their fibre as aerial, whilst the use of buried fibre is kept low to avoid the significantly higher deployment cost. Indicative cost for aerial fibre deployment is USD3,500–4,500/km, while for buried fibre it is in the range USD8,500–9,500/km. [40] There is some geographical difference in deployment costs for fibre (around 10%) with lower-density areas like Kalimantan being more expensive than high-density Java. From a customer standpoint, there does not appear to be any inherent preference for buried fibre, whether self-built or leased. On the other hand, buried deployments can be more complex and require additional approvals from utility companies which can further delay launch.

Material and labour costs are the primary components of the capex incurred for fibre deployment.

40 Analysys Mason estimates

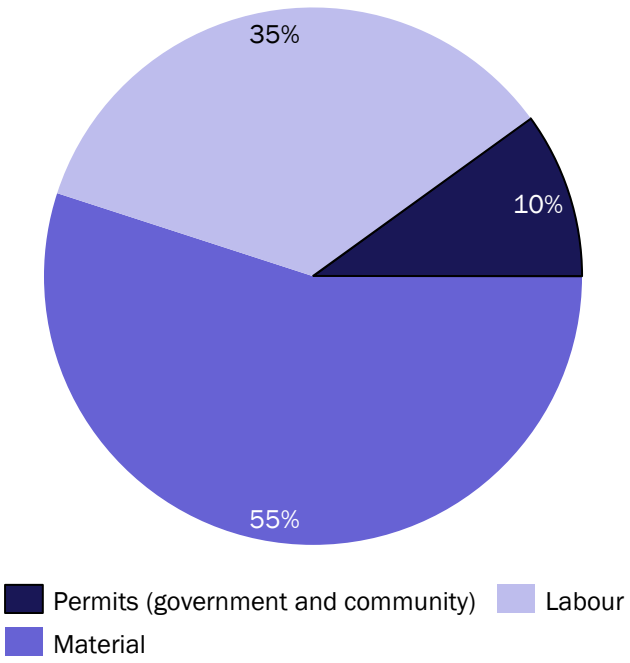


Figure 4.1: Estimated % split of capex for typical fibre deployment [Source: Analysys Mason, 2022]

Once the fibre has been deployed, it is made available to a service provider to meet a particular demand scenario. If the service provider itself deployed the fibre, it will typically be used for its own usage. On the other hand, a pure infrastructure provider will lease the fibre to service providers.

Prices for leasing fibre are in the range USD45–60 per km. Typical lease contracts tend to be several years in duration providing stability of revenue over an extended period. However, price reduction at renewal is common as typically lease prices have been falling on an annual basis.

Increasingly, shared ducts for fibre roll-out are being deployed in certain cities. Current market price for lease of shared ducts is around IDR1,000 to IDR1,500 per metre per month[41].

4.2 Fibre networks of telecoms operators

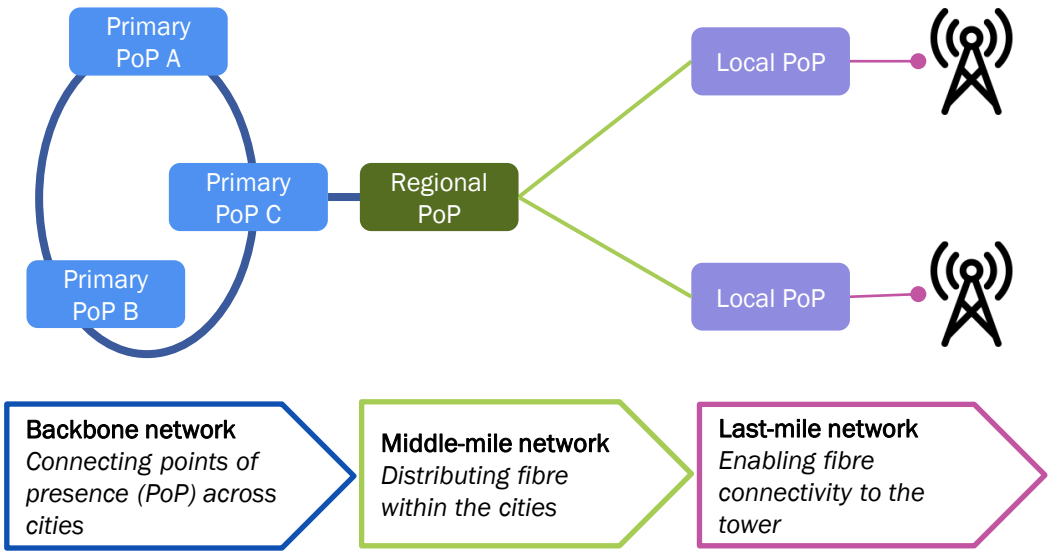
Telecoms operators are key users of fibre base connections in their networks, often leasing capacity from infrastructure providers when expanding coverage and network capacity

Fibre networks for telecoms operators can be grouped into three separate components:

- the national backbone
- the middle mile
- the last mile to tower sites.

[41] Moratelindo estimates

Figure 4.2: Illustrative example of a mobile fibre network [Source: Analysys Mason, 2022]



Backbone network

Multiple backbone networks are already available from various providers (e.g. Telkom, Moratelindo, ICON+, XL) and the Palapa Ring[42] will also improve inter-island connectivity. Players such as Moratelindo, XL and Indosat have backbone networks that in combination are broadly equal to that of Telkom – though there may be overlap of backbone networks in selected areas.

The availability of backbone fibre from multiple players coupled with the recent completion of the Palapa Ring will likely mean that the demand for additional backbone fibre deployment will decrease in the longer term. However, significant demand for leasing the deployed fibre will remain, especially in regions where there is a small number of infrastructure alternatives. As the MNOs expand outside Java, demand for backbone capacity in the other regions is likely to increase benefiting infrastructure providers that have fibre in these locations.

Operators use various approaches for backbone fibre and are not relying on leasing alone:

- self-build: e.g. XL and Indosat have their own backbones in certain parts of Indonesia
- joint build: split the build with another player and share the capacity
- fibre swap: swap fibre pairs in different regions
- leasing: lease access from backbone providers.

42 The Palapa Ring is a USD1.5 billion national strategic infrastructure project led by the government which aims to improve backbone connectivity across multiple regions in Indonesia, connecting the capital of 514 districts and cities across Indonesia. It consists of three sections, namely: Palapa Ring West, Palapa Ring Central and Palapa Ring East.

Middle-mile network

Operators have continued to increase their middle-mile fibre, even where there is existing coverage, in particular in preparation for the launch of 5G e.g. an existing metro fibre ring with eight towers is being split into two rings with four towers each via new fibre.

The initial middle-mile fibre networks were self-built by the MNOs as there were no leased fibre providers. However, most of the new middle-mile fibre builds are now being provided via leasing arrangements over self-build. The operators typically hire fibre providers to provide both the middle-mile and last-mile fibre together in specific locations.

Like in the case of the backbone network, middle-mile network demand is expected to be robust as operators expand outside Java. Owners of fibre infrastructure in these regions stand to significantly benefit.

Last-mile network

In this segment of the network, the deployment of the Palapa Ring Project is not of significant benefit since operators still need to deploy the fibre to the tower sites. There is strong demand to fiberise the tower sites to enable improved network performance and capacity. Currently, apart from Telkomsel, the other operators have fiberised <20% of their tower sites.

Operators undertake limited self-build of FTTT and rely primarily on leasing providing business opportunities to infrastructure providers who have fibre deployed

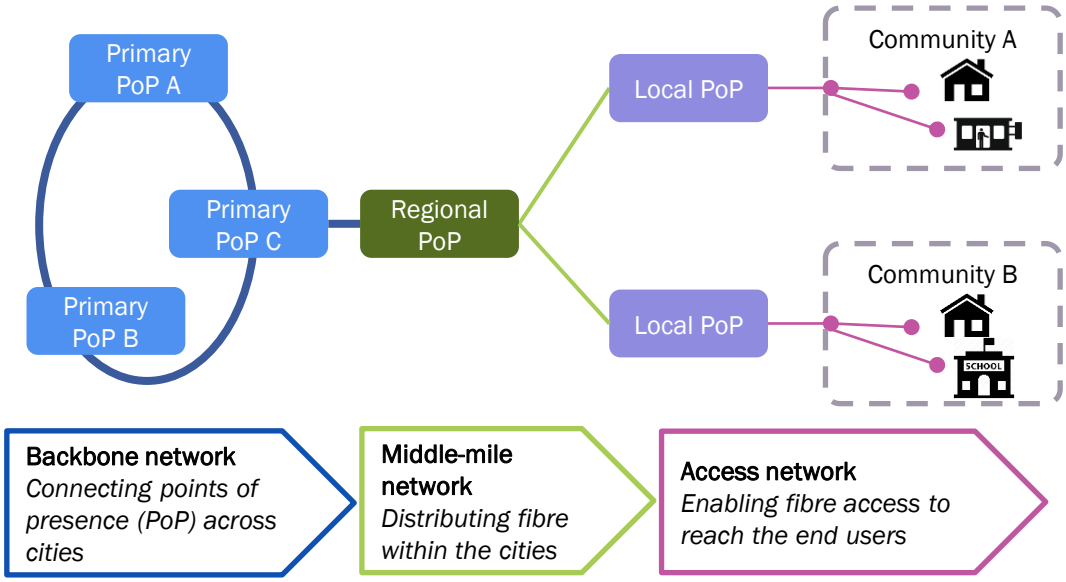
4.3 Fibre networks of internet service providers

Internet service providers are another key customer segment for network fibre and lease capacity to provide different services to enterprises and residential customers

Similar to that of the telecoms operators, fibre networks of internet service providers can be grouped into three separate components:

- backbone network
- middle-mile network
- access network.

Figure 4.3: Illustrative example of a fixed fibre network [Source: Analysys Mason, 2022]



Backbone network

In Indonesia, multiple backbone networks are already available from various providers (e.g. Telkom, Moratelindo, ICON+, XL). Players such as Moratelindo, XL and Indosat have backbone networks that in combination are broadly equal to that of Telkom – though there may be overlap of backbone networks in selected areas. The Palapa Ring may improve inter-island connectivity, though its impact on the connectivity of local communities may not be significant due to challenges in bringing fibre from the points of presence (PoPs) to the targeted cities.

As internet service providers expand high speed services across the country, demand for fibre infrastructure is expected to be robust. Existing players have historically invested in some backbone fibre for their own use, although the newer players are more likely to lease backbone for expansion to new areas.

Middle- and last-mile network

Fibre coverage by both residential and enterprise players has mainly focused on Java given the favourable economics (e.g. higher incomes and population density). Fibre providers are now looking to expand beyond Java, primarily in Sumatra where several large cities have poor coverage. Demand in Sulawesi and Kalimantan is expected to be limited to select areas and is not a key focus at the current time. For instance, cities in Kalimantan are relatively small and further apart thereby making the deployment economics largely unattractive.

Retail providers have mainly been reliant on self-build for their last-mile networks, with limited examples of access network leasing. There are a few exceptions where developers have given exclusive access to a provider in a high-rise building, thus forcing retail providers to obtain wholesale access.

4.4 Industry overview

The supply landscape is diverse with the top five players having considerable network length; Telkom, Moratelindo, etc. have national coverage while many others are regional in nature

Wholesale fibre providers to telecoms operators and internet service providers are relatively diverse and include small providers that focus on specific areas where they can leverage local relationships.

Figure 4.4: Key wholesale fibre providers in Indonesia (as of December 31, 2020) [Source: Operator reports, Analysys Mason, 2022]

Backhaul wholesale providers	Network length (km)	Geographical focus	No. of customers	Description
Moratelindo	48,515	Strong presence in both East Indonesia (Lesser Sunda Islands and Maluku and Papua) and West Indonesia (Java and Sumatra)	*Undisclosed*	• Network length comprises 25,951km of backbone and 22,565km of last mile access • Moratelindo's coverage is widespread throughout the country. Outside Java (e.g., Sumatra, Bali, Nusa Tenggara, Papua), it has better coverage than all others except for Telkom • Spread across the country and with 18,360G capacity
Telkom Indonesia	>200,000	Nationwide presence	*Undisclosed*	• Telkom's wholesale offering is focused on its backbone network • It does not provide retail providers with access to its access network – access network is for its own use only
ICON+	~90,000	Main presence in West Indonesia (Java, Sumatra) with some presence in Sulawesi and Kalimantan	>3,000	• Fibre coverage is mainly in Java and Sumatra though it has ambitions to expand and offer extensive coverage • Its ability to use PLN's infrastructure

Backhaul wholesale providers	Network length (km)	Geographical focus	No. of customers	Description
				and RoW can make it attractive for MNOs as it resolves issues with obtaining permits
Protelindo	~75,000	Main presence in West Indonesia (Java, Sumatra) with limited presence in Kalimantan and Sulawesi	>1,600	• Network includes a Java–Bali backbone along with >5,000km of fibre in Jakarta and Surabaya • Recently acquired STP business brings with its fibre network covering: >1,600km within Greater Jakarta, 558km in Bandung, 102km in Medan and 68km in Surabaya • It also has >600km in submarine fibre-optic networks
Fiberstar	~30,000	Main presence in Java and Bali with limited presence in parts of Sumatra, Kalimantan and Sulawesi	*Undisclosed*	• Fibre length is ~60% national backbone and ~40% access fibre
IBS Towers	~11,000	Main presence in Java and Bali with limited presence in parts of Sumatra, Kalimantan and Sulawesi	*Undisclosed*	• Fibre coverage includes key cities such as Jakarta, Medan and Makassar
Alita	~7,759	Main presence in Java with limited presence in Sulawesi	Likely <100	• Fibre coverage is mainly in East Java including Malang and Surabaya
Sokka Tama Fiber	N/A	Main presence in Lesser Sunda Islands (East and West Nusa Tenggara) with limited presence in Java and Sulawesi	<100	• Focused on Lombok where it has strong local relationships

4.5 Key market drivers

Backhaul requirements and the steady growth of data traffic will fuel market demand

Increasing backhaul requirements as mobile technologies advance (5G)

Backhaul refers to the point-to-point connections between mobile network sites and the core network of the mobile operator. It can be provided using a range of technologies, although microwave and fibre are the most common. As mobile technologies permit higher data rates for end users (5G, etc.), continuous growth in backhaul capacity requirements will be required. Fibre, providing higher bandwidth, interference immunity and longer range, will be the only viable technology to support this capacity although cost of deployment is likely to remain higher than that of a microwave link (fibre backhaul leasing costs around 60% more than a corresponding microwave link).

Growth in residential fixed broadband subscriptions as penetration in Indonesia approaches that of peer markets

Fixed broadband penetration in Indonesia is expected to grow considerably for the following reasons:

- Wireless alternatives are unlikely to be sufficient to meet growth in data demand due to scarcity of spectrum in the long run.
- Mobile operators are generally not offering unlimited prepaid data plans; those that are marketed as 'unlimited' are restricted to specific apps or timing of usage.
- While some mobile operators do offer postpaid unlimited plans, they can be quite expensive.
- There are ongoing government initiatives to support fixed broadband infrastructure and take-up including the National Broadband Plan and the E-commerce Roadmap.

