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Two scenarios for 5G deployment in Indonesia

1. Introduction

The first generation of mobile network (1G) was started and deployed in 1980 with analogue cellular technology and with 2 kbps data speed rate only (Goyal and Sahoo, 2019). Ten years later (1990), 2G came with new technology digital and offered new services such as SMS, MMS and data call. Third generation (3G) came in 2000 with broadband technology with speed up to 2 Mbps (Javed and Siddiqi, 2017). In 2010, 4G was deployed with speed up to 1 Gbps and offered so many innovations such as online everything and wearable devices just like the way we live now (Gopal and Kuppusammy, 2015). Next-generation (5G) aims to have 1000 times faster aggregate data rate (up to 10 Gbps), 1 millisecond latency, lower energy and cost per-link basis and support a lot more type of devices (Andrews et al., 2014).

In order to perform with such requirements and capabilities, 5G needs several technology enablers which constantly developed. They are millimetre wave, beamforming, small cells, massive MIMO, virtualization, low latency, software-defined networking and mobile edge computing (Le et al., 2015; Hu et al., 2015; Hossain and Hasan, 2015). These technologies elevate mobile network services compare to previous generation 4G. For example, is the millimetre wave, which means to use a higher frequency range (> 6 GHz). This technology will be a great addition to lower frequency ranges which have already congested by now (Morgado et al., 2018). Meanwhile, beam forming help 5G to be more power-efficient compare to 4G due to this technology leads to focus energy to an engaged device instead of transmitting energy equally to all directions. This can be imagined as a device is in the spotlight in the performing stage (Han et al., 2015). The new enormous numbers of business use cases might birth from the low latency of fewer than 1 milliseconds, which will be felt as real time experience from the user’s perspective. (Lema et al., 2017)

As per 2020, many countries have deployed 5G with different types of business cases. Several remarkable use cases are 5G network for data linking assembly line Mercdez and automotive 5G manufacturing electric microcar company e.Go, both in Germany; Autonomous 5G driving truck in Sweden; as well as 5G smart harbour at the port Qingdao and 5G smart campus in Haier Tianjin (Holfeld et al., 2016; Ericsson 2019; Chang, 2020). In the meantime, Indonesia is still preparing infrastructures and policies for upcoming 5G deployment. (Admaja, 2015)

This study aims to discuss two scenarios of 5G technology deployment in Indonesia with scenario planning methodology and select the most suitable one based on the analysis and discussion. The scenarios are based on Key Drivers of 5G deployment in Indonesia. By looking at these two scenarios, hopefully, the 5G actors can get the big picture and outlook of 5G deployment in Indonesia. From there, expectantly those 5G actors could build a strategy to face this upcoming technology. Indonesia is considered as unique with a form of the archipelago and high consumerism people in an emerging developing country.

2. Development of mobile network in Indonesia

The first mobile network 1G was deployed in 1984 in Indonesia using analogue technology NMT-450 (Nordic Mobile Telephone), which means using frequency 450 MHz. However, specific for Indonesia case, it uses frequency 470-MHZ, which later called as NMT-470, modification of NMT-450. Two companies running that system were Telkom & Rajasa Hazanah Perkasa. In 1985, new analogue technology came in Indonesia called Advanced Mobile Phone System (AMPS) which was north American based. These two services were used by Indonesian people at least until 1994. Four companies were running the AMPS technology which were Elektrindo Nusantara, Centralindo Panca Sakti, Telekomindo Prima Bakti and Telkom. (Nurjannah, 2011).