Growth in enterprise data revenue

Demand for enterprise fixed broadband is expected to grow strongly – particularly from SMEs. The government has thus been active in educating small businesses with its 'MSME Go Online' programme to drive awareness of the internet for their businesses. Indonesia's Ministry of Communication and Information Technology (Kominfo) has also been providing free internet access on a trial basis to business communities to encourage small businesses to use the internet and become paid users. Migration from consumer to enterprise packages is also likely to lead to growth in the market.

Revenue from dedicated connections is expected to see more gradual but steady growth. Demand for higher-bandwidth connections is projected to grow, particularly to support cloud-based services as seen with the entry of leading cloud players (e.g. Amazon Web Services (AWS) and Google).

Soaring consumer data usage

Data usage per connection is expected to grow strongly and reach ~20GB/month by 2025 based on Analysys Mason Research estimates, driven by:

- Further growth in smartphone penetration, facilitated by increasing availability of low-end smartphones offered by Chinese device manufacturers.
- Increasing consumption of video content via mobile and at higher quality (e.g. full HD, 4K video).
- Popularity of social media platforms, particularly those which involve posting photos and videos and thus drive data usage (e.g. Indonesia boasted >87 million active users on TikTok as of October 2021).[43]
- Rapid growth in the digital economy, led by the local unicorns (e.g. GoTo, Traveloka and Bukalapak) and the resulting growth in related transactions (e.g. e-commerce, ride-hailing).

Current data allowances in Indonesia appear to be constraining data usage and MNOs are expected to expand allowances over time due to competitive pressure and consumer demand. As of 2020, according to Analysys Mason Research Indonesia's current average data usage is lower than peer markets such as Thailand (~11GB/month) and Malaysia (~15GB/month) but is expected to catch up over time.

4.6 Market size

Market is expected to witness robust growth and exceed IDR20 trillion in five years

A key component of market size is telecoms operator fibre demand that depends on the current state of network fiberisation. Today, Telkomsel's site fiberisation is significantly ahead of that of other MNOs. Telkomsel leverages Telkom's fibre network which is typically not available to other MNOs. As such, these other MNOs must find other providers which generally have to deploy new fibre to meet their requirements. These other MNOs significantly lag behind Telkomsel in terms of current site fiberisation but aim to reach similar levels within the next few years. As per Analysys Mason estimates, potential untapped fiberisation opportunity exists for >25,000 network sites and this is expected to increase as new sites are rolled out to handle higher data traffic.

43 https://datareportal.com/essential-tiktok-stats

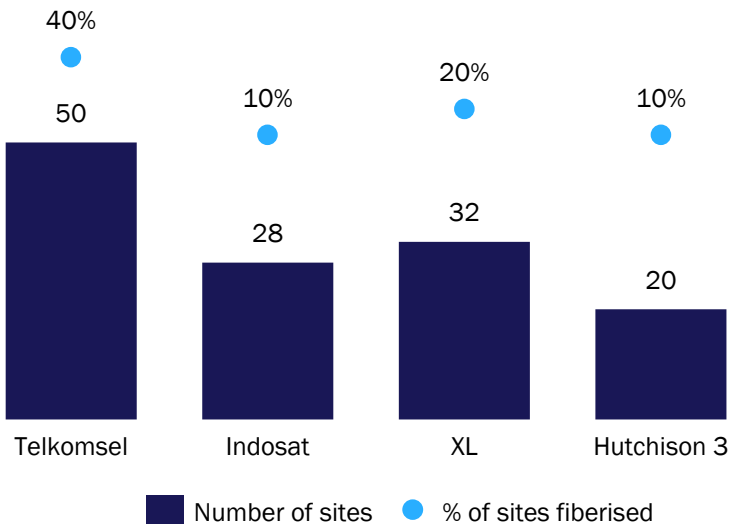
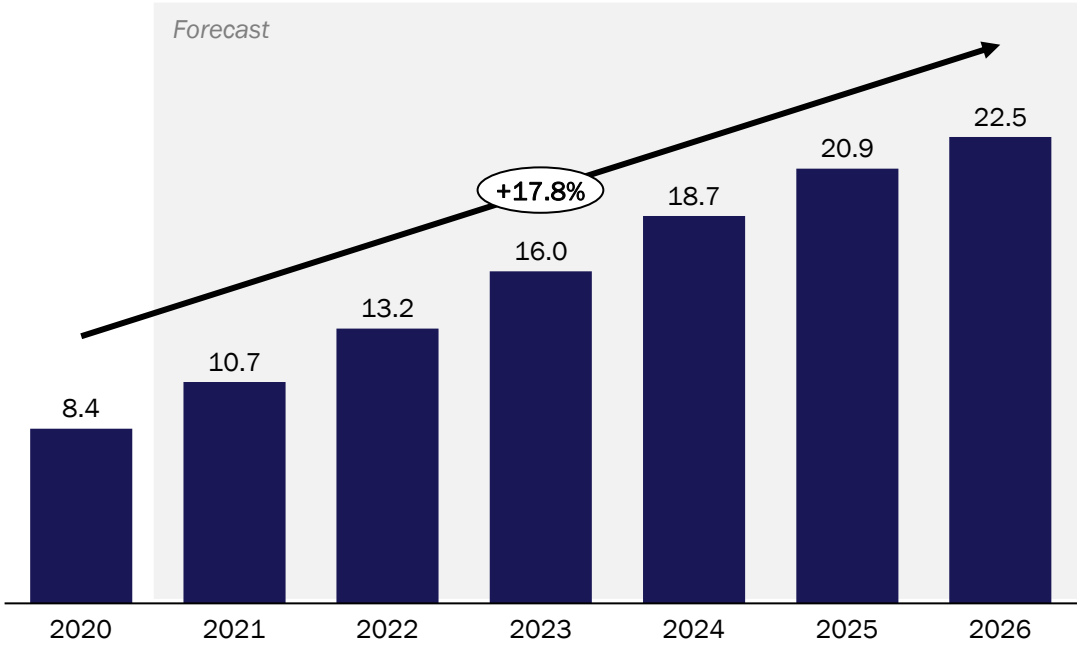


Figure 4.5: Estimated number of sites (thousand) and percentage of site fiberisation by MNO [Source: Analysys Mason, 2022]

In addition to the above, fibre leasing by internet service providers is also expected to increase as they expand their networks across the country to meet customer demand.

Considering these demand sources, the total market for wholesale fibre revenue is expected to grow at a CAGR of ~17.8% between 2020 and 2026 (see Figure 4.6).

Figure 4.6: Indonesia's wholesale fibre market revenue[44] (IDR trillion) [Source: Analysys Mason, 2022]



44 Total wholesale fibre revenue market size is estimated by multiplying the sum of key providers' reported wholesale/total revenue and the estimated annual revenue growth rate. The annual revenue growth rate is estimated based on key providers' historical revenue in 2018–20 and the assumption that, in the long term,

4.7 Opportunities, threats and challenges

Opportunities exist to support regional expansion of the MNOs and from hyperscalers although the threat from disruptive technologies cannot be ignored in the long term

4.7.1 Opportunities

Support the expansion of telecoms networks outside Java

While coverage on Java is extensive for all operators, Telkomsel has a significant lead in terms of network coverage and quality outside Java compared to other operators. The other operators have therefore been increasing their network investments outside Java to enable them to better compete against Telkomsel and capture market share. Average data usage and traffic density outside Java continue to be high in a few provinces e.g. urban centres in Sumatra. As telecoms operators continue to fiberise their sites, there is an opportunity for Moratelindo to position itself as a preferred partner in helping them undertake this migration. The advent of 5G in the future is also expected to significantly increase site numbers, thereby providing additional opportunity.

Opportunity outside Java exists in the wholesale fibre space as well given that residential and enterprise fibre coverage has mostly been focused on Java to date. A wholesale provider can make expansion outside Java more economical. Particularly in Sumatra, there are areas with lack of coverage that could benefit from the availability of a wholesale network. Sumatra also has several not so geographically distant urban centres with high population density that can make deployment economics workable.

Provide fibre connectivity to hyperscalers entering Indonesia

Indonesia has the largest and fastest growing internet economy in South-east Asia, which has been supported by a vibrant start-up ecosystem. Indonesia's internet economy growth has been led by several unicorns that have been relying on cloud providers for their infrastructure requirements. Indonesia's importance as a major market for cloud providers has thus seen it identified as the next key area for expansion of cloud regions in South-east Asia. While Google and Alibaba already have local data centres, AWS has announced plans to enter the Indonesian market, with other global hyperscalers expected to follow.

the wholesale fibre revenue growth rate will resemble the GDP growth rate outside Java since the majority of fibre deployments are expected to be outside Java.

4.7.2 Threats and challenges

Telecoms operators decide to self-build, thereby reducing the need to lease fibre

While leasing has been the preferred way in which to obtain last-mile coverage, in certain situations telecoms operators may indeed decide to build their own connections. These could be areas where lease prices are deemed unattractive – perhaps due to the presence of a monopoly supplier – or where the operator has access to last-mile connectivity already (perhaps via an acquisition it may have made in the past).

Additional competition in the wholesale fibre market appears

There has been a general trend in wholesale fibre providers shifting to establish their own retail operations to own the customer relationship and obtain higher margins. If these fibre players change strategy, then there will be additional competition which can lead to depressed prices.

Alternative technologies reduce demand for direct connectivity

Connectivity solutions based on SD-WAN are already being offered by telecoms operators in the market. Instead of requiring dedicated connections, SD-WAN can use broadband connections (e.g. fibre or mobile) to route traffic. These broadband connections are significantly cheaper than dedicated connections and thus reduce deployment costs. Traffic is dynamically routed via application-aware routing to ensure efficient delivery and improved user experience while maintaining robust security.

4.8 Summary

Fibre networks are used to provide a range of services from wholesale solutions for service providers to direct connections for enterprises and consumers. The wholesale market has a range of suppliers with no clear leader, while Telkom is the clear market leader in the enterprise and residential market. As demand for data-intensive services increases, telecoms operators and internet service providers will have to fiberise all their sites, thereby providing considerable opportunity to infrastructure suppliers. Similarly, growth in the adoption of broadband services will positively affect the demand for fibre as FTTx[45] becomes the most common connection type. The opportunity is also likely to be geographically spread with demand steadily moving out of Java to other regions as service providers start to compete with the incumbents in those markets.

45 FTTx = Fibre to the x. It refers to any broadband network architecture using optical fibre to provide network connectivity.

5 Ducting infrastructure

While fibre in Indonesia is generally deployed aerially, particularly within cities, certain city governments have taken on strategic projects to duct all fibre within their jurisdictions. This initiative has been enforced on new deployments as well as fibre that is today either deployed aerially or underground but not ducted.

Fibre ducting involves digging a trench that is 1–1.2m deep to bury the duct and pulling the fibre cable through the duct. This solution protects the fibre from the wind and other weather conditions which is thus less likely to experience cuts. However, deployment is more difficult and expensive, and feasibility depends on the terrain. Once ducts are deployed, sub-ducts are leased to fibre providers for their own fibre cables. Each sub-duct is typically able to support up to 96 core fibres.

There are several motivations to encourage the adoption of ducting:

- Increase control and visibility over the fibre deployment process since ducting is a licensed operation while aerial deployment of fibre is not
- Improve the aesthetics across the city
- Make the infrastructure more futureproof since it is easier to add new services using ducted fibre. Some city governments have viewed ducting as a necessary requirement to deploy smart city solutions e.g. smart parking, smart street metering etc.

However, currently there is no nationwide regulation governing fibre deployment in Indonesia although the government has explicitly encouraged local governments to prepare ducting channels.

5.1 Business model

Revenue is generated via leasing the ducted fibre although duct ownership can be strategically beneficial

As is typical when deploying public infrastructure, deployment of ducts requires the co-operation of the city governments, often via the establishment of a separate joint venture to undertake the work. Typically, infrastructure deployment within cities has been dependent on the budget the governing authority has available. To avoid dependence on city government budgets, ducting in Indonesia is typically funded by the ducting operator which then recovers the cost, with a margin, by leasing out the ducts to other service providers. The lease price, typically calculated on a per-unit length basis, comprises the revenue that is generated from the ducts. The duct operator typically has a revenue share arrangement with the city government and thus retains a proportion of the revenue only.

In addition to the monetary rewards from leasing the ducts, there are strategic benefits to ownership of the ducts. The deploying operator has unique access to, and ownership of, the infrastructure, a close relationship with the city government and the ability to set lease prices based on expected financial returns.

5.2 Industry overview

The market supply is concentrated at the current time with only two players active in the market

Currently only two cities in Java – Jakarta and Semarang – have started installing fibre ducts. Ducting in Jakarta is led by PT Jakarta Propertindo (Jakpro), while in Semarang it is being undertaken by Moratelindo. Efforts in Jakarta are largely piecemeal, while Semarang is following a more structured approach. In Semarang only aerial fibre is being ducted, while the local state-owned enterprise in Jakarta has mandated all operators to migrate their existing fibre (including existing in-ground cable) to ducts.

As ducting requires close collaboration with the city government, a typical approach has been to establish a joint venture between the telecoms operator and the state-owned enterprise appointed to oversee the ducting. This also helps with obtaining RoW. For example, Moratelindo has co-operated with the municipal government in Semarang to deploy ducts and poles and adopted a revenue share scheme.

Other cities like Bekasi and Bandung are also in the process of beginning ducting. However, they are waiting for the current pilot projects to show positive outcomes before deciding on the next steps.

5.3 Key market drivers

Public-sector ambition to bring visibility to fibre deployments while improving the aesthetic appeal of the cities are key drivers

Facilitate the easier deployment of smart-city solutions in each city

Several Indonesian cities have ambitions to deploy smart-city solutions, from traffic management to assisting with policing and public management. Ducted fibre is much easier to use for such scenarios and simply requires connectivity to the appropriate software systems.

Increase visibility on fibre availability in the market

Deployment of a duct requires the necessary licences before work can be undertaken, and wholesale lease agreements are also licensed. This provides clear visibility into the available fibre infrastructure in the city, which is currently not possible with unlicensed aerial deployments.

Increase the aesthetic appeal of the cities

Fibre in underground ducts is not visible and avoids the messy deployments that are typical in aerial cables.

5.4 Market size

Relatively small market size at the current time although demand could significantly pick up in the coming years

Moratelindo is currently the main provider that is working with various city governments thinking of deploying fibre ducts across Indonesia. Based on the success from the Palapa Ring deployment and the Palapa Ring Project, in the coming five years Moratelindo intends to deploy ducts in nine cities in Indonesia.

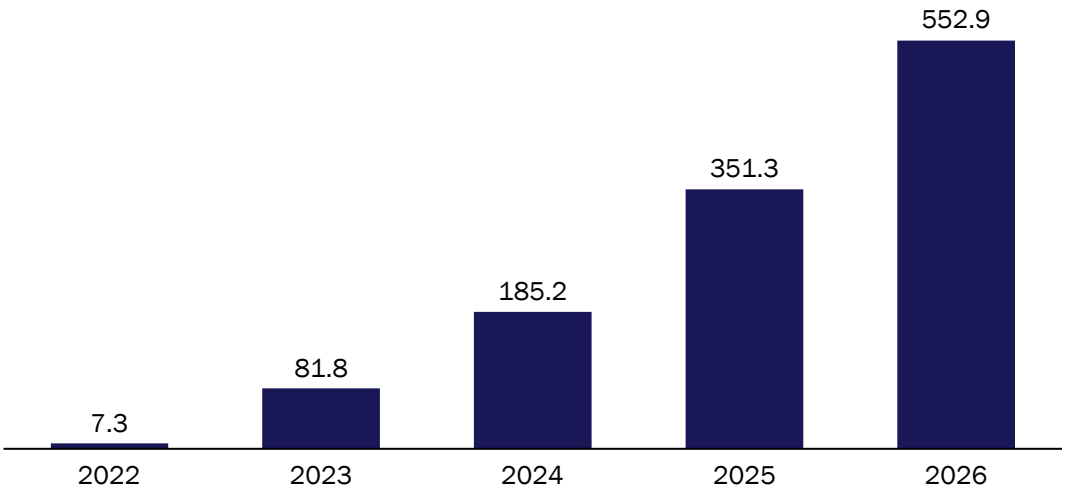
Figure 5.1: Moratelindo's ducting deployments targets [Source: Operator reports, 2022]

Status	City	Proposed ducting length (km)
In progress	Semarang	506
Planned	Bekasi	608
	Surabaya	605
	Bali	509
	Bandung	402
	Palembang	234
	Tangerang Selatan	203
	Sidoarjo	151
	Jambi	87

On average, Moratelindo intends to deploy 400km of ducts in any particular year.

Based on the market rental price of IDR1,200 per month per metre, the ducting market opportunity is expected to be IDR552.9 billion in 2026.

Figure 5.2: Indonesia's ducting rental revenue (IDR billion) market[46] [Source: Moratelindo, 2022]



5.5 Opportunities, threats and challenges

Opportunities exist for expansion to other cities in Indonesia but business has significant dependency on the strategies of city governments

5.5.1 Opportunities

Expansion to other cities based on a successful pilot in Semarang

Stakeholders in other urban areas in Indonesia are following the progress of fibre duct installation in Semarang and could be willing to deploy their own ducts if the outcome of the Semarang project is successful.

Unique access to right of way (RoW) in deployed cities

The party deploying the ducts will have unique access to all the fibre infrastructure in the city. While other parties can be provided with wholesale access, the duct owner will be in a unique position of authority coupled with a strong working relationship with the local authority.

46 The ducting market size is estimated by multiplying the utilised and occupied duct length with the monthly wholesale price to be charged per unit length. The utilised duct length is a fraction of the deployed duct length since all ducts are unlikely to be immediately utilised. Duct utilisation has been assumed to increase from 5% in the first year and plateau at 50% year five onwards. Each utilised duct is assumed to have 140 cables. Duct occupancy, indicating the number of cables that are used in the utilised duct, is assumed to increase from 5% in the first year and plateau at 50% year five onwards.

5.5.2 Threats and challenges

Dependence on vision of city management and local relationships

Strong local relationships with the city management will be needed in order to be selected as the ducting partner that typically follows a tender process. At the same time, city management needs to be forward thinking and successive leaders should share a joint vision. In the absence of that, ducting projects started under one leader may be discontinued under another, thus not providing any of the benefits expected.

5.6 Summary

Fibre ducting has been adopted as a strategic inititiative by a few city governments in Indonesia. Currently, Moratelindo is the primary supplier undertaking this work which places it in a good position to obtain control over the city's infrastructure as well as build a strong relationship with the local government. While the opportunity in the near term may not seem significant, as further cities take up this initiative this market is expected to further grow.

6 FTTx

Optical fibre is mainly used in long routes for core and backhaul networks due to its following advantages:

- high capacity
- low insertion cost per capacity unit
- resilience and immunity against electro-magnetic interference and water ingress
- scalability for new technologies.

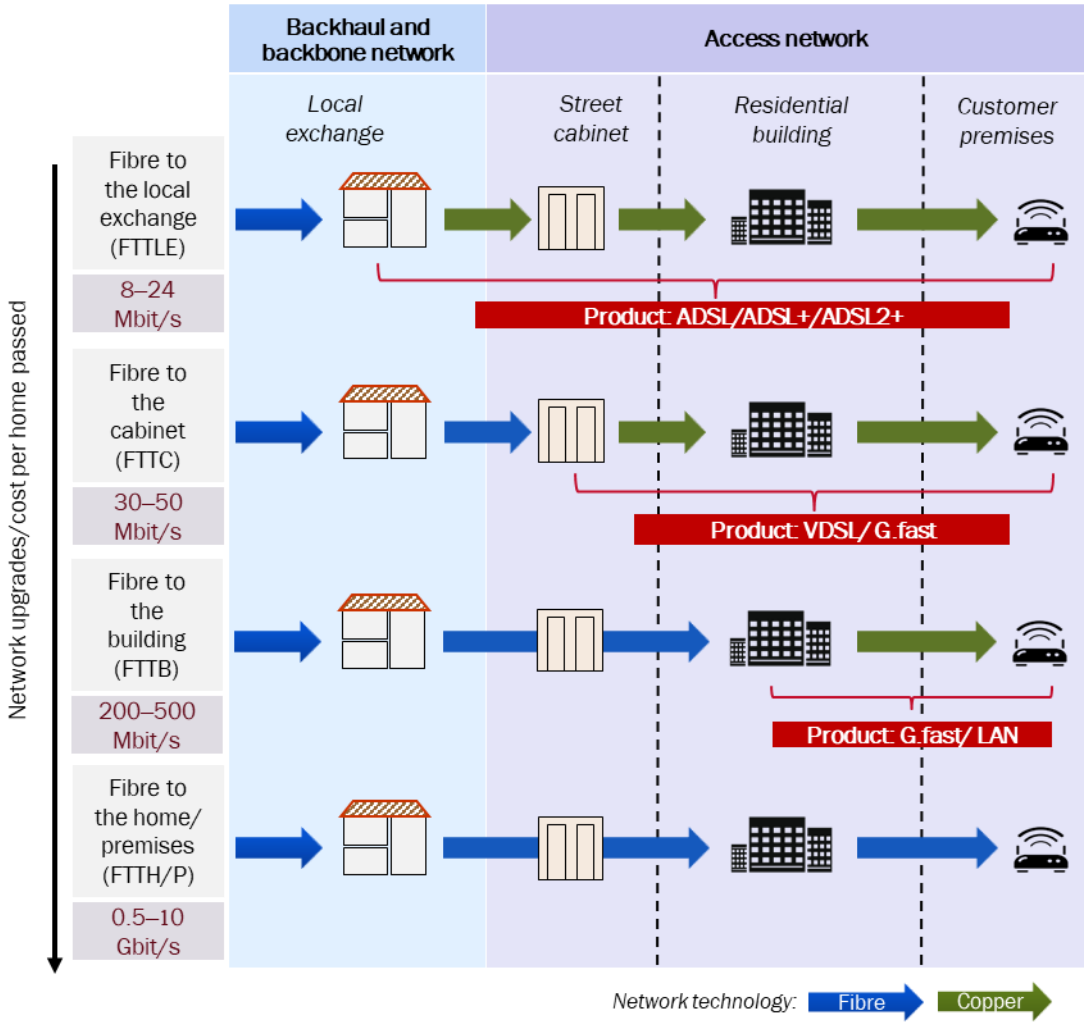
Between 2016 and 2020, global data demand increased significantly – average monthly internet traffic per broadband connection almost tripled and is expected to continue growing at a CAGR of 23% until 2026 according to Analysys Mason Research.

This soaring data demand is driving fibre infrastructure closer to the end user. Fibre technology is increasingly being used for residential access networks (e.g. FTTx) because of the following benefits:

- faster speed: fibre-optic internet is many times faster than the highest-speed copper internet connection
- less signal degradation: the signal of copper lines degrades as the user moves away from the switch, while the signal strength of fibre does not degrade as quickly over distance.

There are multiple ways in which fibre can be provided to a subscriber. Alternative deployments like fibre to the local exchange (FTTLE), fibre to the cabinet (FTTC), fibre to the building (FTTB) and fibre to the home/premises (FTTH/P), each bring the fibre connection closer and closer to customer premises.

Figure 6.1: FTTx topology diagrams [Source: Analysys Mason, 2022]



Telecoms operators, particularly incumbent operators, typically upgrade their fibre networks in a phased manner, with each step taking the fibre closer to the customers' premises.

To roll out FTTx networks, telecoms operators can choose to use:

- a point-to-point (PtP) architecture, where one dedicated fibre is deployed from the local exchange (LE) to each end user's premises
- a passive optical network (PON) architecture, where one fibre is shared by multiple end users (typically 32–64 between the LE and the street cabinet).

The PON architecture is mostly used to provide broadband services unless dedicated bandwidth is continuously needed as is the case with very large organisations in specific industries.

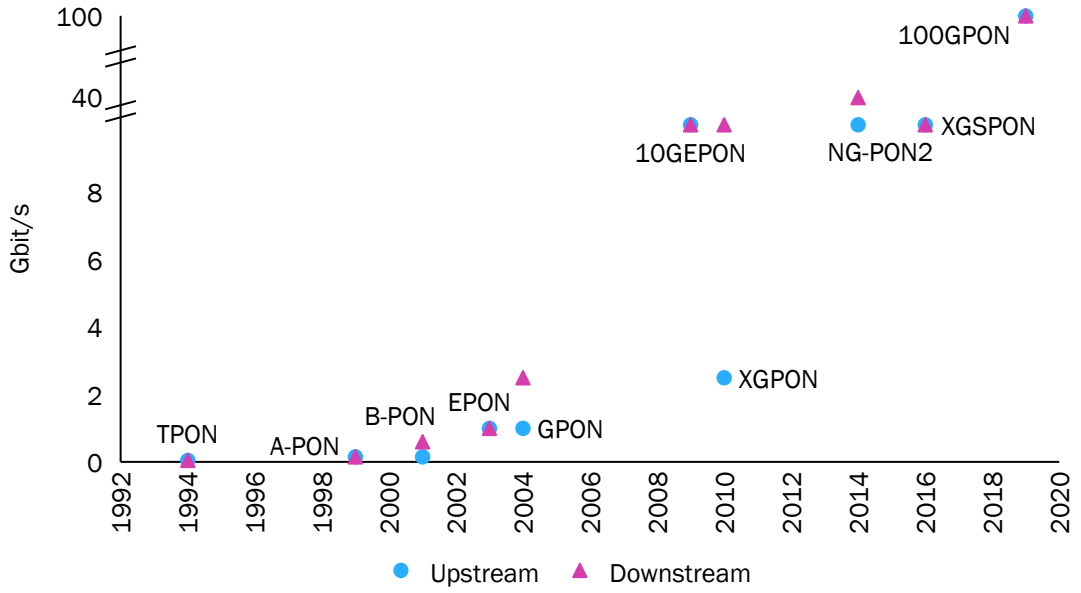
PtP FTTH networks' current equipment allows symmetrical speeds of 1Gbit/s or 10Gbit/s. They are less common than their PON-based counterparts, so the technological roadmap is less detailed. However, since in a PtP network each user is connected by a dedicated fibre, upgrades to higher data rates should require minimal re-investment.

The technology currently used in PONs is GPON (2.5Gbit/s downstream and 1.25Gbit/s upstream), which is shared by all subscribers on the same fibre. Several successors to GPON have emerged, which will only require active endpoint equipment upgrades:

- XGPON (also known as 10G-PON) offering 10Gbit/s downstream and 2.5Gbit/s upstream
- XGSPON offering a 10Gbit/s symmetric connection
- NG-PON2 offering 40Gbit/s downstream and 10Gbit/s upstream.

Discussions began in 2016 regarding 100GPON, a PON technology offering 100Gbit/s bandwidth. The first trials of the technology in 2019 have been successful. However, GPON's current performance generally covers most current and medium-term customer needs.

Figure 6.2: Evolution of PON technologies [Source: Analysys Mason, 2022]



6.1 Business model

Service made available to customers in the form of standard packages with some customisation possible for enterprise customers

The business model for FTTx follows an approach like that of any retail business. Service providers develop and market a range of different connectivity options considering the differing requirements of various customer segments. Each option is typically called a "plan", is uniquely priced and comprises a headline connectivity speed bundled with other value-added services. Customers can select the most appropriate plan depending on their individual requirements. Plans often come with a lock-in period within which there is a penalty for termination. Depending on the plan selected, the customer might also need to purchase some equipment to be installed at the customer premises.

The business model for the enterprise segment is largely similar, although some customisation of the plan is possible for large volume contracts. Enterprise plans may also come with different value-

added services like cyber protection, quality customer care, etc. Payment terms for enterprise plans are also likely to be stricter compared to those for the residential segment.

6.2 Industry overview

Telkom is the leading supplier in an eight- to ten-player market for both enterprise and residential connections

Fibre connectivity can be provided to customers in various configurations. Enterprises typically use dedicated fibre connections or fibre-based fixed broadband services. The retail sector does not typically have dedicated connections, but fibre is typically used for residential broadband services.

6.2.1 Enterprise connections

In Indonesia, there are eight main players in the enterprise connectivity segment providing a range of services from dedicated connections to enterprise broadband.

Figure 6.3: Key enterprise connectivity players in Indonesia (as of December 31, 2020) [Source: Operator reports, press release, Analysys Mason, 2022]

Operator	Enterprise revenue[47] (IDR billion, 2020)	Enterprise customers	Technology	Network length (km)	Fibre coverage and details
Moratelindo	364.1	>6,700	FTTB / FTTx	>48,000	• Has >22,000km of urban network connecting 216 buildings and 6,700 private and governmental entities (who are not telecommunications providers). Provided using a combination of GPON and Metro-E technologies

47 Enterprise revenue refers to fixed broadband revenue and fixed dedicated connection revenue in the enterprise segment. Operators' figures are triangulated based on their reported revenue in relevant segments and/or services. For example, Moratelindo's enterprise revenue is estimated based on the reported retail revenue (which includes both enterprise and residential broadband) subtracting estimated residential broadband revenue. The residential broadband revenue is estimated by reported residential broadband subscriber numbers and total market ASPU.

Operator	Enterprise revenue[47] (IDR billion, 2020)	Enterprise customers	Technology	Network length (km)	Fibre coverage and details
Telkom	19,000	339,182 SMEs, 1,703 large corporates and 935 government organisations	DSL and FTTx	>200,000	• Nationwide across all key regions
ICON+	N/A	>3,000	FTTx	~90,000	• In all provinces on Java and Sumatra as well as some provinces on Kalimantan and Sulawesi
Biznet	762	5,854 postpaid subscribers and 9,004 SME subscribers	FTTx	~61,000	• In >4,600 buildings across 180 cities in 21 provinces, connected to Java, Bali, Sumatra, Kalimantan, Sulawesi and Nusa Tenggara
Link Net	330	>2,500	Hybrid fibre-coaxial (HFC) and FTTx	~34,000	• In 9 provinces across major cities in Java (Greater Jakarta, Bandung and Surabaya), Bali and Medan
Fiberstar	N/A	114 ISP partners	FTTx	~30,000	• 100% fibre optic network in urban villages and cities in Sumatra, Java, Bali, Kalimantan and Sulawesi
Lintasarta	N/A	>2,400	FTTx	N/A	• In 18 provinces across islands of Java, Sumatra, Kalimantan, Sulawesi and

Operator	Enterprise revenue[47] (IDR billion, 2020)	Enterprise customers	Technology	Network length (km)	Fibre coverage and details
					Lesser Sunda Islands
CBN	N/A	~3,000	FTTx	N/A	• In 8 provinces over 26 cities, covers more than 200 commercial buildings mainly in Greater Jakarta, Palembang and Surabaya

Telkom is the market leader in the enterprise segment, accounting for ~73% of overall enterprise revenue share. Telkom has been able to maintain a high market share from focusing on high-profitability services, and prioritising business solutions with high margin and recurring income.