The next era was the second-generation mobile network era which marked by the introduction of GSM and CDMA. GSM came first in Indonesia in 1993, in the form of Pilot Project in Batam & Bintan islands. The next year 1994, the first GSM mobile operator was announced, Satelindo Company as the first commercial 2G services in Indonesia. Competitors then started to come in which was Telkomsel in 1995 and Excelcomindo in 1996. AMPS users slowly neglected the...
technology and migrating to GSM due to more practicality and flexibility in GSM for using SIM Card and Short Message Service. Innovation came in 1998 as the first prepaid sim card introduces by three major operators. In 2001, the first GPRS and MMS called were successfully commercialized by Indosat with its new brand IM3 and followed by other major operators the next year. The real live case GPRS throughput at that time was about 20–30 Kbps only. (Pasaribu, 2006)

CDMA came later in 2002 held by Telkomsel with the brand of Flexi. The following year Bakrie Telecom launched Esia, Mobile Eight Telecom launched brand Fren and Indosat launched StarOne in 2004. This CDMA technology succeeded to grow mobile subscribers exponentially due to cheap handsets and services. At this moment, the fierce competition between mobile operators was started. At that time there were 11 mobile operators and brands in total across Indonesia (Wijaya, 2008).

In May 2005, Telkomsel tested the first 3G network in Indonesia with vendors such as Motorola and Siemens. In 2006, three major operators Telkomsel, Indosat and Excelcomindo were announced as the winners in frequency tender in 1900 MHz. The new services offered by 3G at that time were video call, streaming and internet browsing. At that time, to build 3G infrastructures required a lot of costs (Pasaribu, 2006).

The early stage of the fourth generation of mobile network technology (4G) in Indonesia was divided into two polarization of WiMAX & LTE standards. In 2010, WiMax went live commercially with the brand of Sitra Wimax, while LTE went live commercially in 2013 with the brand name Bolt from Internux Company (Gemiharto, 2015). The following year in the end of 2014, the three major mobile network operators then provided 4G services commercially (Anthony, 2016). As per now, the services from WiMax and Bolt had been terminated, and only 4G LTE services from mobile network operator still alive.

The services of 4G have been very developed nowadays for Indonesia. In the early penetration, 4G was developed only for hot spot solution, since not so many people were using 4G. But now, 4G has changed the ways of living for people in Indonesia. The use cases vary from online shopping, marketplace, IoT and smart house. Not just that, this mobile network solution has succeeded to educate many people of Indonesia in use more connectivity in their daily life, for example, the case of motorbike online transportation Gojek.

The fifth generation of mobile networks (5G) was initially planned to be deployed in Indonesia in 2020 and foreseen to be the enhanced ways of living to the people and elevated ways of working for business and industries in Indonesia. However, due to many reasons, this deployment needs to be delayed and now in the stage of preparation. This study provides possible conditions in the future for 5G deployment in Indonesia through scenario planning methodology. Through this research, 5G actors might be able to see the important things related to the technology and strategize the next acts.

3. Scenario planning for 5G technology

Scenario planning or scenario-based planning is about the visioning process for future states as well as imaging alternative conditions for resolution (Schwartz, 1996). Scenario planning is also defined as a tool and set of methodology that is used for better strategic planning and decision making, by classifying the big amount of data into possible scenarios or states in the field of research. By figuring different scenarios, the decision-maker can experience the whole horizon possibilities rather than just rely on intuition or previous reasoning of decision making. Those multiple scenarios are built from the key drivers of the scope, basic development, uncertainties and rules of interaction (Schoemaker, 1995).

Another technique of Scenario Planning is using the TAIDA rules. They are tracking, analysing, imaging, deciding and acting. Tracking is to keep all the sensors open for both danger and opportunity. Analysing means to analyse that danger or opportunity and build possible scenarios. Imaging is an abstract process to try to feel all alternative scenarios by activating all censors. Deciding is the process of selection after imaging all the scenarios. And acting means to set goals and to do the selected scenarios (Lindgren and Bandhold, 2002).

Scenario planning has been used in so many research fields such as organizational behaviour, environmental study, finance and human resource. This tool is also commonly used to future forecast conditions in a country problem. For example, scenario planning is used for carbon emission in Germany or the IT future industry in India specific case (Kublik et al., 2017; Sankar and Changat, 2017). Scenario planning is also common to be used for new upcoming technology deployment such as 5G.