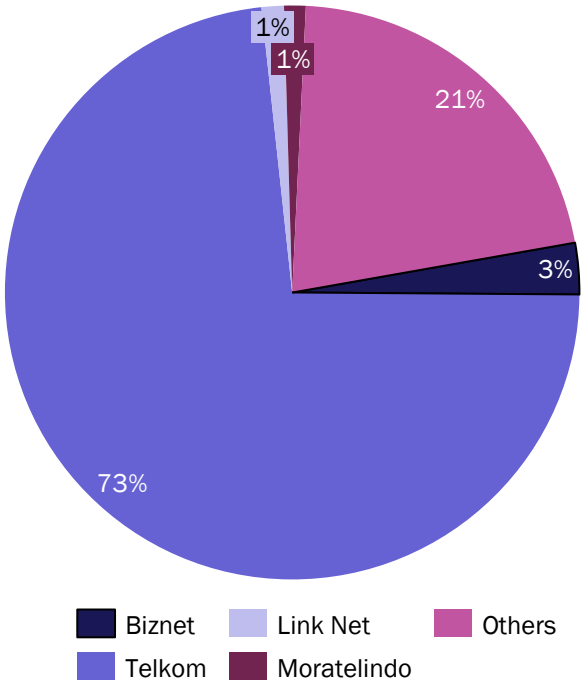


Figure 6.4: Breakdown of market share, by enterprise revenue (enterprise fixed broadband + domestic dedicated connection), 2020 [Source: Analysys Mason, 2022]

6.2.2 Residential connections

There are seven main players in the residential connectivity segment. Most provide fibre-based connectivity, although some players do operate copper-based and cable networks.

Figure 6.5: Key residential broadband providers in Indonesia (as of December 31, 2020) [Source: Operator reports, press release, Analysys Mason, 2022]

Operator	Homes passed[48] (thousand)	Subscribers (thousand)	Technology	Description
Moratelindo	244	~72	FTTx	• Offers services through its Oxygen.id brand
Telkom	30,100	8,460	DSL, FTTx	• Nationwide coverage across all key regions
Link Net	2,831	861	HFC, FTTx	• In 9 provinces across major cities in Java (Greater Jakarta, Bandung and Surabaya), Bali and Medan • Its network includes ~18,000km of fibre and ~16,000km of HFC • XL Axiata acquired 66% stake in Link Net in January 2022
MNC Vision Networks	1,500	~301	FTTx	• Present in Jakarta, Java (West, Central and East) and North Sumatra • Reported a fibre network that stretches 1,165km along the island of Java, in 2019
Biznet	1,150	~300	FTTx	• In >4,600 buildings across 180 cities in 21 provinces, connected to Java, Bali,

48 As reported by operators.

Operator	Homes passed[48] (thousand)	Subscribers (thousand)	Technology	Description
				Sumatra, Kalimantan, Sulawesi and Nusa Tenggara
MyRepublic	1,020	~180	FTTx	• Present in Jakarta, Banten, Java (West, Central and East) and Sumatra (North and South) across 13 cities • Subsidiary of Sinar Mas Group
XL	540	116	FTTx	• In Jakarta, Banten, West Java, Yogyakarta, Bali, South Sulawesi and Kalimantan (East and West) across 44 cities • Acquired a 66% stake in Link Net in January 2022 to develop its FTTH business

As with the enterprise segment, Telkom is the largest player in the residential segment.

6.3 Key market drivers

Soaring data consumption, industry digitalisation and the impact of the Covid-19 pandemic are key drivers

Soaring increase in data consumption by consumers

Consumer data usage has increased significantly in several aspects, which mainly includes social media, gaming and e-commerce[49]:

- Social media: in 2020, internet users in Indonesia ranked eighth globally for time spent online daily (8 hours 52 minutes). Indonesia has the highest number of Facebook and Instagram users among South-east Asian countries – these users drive data consumption, as both social media platforms are known to host image and video content.

49 https://datareportal.com/reports/digital-2021-global-overview-report

- Media and gaming: in 2020, internet users in Indonesia ranked ninth globally for time spent daily playing video games on a gaming console (1 hour 16 minutes) and averaged 2 hours 50 minutes daily watching TV (broadcast and streaming). The significant amount of time spent using these data-intensive applications is likely to drive data consumption.

- E-commerce: Indonesia is home to some of the largest e-commerce platforms in the region. The e-commerce consumer market increased by 49% in 2020 to USD30.3 billion. As consumers migrate more of their shopping activities online, they will spend more time online browsing and comparing, which will drive data consumption.

Impact of the Covid-19 pandemic

Work-from-home and home-schooling arrangements, which could persist post the Covid-19 pandemic, may also add to demand for residential fixed broadband.

Growing addressable market and increasing household income

Gradual growth in the total number of households will continue to expand the addressable market for residential broadband. At the same time, strong growth in the average disposable income of households will help to increase affordability of broadband services.

Digitalisation of enterprises and SMEs

The Indonesian government has made digitalisation of the economy, and particularly the MSME segment, a priority. In addition to the deployment of infrastructure, financial support is provided to eligible enterprises to obtain access to high-bandwidth connectivity services.

6.4 Market size

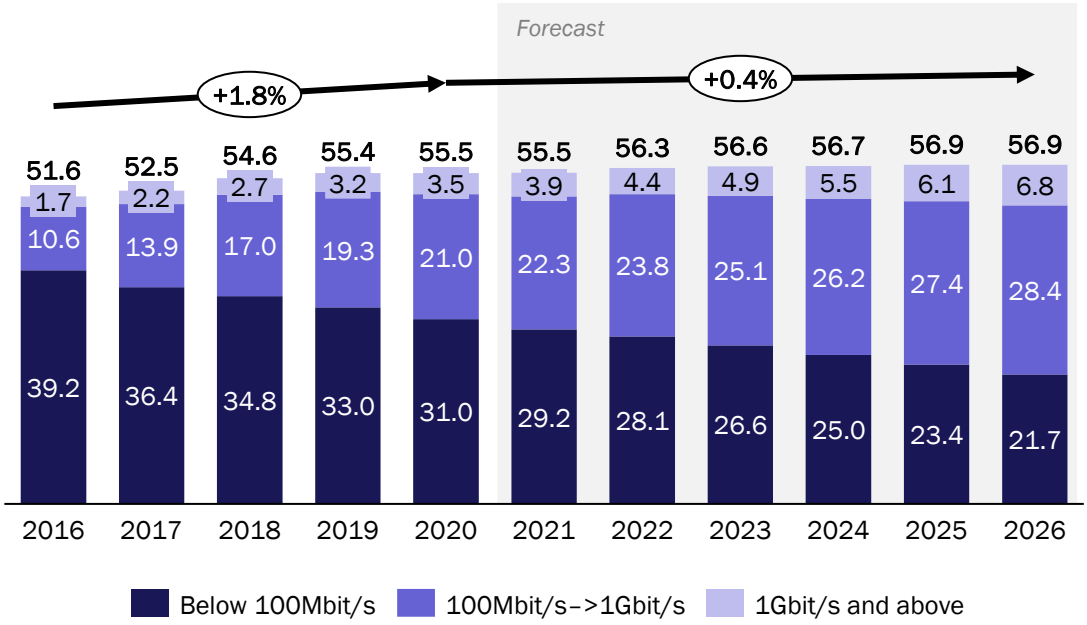
The dedicated connection market is expected to be challenged due to the emergence of alternatives, while fibre-based fixed broadband is expected to continue to see steady growth

6.4.1 Enterprise connections

Enterprise dedicated connections

Demand for dedicated connections has grown moderately in recent years, supported by enterprise digitalisation and the entry of cloud providers in the market (i.e. Alibaba Cloud in 2019 and Google Cloud in 2020) which created demand for private connectivity to cloud services. While disruptive solutions like SD-WAN are in their nascent stages of adoption in Indonesia, we expect their impact to be more prominent in the future. Overall, we expect migration to SD-WAN to outweigh general dedicated connection growth, with the projected number of dedicated connections showing low growth as can be seen in Figure 6.6 below.

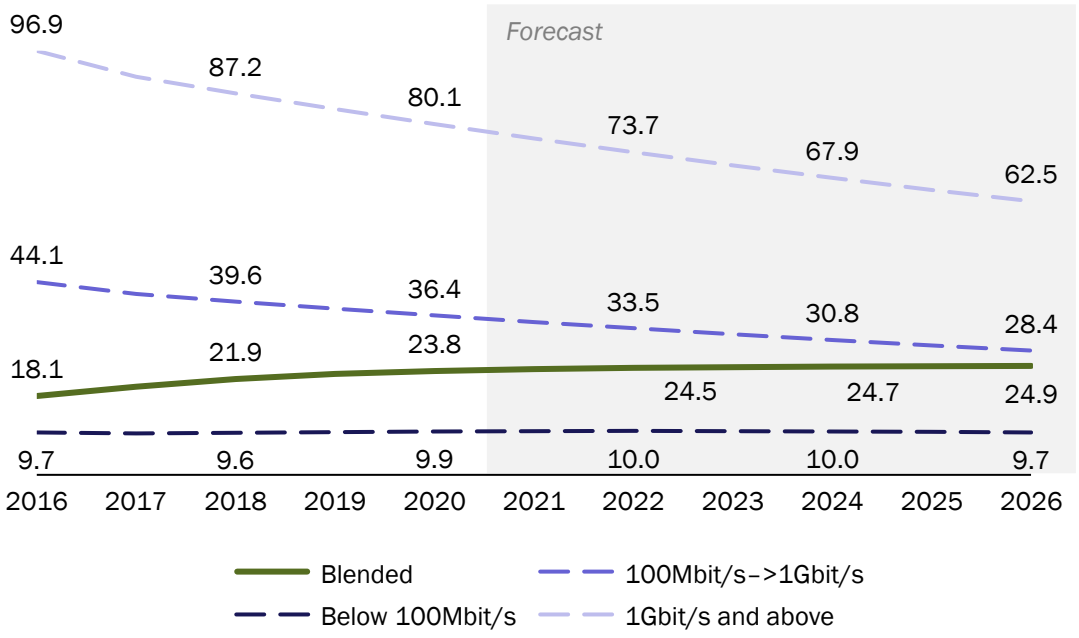
Figure 6.6: Historical and forecast dedicated connections by type (thousand) [Source: Analysys Mason Research, 2022]



As shown in Figure 6.7, average revenue per connection (ARPC) for all connection speeds has generally declined over the past few years, with the '1Gbit/s and above' category experiencing the steepest decline. Overall, blended ARPC for dedicated connections has increased from ~IDR18 million to IDR23 million from 2016 to 2020. This is due to the change in the mix of connections sold with higher-value dedicated connections (>100Mbit/s) comprising a large share in the recent years.

As price premiums for dedicated connections compared to broadband internet are projected to be significant (8 to 12 times higher), we expect enterprise providers may lower dedicated connection prices to remain competitive with alternative disruptive solutions.

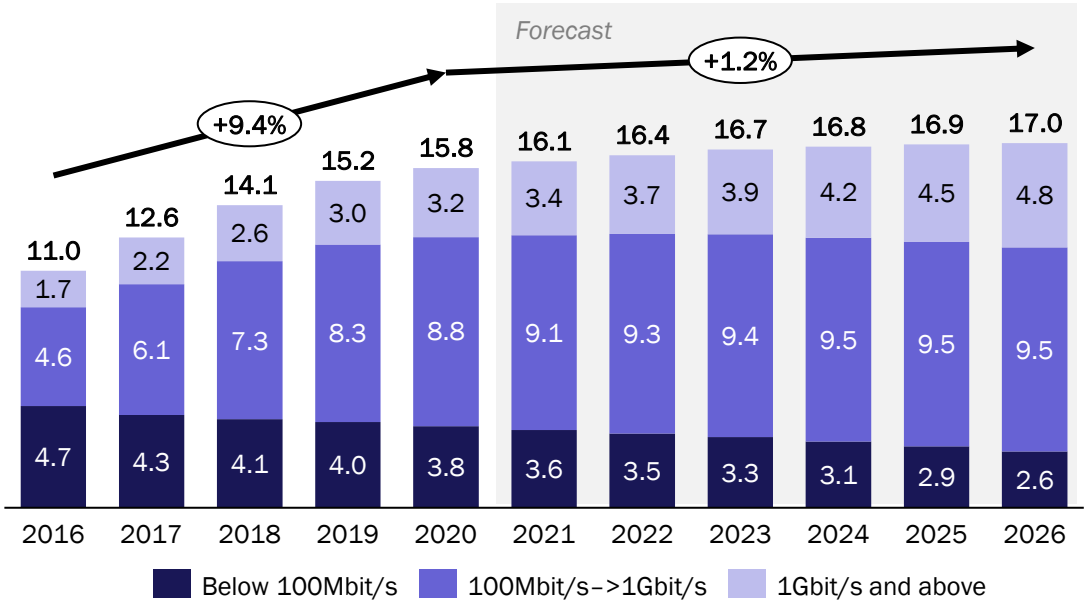
Figure 6.7: Historical and forecast dedicated connection ARPC by type (IDR million) [Source: Analysys Mason Research, 2022]



ARPC for all connection types is expected to decline, although blended ARPC is expected to be flat due to the increasing share of high-bandwidth connections.

Overall, revenue from dedicated connections is expected to continue growing moderately in the coming years.

Figure 6.8: Historical and forecast dedicated connection market revenue (IDR trillion) [Source: Analysys Mason Research, 2022]



Enterprise fixed broadband

Unlike the developments in the dedicated connection market, demand for enterprise fixed broadband has grown strongly over the last few years because of increasing operator investment in rolling out the required network infrastructure. Growth is expected to continue over the period 2020–26.

Specifically, demand from the MSME segment is forecast to grow significantly in the future due to a strong digitalisation push from the government e.g. "MSME Go Online", and the launch of tailored services for this segment.

Fibre has also steadily replaced copper-based technologies as the core fixed broadband technology with 80% share as of 2020. The launch of Indonesia's five-year National Broadband Plan in 2014, which saw the government promote nationwide fibre-optic backbone build-out, is likely to have boosted fibre deployment and encouraged take-up. At the same time, major fixed broadband operator Telkom has been increasingly replacing its DSL network with FTTx and migrating customers to fibre broadband plans.

FTTx technology is expected to eventually reach 91% share in terms of connections due to continuous fibre roll-out by operators, coupled with enterprises' higher receptivity to fibre broadband for enhanced network experience.

Figure 6.9: Historical and forecast enterprise fixed broadband connections (million) by enterprise type [Source: Analysys Mason Research, 2022]

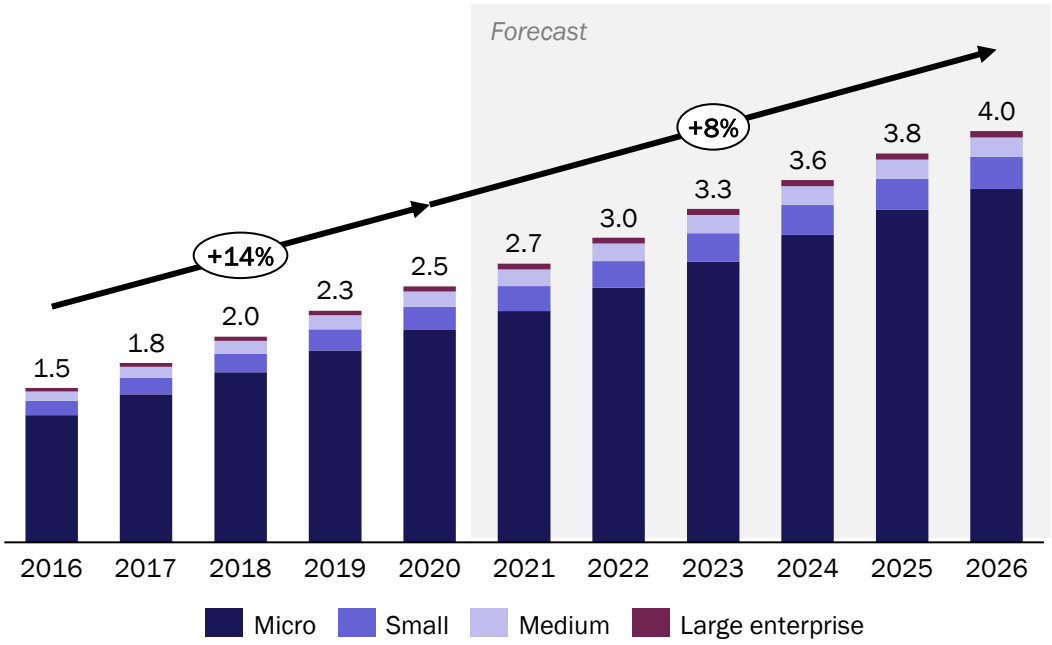
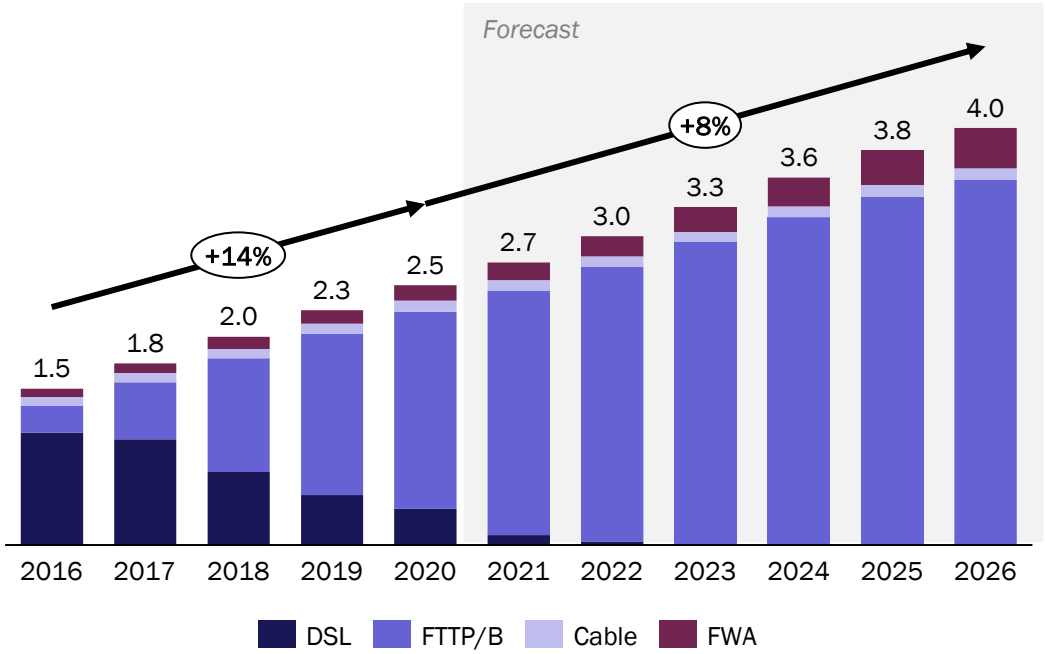


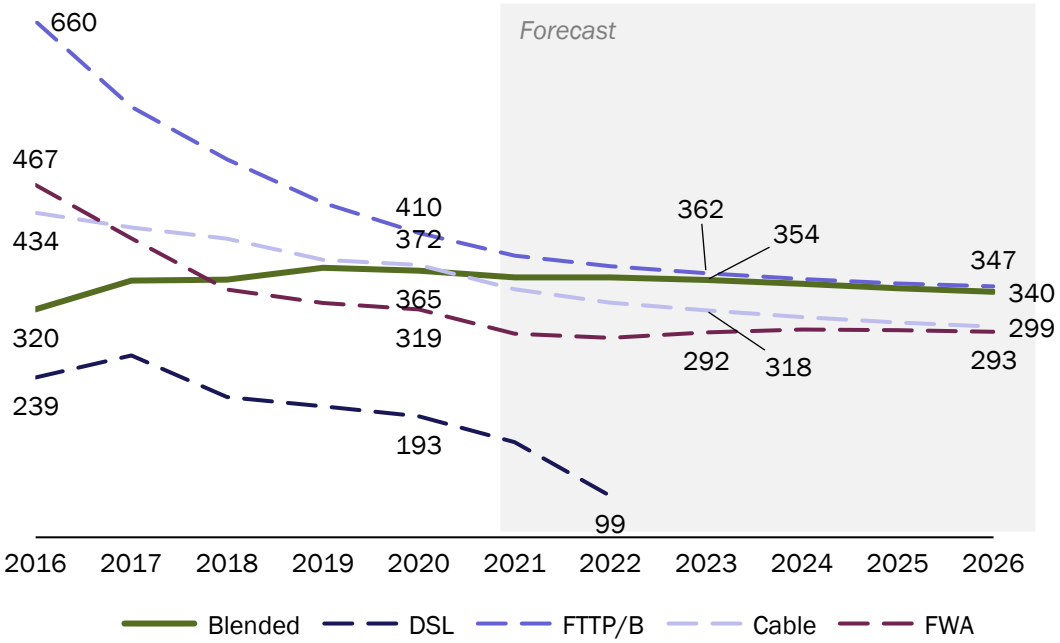
Figure 6.10: Historical and forecast enterprise fixed broadband connections (million) by technology [Source: Analysys Mason Research, 2022]



ASPU for all types of enterprise fixed broadband connections has declined from 2016 to 2020. FTTx ASPU has fallen significantly over the last five years, to a range much closer to cable modem ASPU in 2020. ASPUs of FTTx and cable modem have also declined due to acquisition of lower-value customers from an expanding customer base.

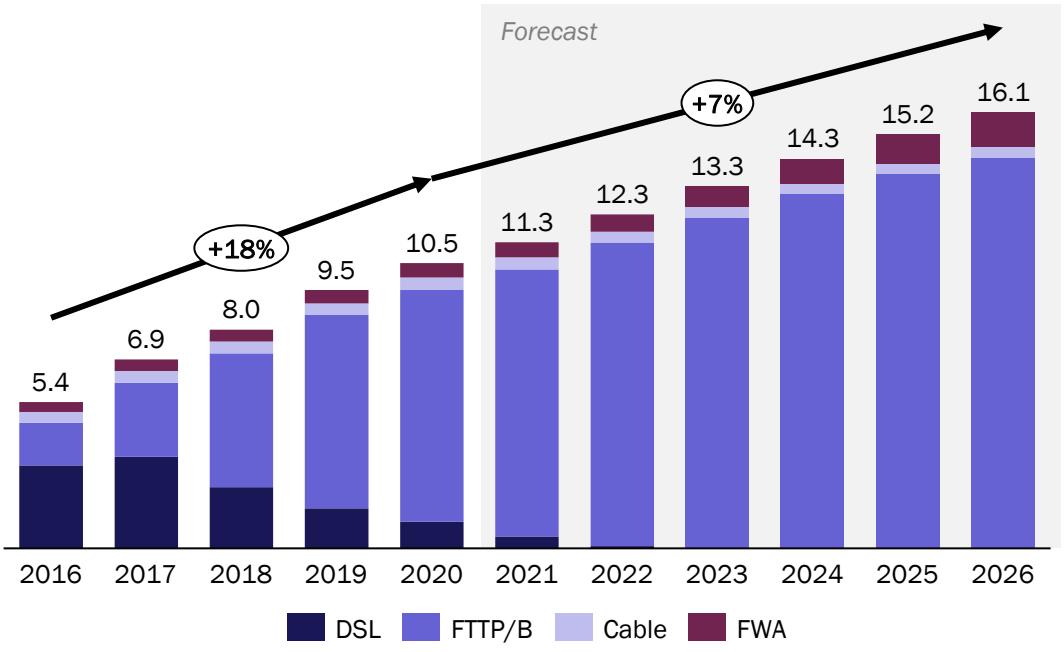
However, blended ASPU has risen over the past few years from rapid migration to FTTx broadband plans priced at a premium compared to other technologies. Blended ASPU is expected to decline at a CAGR of 3% largely attributed to the acquisition of more micro and small-sized enterprise customers, which are expected to sign on to lower-value contracts.

Figure 6.11: Historical and forecast enterprise fixed connection ASPU by technology type (IDR thousand) [Source: Analysys Mason Research, 2022]



Overall, revenue from enterprise fixed broadband is expected to grow at a CAGR of 7% over the next five years as subscriber growth exceeds moderate ASPU decline. 90% of that revenue is expected to be from FTTx which is expected to grow at a CAGR of 7.9% over the period.

Figure 6.12: Historical and forecast enterprise fixed broadband market revenue (IDR trillion) [Source: Analysys Mason Research, 2022]



6.4.2 Residential connections

In Indonesia, the residential fixed broadband market has expanded rapidly with FTTP/B as the main deployment technology. Fixed broadband households have grown at a CAGR of ~27% between 2016 and 2020, largely supported by the deployment of network infrastructure which has facilitated an increase in the adoption of high-speed broadband. Migration from legacy ADSL by Telkom has also been a reason for growth.

Household penetration has grown significantly but remains low as fixed-line network roll-out by operators has largely occurred in bigger cities due to favourable economics. Support from the Indonesian government to invest USD22 billion in fixed broadband infrastructure under the five-year National Broadband Plan 2014–2019 has also contributed to strong FTTP take-up.

Key fixed broadband providers have aggressively expanded their network over the last five years. For example, Telkom has increased the number of homes passed by 2–4 million annually between 2016 and 2020, while some small players have also been deploying aggressively, each adding between ~20,000 and 250,000 homes passed annually over the last few years. Investment in network expansion is expected to continue with major players raising funds for further deployment.

Fixed broadband average spend per user[50] (ASPU) increased from 2018 to 2020 as FTTP/B connections, which have higher ASPU, increased as a share of residential fixed broadband connections at the expense of lower ASPU DSL connections.

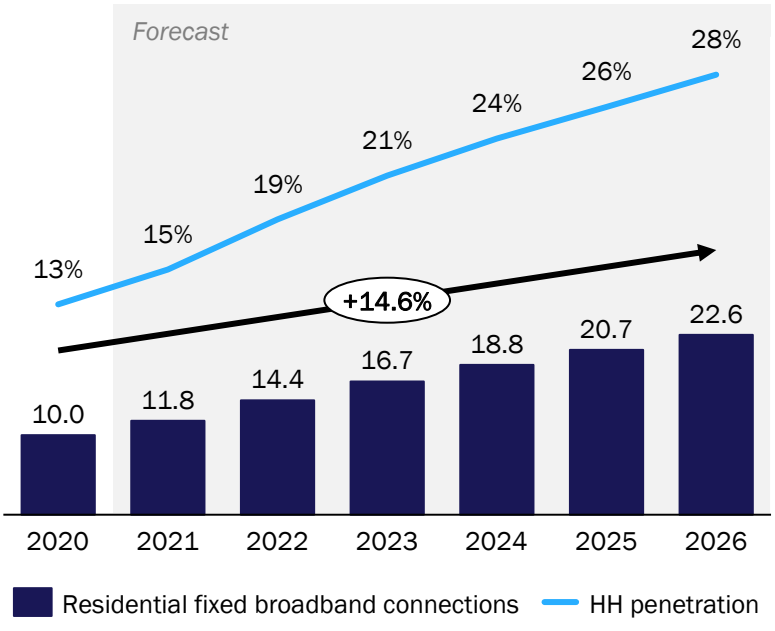


Figure 6.13: Residential fixed broadband subscribers (million) and household penetration (%) [Source: Analysys Mason Research, 2022]

50 Average spend per user is calculated as retail revenue divided by the average number of connections for the period and converted into a monthly figure.

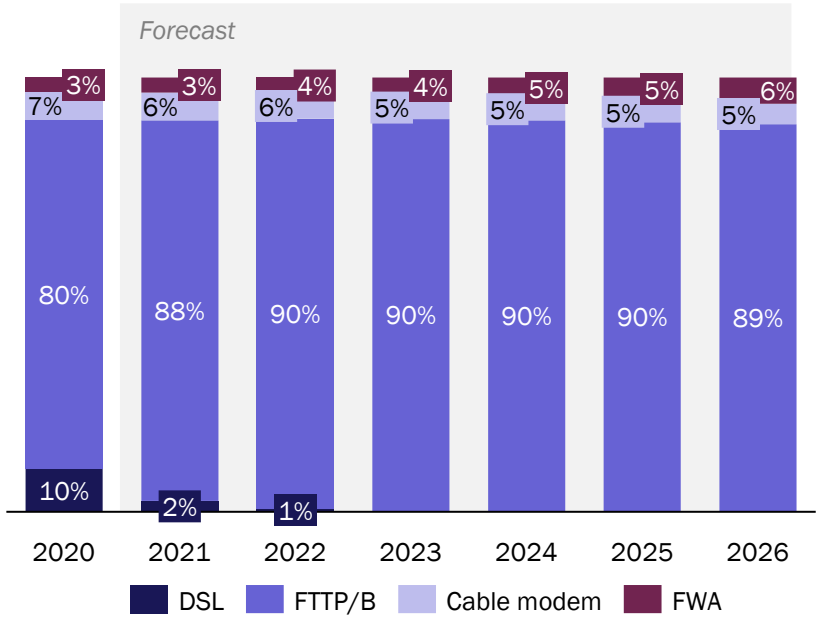


Figure 6.14: Residential fixed broadband connections by technology [Source: Analysys Mason Research, 2022]

ASPU for FTTP/B is expected to decrease moderately due to the dilution effect of new subscribers taking up low-tier packages and enjoying promotions in competitive areas.