One study uses scenario planning and business modelling in 5G to build business models to seek the market. The study builds four scenarios which paired with 4C layers of connection, content, context and commerce (Moqaddamerad et al., 2017). The results are fascinating, which is the identification of dominant services and 5G actors for each scenario. Another study discusses scenario planning for 5G in smart city using light poles on the street. The study builds four scenarios with two-axis uncertainties of low to high internet expansion versus ownership of 5G light poles (MNO or Non-MNO). Those four scenarios could identify investment strategy with considerations of demand and competition. (Gholampooryazdi et al., 2017). Another study discusses scenario planning for supply chain issue in 5G infrastructures such as spectrum frequency, equipment and capital expenditure (Ougthon, et al., 2018).

In Indonesia case, there are also studies for 5G using scenario planning as the tool. One study use scenario planning to explain the early state of 5G condition in Indonesia using the concept of TAIIDA (Lindgren and Bandhold, 2002). However, this study only did the part of tracking and analysing. While the other three parts remain open for future studies, the condition might also have changed compared to when the study was written (Admaja, 2015). Another study uses three-axis scenario planning to build eight possible conditions for 5G technology commercialization. The first step is to identify key success factors for 5G technology commercialization itself. The results are three key success factors which are technology application value (use cases), innovation ecosystem and complementary technologies. After that, those factors are considered as the uncertainties and put on three axes non favourable to favourable. Eight possible scenarios occur based on that three-axis treatment. The study also suggests the strategy (and possible back up strategy) to move from one scenario to another along the time (Hutajulu et al., 2020).

This study proposes two scenarios based on key drivers, trend and uncertainties from the data. This research can also be considered as a complete sequence of TAIIDA concept with high level proposed actions at the end of this study. These are the novelty of this study compare to the existing literature about 5G deployment in Indonesia.

4. Methodology

The methodology for this study is based on interpretivism philosophical thinking with the inductive approach (Okasha, 2002). This means the researcher builds the model by interpreting the ideas or constructs of respondents based on the explanation given by the respondents. Apart from that, scenario planning is used to explore the subject of this study. It is considered suitable because the goal of this study is to understand and discuss the outlook of new technology which coming to Indonesia, by showing possible conditions which might happen in the future. With this methodology, it will be easy for 5G players in Indonesia to evaluate the deployment of previous-generation technology (4G), learning how to change action in the past, planning and innovate for better new technology implementation in the future. (Lindgren and Bandhold, 2002).

This study uses the qualitative in-depth semi-structured interview and focus discussion group (FGD) on collecting the data. The
respondents are twenty-one (21) experts in the ICT field, with experiences more than 15 years, even more than 30 years experiences. The job title of the respondents varies from the manager, senior manager, vice president and director level, as well as from the academic experts. For triangulation purpose, the researcher collects the respondents from all possible 5G actors’ organizations such as vendors, Mobile Networks Operators (MNOs), Government Staff and academic experts. With this data collection strategy, this study can build the two scenarios from as much as possible perspective. Table 1 describes the list of respondents of this study.

Respondents were asked to list key drivers and uncertainties of 5G deployment in Indonesia. Based on those answers, respondents were also asked to build two scenarios that best describe the answers of the deployment in Indonesia. What are the needs to deploy 5G in Indonesia, the drivers to change from the current situation? The answers from the respondents are varied and surprisingly cover a wide range of drivers with some aspects of the human being. They are not just considered about the technology-wise, but also from economic, social, ecosystem, industry, law and politic. These set of data are triangulated with a different type of data about 5G updates which the respondents are not aware of. This triangulation could increase the credibility and validity of this study (Natore, 2020).

5. Dataset

The data from the interviews, FGD and webinar, show a fascinating range of information. The discussions spread almost to the whole aspects of the human being. They are not just considered about the technology-wise, but also from economic, social, ecosystem, industry, law and politic. These set of data are triangulated with a different type of positions and organizations and cover the 5G information in Indonesia thoroughly (Noble, 2019).

The first set of data is about key drivers for 5G deployment in Indonesia. What are the needs to deploy 5G in Indonesia, the drivers to change from the current situation? The answers from the respondents are varied and surprisingly cover a wide range of drivers with some

**Table 1**

| No    | Position Level     | Org.    | Data Coll. Type                       | Meeting Type       | Duration |
|-------|-------------------|---------|---------------------------------------|--------------------|----------|
| 1     | Director Level    | Vendor  | Semi-Structured In-Depth Interview    | Face to Face       | 43 Min   |
| 2     | Director Level    | Vendor  | Semi-Structured In-Depth Interview    | Face to Face       | 22 Min   |
| 3     | Technology Specialist | Vendor  | Semi-Structured In-Depth Interview    | Face to Face       | 34 Min   |
| 4     | Head Unit Level   | Vendor  | Semi-Structured In-Depth Interview    | Face to Face       | 46 Min   |
| 5     | Manager Level     | Vendor  | Semi-Structured In-Depth Interview    | Face to Face       | 35 Min   |
| 6     | Manager Level     | Vendor  | Semi-Structured In-Depth Interview    | Face to Face       | 25 Min   |
| 7     | Technology Specialist | Vendor  | Semi-Structured In-Depth Interview    | Face to Face       | 45 Min   |
| 8     | Manager Level     | Vendor  | Semi-Structured In-Depth Interview    | Face to Face       | 38 Min   |
| 9     | Head Unit Level   | Vendor  | Focus Discussion Group                | Face to Face       | 38 Min   |
| 10    | Manager           | Vendor  | Focus Discussion Group                | Face to Face       | 38 Min   |
| 11    | Head Unit Level   | MNO     | Semi-Structured In-Depth Interview    | Face to Face       | 25 Min   |
| 12    | Technology Specialist | Vendor  | Semi-Structured In-Depth Interview    | Face to Face       | 27 Min   |
| 13    | Director Level    | MNO     | Focus Discussion Group                | Face to Face       | 1 hour 7 min |
| 14    | VP-Level          | Vendor  | Semi-Structured In-Depth Interview    | Face to Face       | 36 Min   |
| 15    | VP-Level          | Vendor  | Semi-Structured In-Depth Interview    | Face to Face       | 48 Min   |
| 16    | Director Level    | Government | Semi-Structured In-Depth Interview    | Face to Face       | 52 Min   |
| 17    | Academic Expert   | University | Semi-Structured In-Depth Interview    | Face to Face       | 1 hour 3 Min |
| 18    | Technology Specialist | Vendor  | Semi-Structured In-Depth Interview    | Online             | 48 Min   |
| 19    | Head Unit Level   | Vendor  | Semi-Structured In-Depth Interview    | Online             | 1 hour 47 Min |
| 20    | Manager           | MNO     | Focus Discussion Group                | Online             | 1 hour 47 Min |