FWA ASPU is expected to decrease slightly in the short term as higher-bandwidth (and therefore likely higher-priced) packages are only expected to be launched with the deployment of full 5G on dedicated 5G spectrum from 2023.

Overall, as the composition of the market skews towards FTTP/B connections and price competition intensifies, blended ASPU is expected to decline moderately. Overall revenue from residential broadband is expected to continue rising substantially as subscriber growth offsets mild ASPU declines. By 2026, FTTP/B is expected to contribute 91% of that revenue.

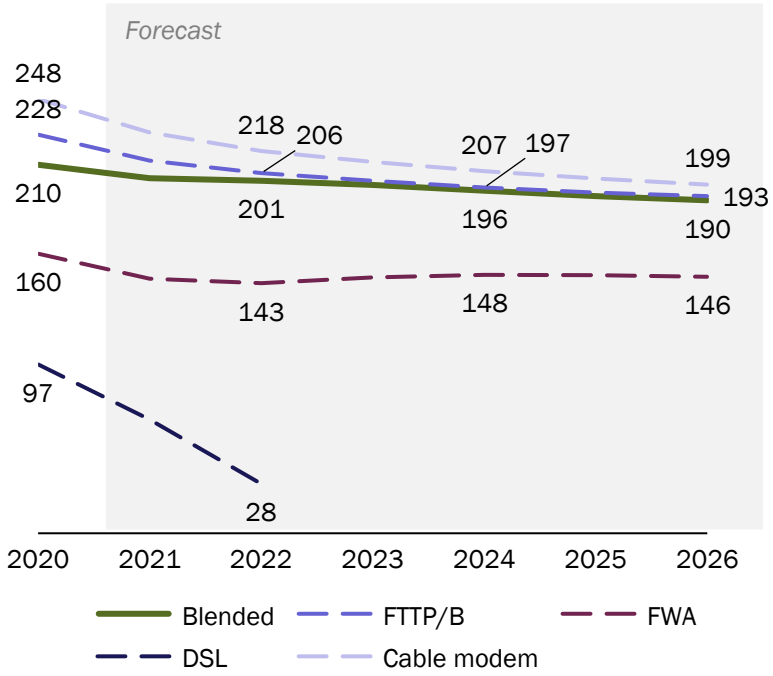
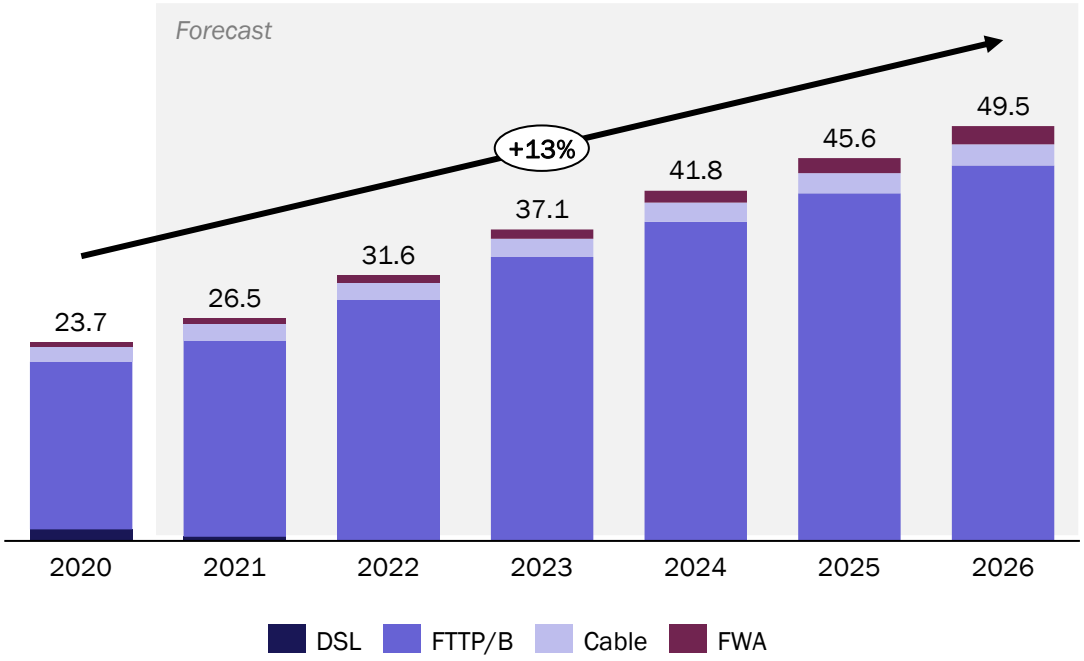


Figure 6.15: ASPU for residential fixed broadband by technology type (IDR thousand/month) [Source: Analysys Mason Research, 2022]

Figure 6.16: Residential fixed broadband market revenue by technology type (IDR trillion) [Source: Analysys Mason Research, 2022]



6.5 Opportunities, threats and challenges

Foreign investment can accelerate the deployment of networks

6.5.1 Opportunities

Relaxation of foreign investment restrictions in the telecoms market would spur further investment

Prior to 2021, Indonesia's Negative Investment List capped foreign ownership in the telecoms sector at certain levels and partially constrained foreign investments in Indonesia's telecoms, media and technology (TMT) landscape.

Recent regulatory changes brought on by the Omnibus Law in March 2021 replaced the Negative List with a new Positive List, which lifted foreign investment restrictions across various TMT sectors (including fixed telecoms services and internet service providers) and also provided additional incentives (e.g. tax holidays) in some areas.

These changes have opened the telecoms market to foreign investment, which could spur further investment in the broadband market.

Growth in the adoption of cloud services will continue to require the need for enterprise connectivity services

Cloud services are increasingly integral to the product portfolio of enterprises, and connectivity providers are well positioned to capture this growing demand. According to Analysys Mason's 2019 business survey of the Indonesian market, on average 65% of businesses surveyed said that they would consider purchasing cloud services from their fixed operator. This suggests that enterprise connectivity operators have a much larger opportunity than they are currently capturing.

6.5.2 Threats and challenges

Deployment of 5G in areas where fixed network deployment can be difficult

As the largest archipelago in the world with a mountainous topography, fibre/cable deployment in Indonesia is challenging. According to the World Bank, 43% of Indonesia's population resides in rural areas dispersed across the ~6,000 inhabited islands. The tedious permitting process to obtain rights of way for underground digging and the necessary approvals from central, regional or local governments, affects speed to market with fibre deployments. Lead times are likely to decrease significantly if FWA can be used as FWA would enable operators to bypass this tedious permitting process and offer fixed broadband services.

However, at the current time, Indonesia is a relatively spectrum-constrained market and the timing for the release of 5G spectrum is uncertain. With key 5G bands still allocated to other uses (e.g. broadcasting, satellite), it may take several years before the existing users and services are migrated;

after the migration the bands can then be allocated to operators for mobile use. There are also four MNOs fighting for scarce 5G spectrum, which could limit network capacity available for FWA.

However, should spectrum for 5G be made available earlier than anticipated, it could reduce the demand for fibre-based broadband especially in areas where deployment is difficult e.g. difficult terrain, complicated permit approval process, etc.

6.6 Summary

As the demand for high-bandwith connections grows and legacy copper networks are retired, fibre becomes the preferred way to provide connectivity to enterprises and homes. While deployment can be challenging, the market is considerably under-penetrated, leaving room for significant expansion in connection numbers. Competition from new mobile technologies is also likely to be limited in the near term, providing fibre infrastructure suppliers with an attractive playing field. Broadband connections, for both the enterprise and retail segments, are expected to be the key growth engine.

7 Data centres

A data centre is a physical facility that organisations use to house their critical applications and data. Data centres are designed to support business applications and activities. The key components of a data-centre design include routers, switches, firewalls, storage systems, servers and application-delivery controllers.[51]

Together, they provide:

- network infrastructure: to connect servers (physical and virtualised), data-centre services, storage and external connectivity to customer locations
- storage infrastructure: to hold the data customers place in the data centre
- computing resources: to provide the processing, memory, local storage, and network connectivity that drive applications.

Data-centre components require significant infrastructure to support the resident hardware and software. These include power subsystems, uninterruptible power supplies (UPS), ventilation, cooling systems, fire suppression, back-up generators, and connections to external networks.

There are different types of data centres, each catering to different customer groups.

Figure 7.1: Types of data centres [Source: Analysys Mason, 2022]

Type of data centre	Description	Customer base	Connectivity requirement	Number of tenants/ customers
Hyperscale	Typically, purpose-built data centres which are owned and operated by a hyperscaler or third party	Hyperscale	Ultra-high-speed fibre network	1–3
Wholesale co-location	Owned and operated by a third party that leases space to large enterprise /hyperscale customers	Enterprise/ hyperscale customers	High-speed fibre network	<100
Retail co-location	Owned and operated by a third party that leases space to smaller enterprise customers	SMEs/retail customers	Interconnection to SaaS and PaaS	100–1,000

51 https://www.cisco.com/c/en_sg/solutions/data-center-virtualization/what-is-a-data-center.html#~types-of-data-centers

Type of data centre	Description	Customer base	Connectivity requirement	Number of tenants/ customers
Enterprise	Owned and operated by the company it supports. Typically housed on site and managed by the company's IT team	-	-	1
Telecoms	Owned by a telecoms service provider that leases space to companies that have very high connectivity requirements	Content providers, mobile service providers	Large bandwidth required for content delivery	~100

A new model of data centres – edge data centres – has been emerging. These are typically small facilities situated close to end users to reduce latency; their short-term use is in content data network (CDN) caching, but more varied uses are expected to develop. Currently, their main function is to reduce latency and enhance user experience (by cutting the distance that such data must traverse to and from the network core).

Edge data centres also bring computing power closer to the end users and reduce the amount of data needing to be sent to the centralised locations in the network for processing.

In the longer term, usage of edge data centres is expected to be more varied, involving applications that require real-time processing and timely response such as applications and games based on augmented reality and virtual reality, connected vehicles and street infrastructure, and industrial automation (e.g. machine vision).

Indonesia's large and vibrant internet economy is driving the growth of its data-centre market. Investment into the data-centre market has witnessed high growth in 2019–21, which is expected to continue albeit at a slower rate. According to Analysys Mason estimates, data-centre capacity is expected to increase from 74MW in 2020 to 328MW in 2026, Indonesia being one of the largest and fastest growing markets among South-east Asian countries.

Future growth in the hyperscale market is expected to come from the expansion of hyperscalers – with Alibaba Cloud and GCP launching cloud regions[52] in 2019 and 2020 respectively, Tencent launching two regions in 2021 and AWS doing the same in 2022; Microsoft Azure also plans to launch in the near future. Apart from hyperscalers, several data-centre service providers are also present in the market, focusing on co-location services to multiple enterprises.

52 According to Google Cloud, a cloud region is an independent geographical area that consists of deployment areas for Google Cloud resources in one or more physical data centres.

Data-centre revenue is expected to continue growing as Indonesia's internet economy growth remains strong and operators continue to roll out potential capacity. According to Analysys Mason estimates, the size of the market is expected to increase at a CAGR of 32%, from USD150 million in 2020 to USD780 million in 2026. Revenue from the hyperscale segment is expected to grow at a CAGR of 63% over the same period and exceed revenue from the traditional segment (which encompasses wholesale/ retail co-location, enterprise and telecoms data centres) in 2022.

7.1 Business model

Revenue for co-location services is generated by leasing space or capacity

Deciding on building a data centre starts with location selection. Once a location has been selected based on expected demand and business potential, the actual build can commence.

Building a co-location data centre is typically a three-step process which concludes with the establishment of fitted co-location capacity.

Figure 7.2: Steps towards building a data centre [Source: Analysys Mason, 2022]

Step	Description	Estimated time required
Land acquisition	• Acquisition of land upon which to build a data centre • Cost of land and duration required can vary substantially by market – e.g. regulatory red tape to obtain approval can slow down the process	12–24 months
Shell construction	• Construction of the data-centre building, excluding equipment • Data-centre providers often build this ahead of time given the relatively long construction period and relatively low capex (vs. the fitting out process)	4–8 months
Fitting out	• Fitting out the interior of the data centre with required equipment (e.g. cooling systems, uninterruptible power supply) • Given its high proportion of capex, data-centre providers typically perform this only when there is concrete demand	6 months

Fitting out the data centre with mechanical and electrical equipment is the primary component of capex deployment when building a data centre. Typically, this is done when there is clear indication of demand.

Figure 7.3: Key initial capex components for a data centre [Source: Analysys Mason, 2022]

Component	Description
Mechanical and electrical equipment	• Includes electrical equipment such as: power distribution units, transformers, patch panels, uninterruptible power-supply systems, auto transfer switches and generators • Includes mechanical equipment such as: computer room air-con units, refrigerant loops, condenser plants/chillers and water tanks)

Component	Description
Construction	• Includes architectural planning and design, building permits, local taxes, land excavation and grading, roadways, tie-ins to utilities and base building shell • Construction costs increase with the redundancy level of Tier 3/4 facilities as compared to Tier 1/2[53] due to stricter specifications needed for redundancy and fault tolerance for higher-tiered facilities
Land acquisition	• Includes transaction, consultant fees and brokerage fees • Cost of land can vary substantially by geographical region

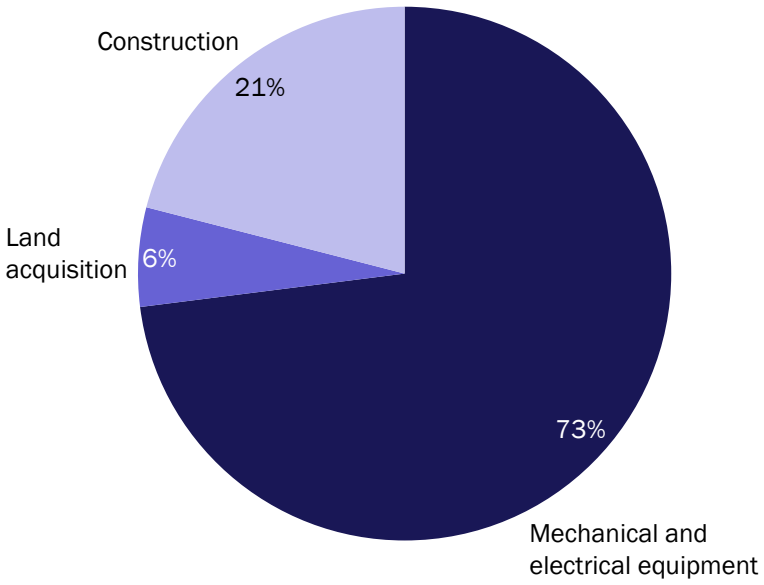


Figure 7.4: Breakdown of typical initial capex required for a data centre [Source: Analysys Mason, 2022]

The specific breakdown of initial capex can vary by market (e.g. due to differences in land costs), though equipment costs are generally the largest component.

Power is typically the largest opex component for a data centre and includes costs to both run and cool the IT equipment located in the data centre.

Figure 7.5: Key annual opex components for a data centre [Source: Analysys Mason, 2022]

Component	Description
Power	• Typically, half for running IT equipment and the other half for cooling and power infrastructure
Staffing	• Includes security, operations, on-site IT engineering and management staff, with most positions being 24×7×365 to maintain and operate data centres
Taxes	• Includes property, sales and income taxes

53 Data-centre tiers describe the infrastructure components used at a business's data centre rated for levels of redundancy and fault tolerance. See glossary for detailed description of each tier.