**Table 2**

| Key Drivers to Change | Rep. | Key Drivers to Change | Rep. |
|-----------------------|------|-----------------------|------|
| 1. Global Competition |      | 5. Digitalization of Vertical Industry |      |
| Global Standard New Adoption | 1    | Digital Transformation in Industry (Industry 4.0) | 6    |
| Push from ASEAN Countries with 5G | 1    | Efficiency & Higher Productivity | 5    |
| 2. Government & National Interest |      | Automation for Productivity & Efficiency | 3    |
| Country Competitive Advantage & Interest | 11   | The needs of IoT | 1    |
| New Capital City of Indonesia (Smart City) | 4    | 6. Evolution Ecosystem |      |
| 5 Work Priority from President | 3    | Race for New Innovative Applications | 1    |
| Industry 4.0 Roadmap in Indonesia | 4    | Critical IoT Implementation Across |      |
| 3. End Users Demand |      | Universities Involvement | 1    |
| Rising Demand from User (Social Media & Video) | 7    | Technologies Integration (IoT, AI, AR/VR, etc.) | 2    |
| User is hunger, Higher, Better, Expectation | 6    | 7. Economic Benefit |      |
| New Use Cases (MBB, Massive-IOT, Critical-IOT) | 4    | GDP Growth (10% internet users, 1.3% of GDP) | 4    |
| Device to Device Connection | 1    | Local Remote Area Economy Growth | 1    |
| 4. MNO needs |      | 8. Solving Social Problems |      |
| Sustainability & Business Growth | 1    | Revolutionize Digital Society (Process in Society) | 2    |
| Lower Operational Cost per GB Operator | 7    | Enhance Human Skills & Quality of Life | 3    |
| New Services & Revenue Operator | 4    | Smart Everything | 1    |
| Additional Spectrum Frequency & Capacity | 2    | 9. Technology Influence from Vendor |      |
| Wide 82B Vertical Industry Partnership | 1    | R&D Commercialization | 1    |
| E2E Network Revolution (Slicing, RAN, Optic) | 1    | Influential & Consultation | 2    |
| Maintain Subscribers | 1    | | |
repetitions. The drivers could be categorized as global competition, government and national interest, end-users demand, needs to change from MNO, digitalization of vertical industries, the evolution of the entire ecosystem, technology influence from telecom vendors, economic benefit and solving social problems. The key drivers to change for 5G deployment in Indonesia and their repetitions is described in Table 2.

The first key driver is about the global competition in 5G technology. Many countries now have 5G live networks in their territory. This somehow gives some push to Indonesia as a country to also adopt the same technology to catch the investments. The pressure becomes even bigger when South East Asian countries such as Philippines, Malaysia, Thailand, Singapore and Vietnam have launched the 5G networks in 2019 and 2020 (Atkearnry, 2019). Indonesia, of course, do not want to be left behind and keep the effectiveness of regional cooperation.

It is, of course, national interest to have more investment coming to Indonesia. One of the highlighted things by the investor is the technology adoption by that country. How successful the country digitalized its nation, increase the competitive advantage as well as resilience from becoming a disrupted country. Investor desires to have relatively cheap labour as Indonesia combined with efficient technologies. Luckily, the government of Indonesia has already realized this matter. 5G deployment is included in five (5) work priority from the president, included in Industry 4.0 roadmap and tourism connectivity. The mega project blueprint of moving capital city Jakarta to West Kalimantan in smart city concept is also considering 5G as the base of connectivity. From economic benefit point of view, Indonesia hopes for higher GDP and GDP growth after 5G being implemented. One of the experts stated that for Indonesia case, Addition of 10% of internet users could contribute 1.3% additional national GDP. This additional benefit can come from various industries such as communication, trading, transportation, tourism and SMEs (Flag, 2020).

The demand from end-users is also the essential driver for 5G deployment in Indonesia. Since Indonesian people are now so caught up with social media and online video, a huge amount of data is required. One of the respondents from MNO said that the demand for data calls in Indonesia rise about 1.5 times per year, that the current network might no longer be able to hold it. Besides that, the end-users are also hungry and thirsty of better quality and higher expectation. This expectation can be translated into new interesting and solving-the-problems applications and use cases for them. End users expect 5G solution to revolutionizes the processes in society and transform it into a digital society. 5G is also awaited to enhance the quality of human life, to upscale skills, to change to healthier & greener lifestyle and to evolve society. 5G is also awaited to enhance the quality of human life, to upscale skills, to change to healthier & greener lifestyle and to evolve society. 5G is also awaited to enhance the quality of human life, to upscale skills, to change to healthier & greener lifestyle and to evolve society. 5G is also awaited to enhance the quality of human life, to upscale skills, to change to healthier & greener lifestyle and to evolve society.