Component	Description
Others	• Maintenance, insurance, security, landscaping and administration costs • Repairs, replacement and upgrades of IT equipment and infrastructure (typically a few years after start of operations)

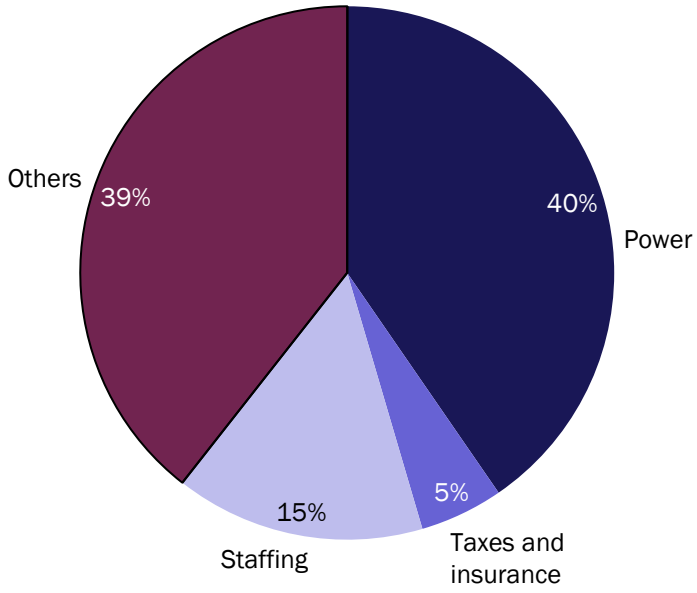


Figure 7.6: Breakdown of typical annual opex required for a data centre [Source: Analysys Mason, 2022]

As in the case of capex, the specific breakdown of opex can vary by market (e.g. due to differences in electricity pricing), though generally power is the largest component.

The revenue model for a co-location provider is relatively straightforward. The data-centre provider supplies racks which the customer leases to house its own servers. The customer pays the lease fee and charges for electricity and connectivity. Lease fees can be charged based on the number of racks used or even on the total power consumed by a customer. Connectivity charges apply to the customers' own premises as well as any connections the customer needs to make within the data centre.

In addition to the core co-location lease price, data-centre operators can also provide a range of value-added services. These are typically services like connectivity to hyperscalers and other parties in the data centre, firewall as well as dedicated personnel to manage customer equipment.

Hyperscale co-location prices in Indonesia are high, likely due to the scarcity of hyperscale facilities in the country and its rapidly growing digital economy driven by large internet companies. This is expected to continue as it has become increasingly difficult for companies to secure capacity in traditional alternate site Singapore due to the power moratorium.[54] The influx of supply is expected

54 A moratorium on new data-centre builds was imposed by the Singaporean government between 2019 and 2021 due to sustainability concerns - development of new data centres on existing state land and release of state land for data centres were put on pause. The Singaporean government subsequently announced in early 2022 that the moratorium would be lifted soon, although restrictions are expected to be introduced which may constrain new builds.

to meet the rapidly growing demand for data-centre capacity, which will likely lead to an increase in prices in line with inflation.

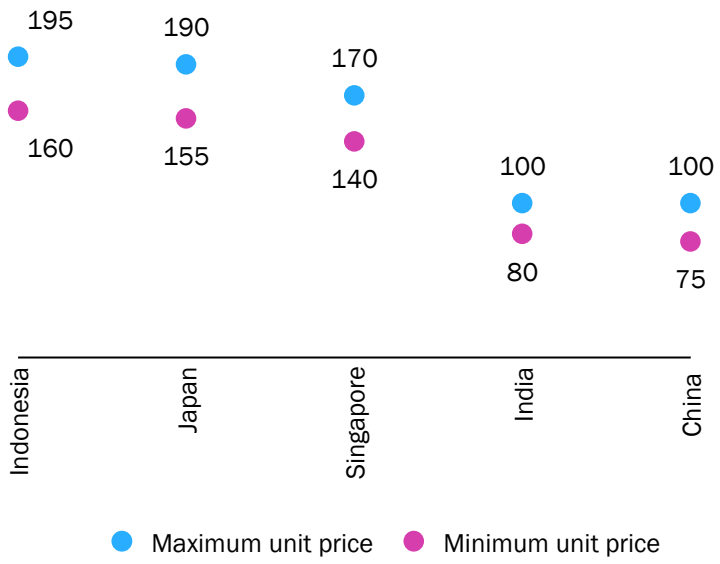


Figure 7.7: Range of hyperscale co-location data-centre prices in selected markets (USD per kW/month) [Source: CBRE, operator reports, Analysys Mason, 2022]

Meanwhile, retail and wholesale co-location prices in Indonesia are generally higher than regional peers. While increased competition from new entrants would likely exert some downward pressure, pricing pressures are expected to be largely muted since factors not related to price, such as relationship with customers and features of the data centre (i.e. location, availability capacity, power redundancy), also play strongly into eventual customer wins.

Figure 7.8: Range of wholesale co-location data-centre prices in selected markets (USD per kW/month) [Source: CBRE, 2020]

Figure 7.9: Range of retail co-location data-centre prices in selected markets (USD per kW/month) [Source: CBRE, 2020]

7.2 Industry overview

Fragmented market with only a few players supplying the hyperscaler segment

Data-centre players in Indonesia can be grouped into three categories based on the quality of their assets and key target segments.

Figure 7.10: Overview of data-centre types in Indonesia [Source: Analysys Mason, 2022]

Category	Description	Typical target segments
'Data-centre focused'	• Operators that typically focus on providing Tier 3/4-certified facilities and cater to customer segments with stricter requirements • Some operators are expanding into edge data centres to cater to increased content distribution needs • Mostly located within Greater Jakarta	Hyperscale, wholesale and retail
'Telco-linked'	• Operated/partially owned by the telcos • Co-location data centres are located nationwide and often built off previous captive facilities, with some being edge data centres serving content providers • Typically, only a proportion of their facilities are Tier 3/4 certified	Hyperscale, wholesale and retail
'Small players'	• Made up of many small players with smaller capacity and typically lack Tier 3/4 certification	Retail only

Most data-centre-focused players have specific competitive advantages such as fibre connectivity or access to crucial resources such as power, land and capital. The telco-linked players appear to have limited Tier 3/4 capacity in Greater Jakarta with Telkom and PDG announcing plans to be more aggressive in the data-centre space.

Figure 7.11: Overview of key players [Source: Operator reports, Analysys Mason, 2022]

Category	Operator	No. of data centres	Gross data-centre space (m^2)	Critical IT capacity (MW)	Description
Data-centre focused	DCI	4 current + 1 under construction	*Undisclosed*	37	• Data-centre campus is sited on 8.5 hectares of land that can be scaled to 300MW • Understood to be serving hyperscalers such as Alibaba Cloud and Google Cloud, which highlights the suitability of its assets to meet the stringent requirements of such customers
Data-centre focused	NTT	2 current + 1 planned	~7,700 (current) + 18,000 (planned)	>9	• Building a 45MW data centre with investments of ~USD500 million that may be well placed to meet cloud providers' requirements given large potential capacity and redundant power routes • In addition, NTT owns and operates one of the world's largest Tier-1 global IP backbones which can facilitate connectivity between Jakarta and overseas cloud regions
Data-centre focused	Biznet	3 current + 1 planned	>7,000 (current)	>10	• Currently has three data centres, with plans to expand to Surabaya and Yogyakarta
Data-centre focused	GTN	1 current	~6,500 (current)	5	• Tier 3-equivalent facility in Cikarang has potential for expansion to 40MW
Data-centre focused	Space DC	1 current + 1 planned	>40,000 (planned)	1.5	• Upcoming player that operates a Tier 3 facility in Greater Jakarta with 1.5MW capacity and is building a 24MW facility in the existing data-centre campus that is expected to fully come online in 2022
Data-centre focused	IndoKeppel	1 (planned)	>9,800 (planned)	N/A	• Upcoming player that has suggested that it will be targeting cloud players • Facility is being built on a 3-hectare plot with potential to expand to become a 7-hectare data-centre campus which claims to provide 40MW of capacity
Telco-linked	Telkomsigma	>15 current + 1 under construction	*Undisclosed*	>25	• Has 3 larger data centres serving enterprises and more than 12 smaller data centres serving SMEs • Primarily serves financial institutions which comprise >50% of its customer base

Category	Operator	No. of data centres	Gross data-centre space (m^2)	Critical IT capacity (MW)	Description
					• The new Telkom Hyperscale Data Centre construction broke ground in June 2020 – the facility will be built on 65,000m^2 of land, housing 10,000 racks and boasting an IT capacity of 75MW. First stage of this facility is understood to have gone into operation in 2021, delivering 25MW
Telco-linked	PDG	5 current + 1 planned	~16,000 (current) + ~24,000 (planned)	~10	• PDG acquired 70% of XL Axiata's data-centre assets in July 2019, which includes two Tier 3/4 facilities within Greater Jakarta • Announced in 2021 that it is developing a 22MW facility adjacent to its JC1 facility
Telco-linked	Lintasarta	3 current	5,100 (current)	>3	• Tier 3 facility in Jakarta appears to have limited capacity and uses PLN as its electricity supplier which may deter customers given concerns on reliability
Small players	Moratelindo	6 current	5,724	*2.2*	• Data centres in Jakarta, Surabaya, Medan, Palembang, Bali and Batam, with a total of 514 racks • Within the Mora internet exchange point (Mora IXP) network, and connected to Public Data Center and other exchange-points in Indonesia
Small players	DTP	5 (current)	~900	*Undisclosed*	• Small player with a portfolio of small facilities that houses <100 racks each

There has been an influx of activity in recent years, with expansion of existing players as well as the launch of new entrants (PDG, IndoKeppel) as cloud service providers continue to grow in the Indonesian market:

- **Q4 2021:** Data Center First announces plans to launch a data centre with 30MW of capacity in Indonesia; Amazon Web Services (AWS) establishes a cloud region in Indonesia
- **Q3 2021**: Telkom and Etisalat announces plans to develop a new data centre in Riau
- **Q2 2021:** DCI launches its fourth data centre with 15MW of capacity
- **Q2 2021:** Tencent cloud launches its first data centre in Indonesia
- **Q1 2021:** Microsoft announces plans to establish a cloud region in Indonesia
- **Q1 2021:** DCI Indonesia goes public on the Indonesia Stock Exchange, raising IDR150 billion (~USD10.5 million)
- **Q4 2020:** Space DC (formerly Polymer Connected) launches its first data centre with 1.45MW of capacity
- **Q3 2020:** Alibaba announces plans to open its third data centre in 2021
- **Q3 2019:** Telkom's CFO states that they will begin construction of new data centres in 2020 with a potential investment of USD70 million
- **Q3 2019:** DCI Indonesia states its plans to achieve more than 100MW IT load in the future
- **Q3 2019**: Princeton Digital Group acquires a 70% stake in five of XL Axiata's data centres.

This has led to a robust pipeline of new supply as both existing and new operators look to capture the demand in the market.

7.3 Key market drivers

The increasing demand from the start-up ecosystem is expected to drive the growth in the hyperscaler segment

Demand from vibrant start-up ecosystem

Indonesia has a vibrant start-up ecosystem with multiple local rather than regional unicorns that are actively relying on the cloud for their infrastructure needs and have fast-growing IT requirements.

Indonesia's strong internet economy has spurred it to be the largest market for cloud spend in the region. Today, spend on cloud servers in Indonesia is primarily addressed via Singapore cloud regions and thus Singapore data centres – this is expected to gradually move towards Indonesian data centres as the Indonesian cloud regions get established (e.g. Microsoft announced its intention to establish a data-centre region in Indonesia in February 2021).

Change in perception of co-location and cloud services from established industries

Many legacy industries are expected to adopt a hybrid-cloud approach with some demand for co-location due to data privacy concerns.

Figure 7.12: Change in reliance on co-location and cloud services from 2019 [Source: Analysys Mason, 2022]

Industry Segment	Change in reliance from 2019		Outlook
	Co-location	Cloud	
Financial institutions	No/minimal change	Moderate increase	• Expected to maintain their demand for on-premises servers over the next five years due to the need to maintain security for sensitive financial data • Cloud migration relating to data requirements for non-sensitive operational data and applications is expected to increase over the next five years as banks increasingly digitalise their solutions; growth in fintech players also contributes to cloud adoption over co-location services
Telco	Moderate increase	No/minimal change	• Continue to be heavily reliant on co-location; the introduction of virtualised 5G technology will increase the need for co-location
Hyperscalers (i.e. internet economy, social and online media)	No/minimal change	Marked increase	• Vibrant start-up ecosystem led by local-focused unicorns (e.g. GoTo, Traveloka, Bukalapak) which generate large amounts of data and are likely to rely mainly on the cloud for their IT requirements given the high scalability that it offers • However, they are expected to gradually migrate to local cloud regions due to cost savings and performance benefits, but this will involve a gradual process due to migration challenges
Enterprises	Moderate increase	Moderate increase	• Expected to rely more on cloud/co-location over time to reduce their investment in on-premises assets and they increase their IT sophistication
Government	Moderate increase	No/minimal change	• Some migration to co-location is expected, with a more gradual migration to the cloud due to expected government concerns over the storage of sensitive data in the cloud

Demand for content caching as traffic booms

Online content usage has increased significantly in recent years fueling demand for locally cached content that can improve user experience. Content distribution networks (CDNs) are typically used to cache poplar content and rely on local data centres to reduce latency. Currently, most CDN providers only have PoPs in Jakarta – Akamai is the only CDN provider with PoPs outside the capital. As content providers like social media platforms and OTT providers continue scaling their

operations in Indonesia and serving customers outside Jakarta, there will be increasing demand for more CDN services and data centres around the entire country to cache content close to end users.

Regulation and policy on storage of sensitive data (e.g. data sovereignty, new data protection laws/regulations) could increase local data-centre demand, though some uncertainty remains

Under the recently passed Regulation No. 71 (GR71), Public Electronic System Operators (ESOs) must place their electronic systems and data in Indonesia unless the storage technology is not available locally. This covers state institutions or other institutions appointed by a state institution that operate an electronic system. Private ESOs are not subject to the same requirement at the current time.

There is an additional requirement where the government will specify which private/public institutions have 'strategic electronic data' and must be protected by connecting their electronic documents/back-up records to a certain data centre, with details to be defined via subsequent regulations. While not explicitly defined, 'strategic electronic data' is expected to cover institutions that own vital information from various sectors (e.g. financial services, telecoms, IT, etc.).

In addition, there is a separate requirement imposed by Bank Indonesia, where the use of overseas data centres by commercial banks is permitted only with prior approval.

Given the emergence of these regulations and their associated requirements, local demand for data-centre space is expected to remain robust.

7.4 Market size

Demand for data-centre services is expected to be strong driven by anticipated demand from hyperscalers

Demand for co-location data centres in Indonesia is expected to reach ~328MW by 2026, almost three times the level of demand seen in 2021 as the use of on-premises servers and/or captive data-centre facilities is expected to reduce over time across all segments as organisations and businesses increasingly outsource their infrastructure requirements for scalability and flexibility.