The big chances in 5G compare to the previous generation is its impact on vertical industries. Features in 5G create a huge possibility of broad innovations for applications and use cases. Many industries need to be digitalized to achieve better efficiency and higher productivity. Automation in manufacturing will take charge in most parts, leaving the manual processes behind. Vertical industries such as healthcare with telemedicine and remote surgery ensure people in the remote area able to receive best in class services. Many other industries will be revolutionized such as agriculture, art & entertainment, construction, education, finance & banking, health, mining, manufacture, real estate, transport, utilities, retail & wholesale, farming, plantation, and even SME with new business use cases such VR/AR gaming, autonomous car, remote truck & excavator, IoT sensors, fintech, hologram call, 3D printing (IHS, 2019). 5G ecosystem, especially the innovation ecosystem is in the race of creating new killer applications. The same ecosystem also innovates by doing technology integration for 5G, IoT, AI, Big Data, AR/VR, Autonomous Car, robotic, semiconductors for end users.

The next thing queried to the respondents is about trends that are happening around the globe. Since this study is about Indonesia specific, then the trends are divided into two major categories which are global trends and national trends. These trends are collected to help this study in analysing scenarios, especially the impacts on the scenarios. Trends that are related to 5G deployment in Indonesia can be seen in

### Table 3
Trends Related to 5G Deployment in Indonesia.

| Trends                                             | Rep. | 2. National:                                | Rep. |
|----------------------------------------------------|------|---------------------------------------------|------|
| Pandemic Corona Virus                              | 2    | Two political polar in Indonesia            | 1    |
| Trade War between USA & China                      | 1    | Higher Consumerism in Indonesia             | 1    |
| Autonomous Vehicle is spreading everywhere         | 1    | Automation might raise in the next five years | 1    |
| Bigger screen, higher resolution and connected for TV| 1    | Industry Game & Entertainment are formed    | 1    |
| High use of VR & AR                                | 1    | Fintech is daily life now.                  | 1    |
| Social Media Addiction                             | 1    | New MVNO Operator as a bridge to Main MNO  | 1    |
| Smart Cities are borne                             | 1    | Coverage 4G in Indonesia (80–90%)           | 1    |
| AI usage is elevating                              | 1    | New Capital City of Indonesia               | 1    |
| Surveillance Camera by Government begins           | 1    | Youtuber & Tik-Toker is a career now        | 1    |
| End Users Needs Higher Data                        | 2    | Low-cost devices from China                 | 1    |
| Space X is Launching StarLink for Worldwide Internet| 1    | Device to Device is trending               | 1    |
| Higher Revenue in OTT rather than Infrastructure    | 1    | The Spent on Gb is rising 1.5–2 times per year| 1    |
| Devices are changing will no longer just smartphone| 1    |                                              |      |
| Video Streaming is highly watched (Netflix), less TV| 1    |                                              |      |
| Civilian Journalism                                | 1    |                                              |      |
The global trends, of course, start with the Pandemic Coronavirus Covid-19. This condition might hold all development in many countries and focus on healing the economy first. The trade war between USA and China will also absolutely influencing 5G deployment in around the world, including Indonesia regarding bilateral cooperation, vendor selection and Open RAN influence (Keiser, 2020). The next global trends are more about the applications and use cases of 5G later for Indonesia, such as autonomous vehicle, higher resolution video, VR/AR, social media, AI, smart city, video streaming, and activity of civilian journalism. Since 4G, this layer of application is exponentially increasing compared to the business value of layer infrastructure. The trends which might be disruptive for the telecom industry is Star Link project by SpaceX; a project to give internet all around the world by low altitude constellation of satellites at around 550 Kms (Thompson, 2020).