The hyperscale segment is expected to drive the growth in co-location demand in Indonesia as major cloud service providers (CSPs) have highlighted Indonesia as their key growth market in South-east Asia; some have already launched a cloud region while others have announced plans to do so soon.

The enterprise segment may see some incremental demand from Indonesia's data localisation requirements. Based on new legislation, 'strategic electronic data' is required to be stored domestically, although this has yet to be defined/clarified via implementing regulations.

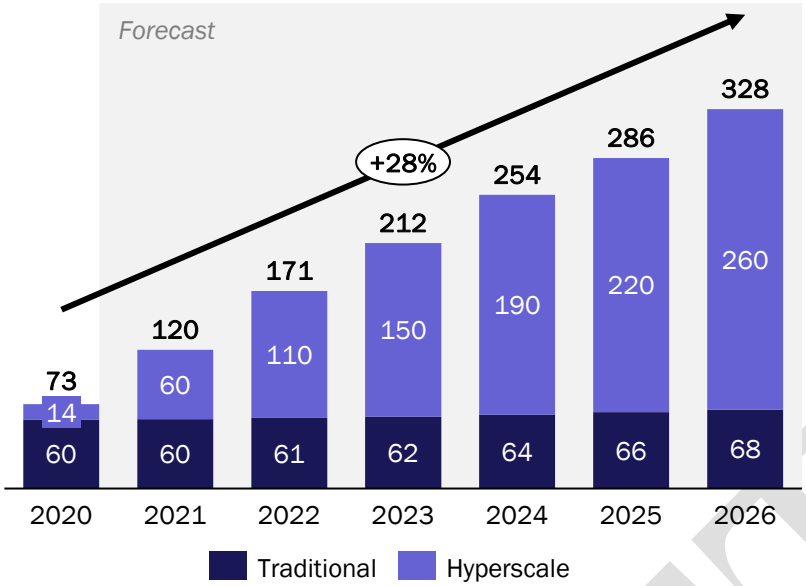


Figure 7.13: Co-location data- centre capacity in Indonesia (MW) by type [Source: Analysys Mason, 2022]

Indonesia's co-location market is projected to reach ~IDR10 trillion by 2026, more than four times its size in 2021.

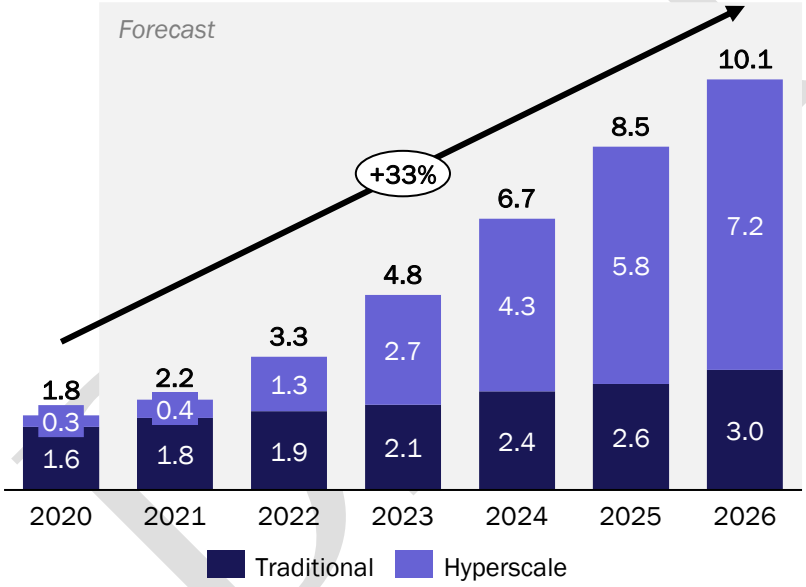


Figure 7.14: Co-location data-centre market size in Indonesia (IDR trillion), by type [Source: Analysys Mason, 2022]

7.5 Opportunities, threats and challenges

Opportunities exist to be the preferred partner to hyperscalers, although regulatory uncertainty on data residency requirements remains

7.5.1 Opportunities

Be the preferred partner to hyperscalers as they expand their business in Indonesia

As hyperscalers expand their business in Indonesia, they will look for local partners to increase their infrastructure presence in the country. Opportunity exists for local data-centre operators to position themselves as the preferred partners to these companies and provide infrastructure to meet their requirements.

Capitalise on the growing data requirements enabled by the rise of smart devices

The rising demand for smart devices, increasing demand for analytics and cloud services, and the growth of wireless networking have led to many organisations investing in big data and IoT technology.

7.5.2 Threats and challenges

Regulatory requirements on 'greening' of data centres could incur additional cost and complexity

In line with developments in other markets, developers of data-centre assets may be obligated to meet green energy targets either via the use of renewable energy sources or the use of carbon credits. Either way, such requirements will add complexity, and cost, to the development of data centres.

Increasing power costs could affect the profitability of the data-centre business

Power is the largest operational expense for an operational data centre. Currently, Indonesia has low power prices compared to those in other large developing markets primarily due to numerous subsidies offered by the government. If prices increase in the future, especially if revenue is challenged, it will make the business case for data-centre investment less attractive.

At the same time, power reliability remains a major issue in the country. Data-centre operators need to procure redundant back-up systems to tackle power outages, all of which adds to operational costs. Hyperscale data centres, given their high-power consumption, are expected to make these requirements more stringent.

Regulatory uncertainty may affect data-centre demand

Further regulation is required to clarify unclear items from Regulation No. 71 (GR71). There remains uncertainty on the requirements surrounding 'strategic electronic data' and whether this may affect data-centre demand in Indonesia. It is uncertain whether the requirement to connect to a certain data centre would in effect result in a need to store the 'strategic electronic data' locally.

For non-state institutions (e.g. any company operating an electronic system) which comprise the majority of data-centre customers, there is no explicit data localisation regulation applicable. Clarity on that regulatory stance is required.

Singaporean market may re-open and increase competition

At the current time, there is a moratorium on new data-centre developments in Singapore. If this restriction is lifted in the future, then some workloads, especially from sectors that do not have regulatory restrictions, could likely be hosted in Singapore. Low internet protocol (IP) transit prices will also assist in making this happen.

Natural disasters can disrupt or destroy data-centre operations

Indonesia is highly prone to natural calamities such as floods, earthquakes, volcanic eruptions, etc., which makes site selection for a data centre critical. As demand for services spreads out across the country to more challenging terrains, the risk of a force majeure event increases significantly.

Cyber-security breaches could lead to data leakage

The risk of data leakage or infiltration by state and non-state actors is an ever-increasing challenge for large IT systems like data centres.

Lack of skilled workforce may make operations challenging or increase costs

The skilled workforce in the country is currently moderate and the shortage will increase considerably with the construction of multiple data centres. Lack of training and migration of skilled workers to other countries are the main reasons for the shortage in the skilled workforce. As per the National Association of Indonesian Consultants, Indonesia currently faces a major shortage of engineers – 12.8% in manufacturing, 5.1% in finance and 11.1% in the technology sector. The World Bank has estimated that, between 2015 and 2030, there will be a shortage of around nine million skilled and semi-skilled ICT workers in Indonesia.

7.6 Summary

The data-centre market in Indonesia is in its early days and expected to demonstrate robust growth in the coming years. The entry of hyperscalers into the market and the demand for local data storage, as mandated by regulation in some scenarios, will drive steady growth in the demand for co-location services. Established international players have identified this opportunity and there has been a recent influx of capital to build data centres in the country. While the reliability of steady power supply and availability of skilled workforce remain challenges that service providers need to find solutions to, the growth in the digital economy and its demand for supporting infrastructure will ensure demand is steady for many years to come.

Annex A Glossary of terms

2G	Second-generation mobile network or service. Generic name for second-generation network, for example GSM *(Source: ITU)*
3G	Third-generation mobile network or service. Generic name for third-generation network or service under the IMT-2000 banner, for example W-CDMA *(Source: ITU)*
4G	Fourth generation of cellular wireless standards. It is a successor to 3G and 2G standards, with the aim of providing a wide range of data rates up to ultra-broadband (gigabit-speed) internet access to mobile as well as stationary users. Refers to IMT Advanced (International Mobile Telecommunications Advanced) *(Source: ITU)*
5G	Fifth generation of mobile technology. It is expected to deliver faster, lower-latency mobile broadband, and to enable more revolutionary uses in sectors such as manufacturing, transport and healthcare
ARPU (average revenue per user)	The average revenue per connection per month, calculated as the total service revenue divided by the average number of connections per month
ASPU (average spend per user)	The average spend per connection per month, calculated as the total retail revenue divided by average number of connections per month
ASEAN	Association of South-east Asian Nations
Backbone	The part of the network infrastructure that interconnects different networks and provides a path for exchange of data
Backhaul	The part of the network infrastructure that transport data from end users to the central core network (and vice versa)
Build-to-suit (B2S)	A tower that is planned and built based on criteria specified by an operator, where the operator has contractually committed to locate its telecoms equipment on the tower, subject to the specifications being met
CAGR (compound annual growth rate)	The annual growth rate over a period of years, calculated on the basis that each year's growth is compounded; that is, the growth each year is included in the following's year's number, which in turn grows further *(Source: Financial Times)*

Capex (capital expenditure)	Financial expenses used by a company to acquire or upgrade physical assets such as property, plant or equipment, where the benefit continues over a long period
Central Bureau of Statistics (BPS)	An Indonesian government agency responsible for providing data on the country's economy, social changes and environment
Co-location	A process where two or more telecoms devices, such as transmitters and antennas, are placed on a common support structure. It enables sharing of infrastructure and is a common strategy for minimising the number of towers, poles and monopoles needed to construct communications infrastructure
Coverage site	A tower site where an operator locates its telecoms equipment and which enables its radio access systems to communicate with devices within a specific geographical area; without this, devices would not receive any signal. A coverage site is primarily planned and deployed to provide coverage within a specific geographical area. As such, it differs from a capacity site (see the definition of *capacity (in-fill) site* above)
Data-centre tiers	According to Cisco, the most widely adopted standard for data-centre design infrastructure is ANSI/TIA-942. It includes standards for ANSI/TIA-942-ready certification, which ensures compliance with one of four categories of data-centre tiers rated for levels of redundancy and fault tolerance: Tier 1: Basic site infrastructure. A Tier 1 data centre offers limited protection against physical events. It has single-capacity components and a single, nonredundant distribution path. Tier 2: Redundant-capacity component site infrastructure. This data centre offers improved protection against physical events. It has redundant-capacity components and a single, nonredundant distribution path. Tier 3: Concurrently maintainable site infrastructure. This data centre protects against virtually all physical events, providing redundant-capacity components and multiple independent distribution paths. Each component can be removed or replaced without disrupting services to end users. Tier 4: Fault-tolerant site infrastructure. This data centre provides the highest levels of fault tolerance and redundancy. Redundant-capacity components and multiple independent distribution paths enable concurrent maintainability and one fault anywhere in the installation without causing downtime. *(Source: Cisco)*

EB (Exabyte)	A unit of data equal to 10^{18} bytes
EBITDA (earnings Before interest, taxes, depreciation, and amortisation)	Operating income (loss) plus depreciation and amortisation, non-cash general and administrative compensation charges, asset write-down charges and restructuring charges
Fibre-optic cable	A technology that uses glass or plastic threads to transmit data into light waves. Fibre-optic cables have larger bandwidths than traditional copper cable, allowing more data to be transmitted over the same distance
Fixed broadband	Includes both fixed-line and fixed-wireless technology. It is a high-speed internet connection in the home or office, delivered via radio or cables and distinguished by the lack of mobility of the internet access. Signals are transmitted to a router which can then be connected to via Wi-Fi or an Ethernet cable for internet access
Frequency band	A range of frequencies defined and dedicated to a specific service or radio technology. A frequency band is usually divided into several channels
Fixed-wireless access (FWA)	The process of providing wireless broadband using radio links between two fixed points
FTTH	Fibre to cabinet
FTTH	Fibre to the home
FTTP/B	Fibre to the premises and fibre to the building
FTTT	Fibre to the tower
FTTx	Fibre to the x. It refers to any broadband network architecture using optical fibre to provide networks connectivity
GB (Gigabyte)	A unit of data equal to 10^{9} bytes
GDP (Gross domestic product)	A measure of the average output of a country, which reflects economic growth and productivity
GDP (Gross domestic product) per capita	A measure of the average output per person in a country

GSM (Global System for Mobile Communications)	A European-developed digital mobile cellular standard. It is the most widespread 2G digital mobile cellular standard, available in over 170 countries worldwide *(Source: ITU)*
HFC	Hybrid fibre-coaxial is a telecoms network, typically used to provide broadband services, that combines optical fibre and coaxal cable
ICT	Information and communications technology
IDR	Indonesian Rupiah
Indonesian Broadband Plan (IBP)	A five-year government initiative from 2014 to 2019 that aimed to expand internet access and improve network quality (both fixed broadband and mobile services) especially in regions outside Java, through collaboration with both private and public entities. The initiatives include deployment of infrastructure, development of government connectivity, and promotion of e-services
IoT (Internet of Things)	A network of machines that is able to exchange data over the internet without requiring human interaction
IPTV (Internet protocol TV)	The delivery of television content over Internet Protocol networks
Kemkominfo (The Ministry of Communication and Information Technology)	A ministry of the government of Indonesia that is responsible for communication and information affairs
LEO satellite	Low-Earth orbit satellite which orbit between 200 kilometres and 2,000km above the Earth's surface
LTE (Long-Term Evolution)	Commonly marketed as 4G, LTE is a standard for wireless communication of high-speed data for mobile phones and data terminals. It is based on the GSM/EDGE and UMTS/HSPA network technologies, increasing the capacity and speed using a different radio interface together with core network improvements. The standard is developed by the 3GPP (3rd Generation Partnership Project)
Mobile broadband	A wireless data transmission technology delivered via radio to devices including smartphones, laptops, tablets, dongles, etc. The difference between fixed-wireless and mobile broadband is the portability of the connection; a fixed-wireless connection is intended for use inside a premises (home or office) within a certain coverage area, whereas a mobile broadband connection allows mobility

Mobile network	A cellular telecoms system comprising mobile switching centres (MSCs), antenna cell sites and radio base stations
Mobile network operator (MNO)	A company that owns and operates one or more mobile networks
Over-the-top (OTT) applications	Applications and services, accessible over the internet, which bypass traditional distribution, most typically related to media and communications such as video-streaming, social networking or instant messaging
Palapa Ring	Indonesia's terrestrial and submarine fibre-optic cable network that is still under construction, with the objective of connecting 17 000 islands with faster broadband services. The Palapa Ring project is part of the Indonesian Broadband plan which was completed in 2019
QoS	Quality of service
RAN (radio access network)	A technology that connects individual devices to other parts of a mobile network through radio connections
RoW (right of way)	A legal right to pass along a specific route
Smartphone penetration rate	The number of smartphone connections expressed as a percentage of total connections
Towerco	A company that owns multiple mobile towers on which it leases space to mobile operators for them to locate their telecoms equipment