The national trends begin with two polar political views in Indonesia, continuing the last presidential election, which put every government move into the spotlight. Another related trend is about high consumerism in Indonesia, with new daily lifestyles such as fin-tech, game and entertainment, content creation like Youtube and TikTok, as well as the use of cheap devices and the rise of smart home. This is calculated as 1.5–2 times data needs increment per year. The movement of the capital city of Jakarta to East Kalimantan is also a big thing and might accelerate 5G penetration, besides the coverage of 4G which already in 80–90%. Finally, in 5–10 years, automation in manufacturing industry might spread together with the born of Micro Network Operator (using MVNO) and spectrum broker to provide infrastructure and solution to that manufacturer (Laguna De Paaz, 2012).

This study next asked respondents about uncertainties in 5G deployment in Indonesia case. The respondents share their thoughts with so many various answers. To make it easier to understand, those answer then categorized into several only; as if the uncertainties are coming from the key drivers themselves. They are global unpredictable, government indecision, MNO hesitancy, Vertical Industry Baby Step, ecosystem queries, social vagueness and end-users (e-MBB) variability. Some trends from the previous section become the uncertainties in this section due to their nature to create disruption or variability. The uncertainties of 5G deployment in Indonesia is Table 4 below. The table is equipped with the number of repetitions of constructs that are explicitly mentioned during the data collection.

The global unpredictability for 5G in Indonesia comes from pandemic Covid-19, Starlink project by SpaceX and global spectrum frequency harmonization. Pandemic situation due to coronavirus, of course, halt many economic engines around the world and delayed any technology implementation until get better. In the other hand, project satellite constellation for rural telecommunication, Starlink, from SpaceX, of course, will be the disruption for current telecommunication model around the world. With data speed claimed to be 1 GB maximum and 20 ms of latency, end users might choose Starlink over 5G despite critics from astronomy (McDowell, 2020). Global spectrum frequency harmonization is about the willingness of every country to follow guidelines from ITU-T about 5G spectrum frequency recommendation. However, not every country can easily follow that recommendation. For example, Indonesia in which spectrum frequency 3.5 GHz is used for satellite communication. Too much frequency alternatives might lead to higher cost of 5G, especially in equipment receiving parts.

The highest uncertainties among the respondents are from government indecision. It can be seen from the number of repetitions of this category. The government willingness and strategic policies and regulations are related to the understanding of government about the importance of 5G and effort to make it happen. It is also related to the political will of the current and next government, to continue the vision. The other two are applications for government operations that can use 5G and the readiness of the education system in Indonesia to prepare for upcoming 5G.

Infrastructure solution is the highest uncertainties among all 5G actors. It is closely related to spectrum allocation for 5G which needs three requirements which are low band (700 MHz), middle band (2.3 or 2.6 or 3.3 or 3.5 GHz), and high band (26 or 28 GHz). Those requirements are now occupied with other types of communications, except for high band. It is also uncertain about 100 MHz needed for 5G and the concept of frequency sharing (Ekawibowo et al., 2018). The cost of 5G spectrum is also contested, whether the government want to assume this as investment or source of income. In the form of spectrum sharing between MNOs or MNOs & satellite, how will be the practicality? And the last one is the regulation which governs those spectrum frequencies, cost and spectrum sharing. That regulation is known as “RUU Gipta Kerja” is now submitted to People’s Representative Council (DPR) and seemed to be rejected by Indonesian people due to the other part of the law, is perceived as reducing the benefit of people.

The other important aspect about infrastructure solution is the passive infrastructure such as tower, building, land and others. This is also highlighted because it is one of highest costs for any mobile network implementation. The cooperation between ICT ministry, Public Works & Housing Ministry and local government to create passive infrastructure sharing is perceived as weak. Another subcategory for infrastructure is about telecom transportation such as cable optic and microwave. The requirement of 5G network is very high; thus, the implementation of cable optic end to end is rather necessary. The project Palapa Ring which connect all-optical backbone around Indonesia is claimed as 100% completed. However, the backhaul and optic to site implementation are sometimes held due to less cooperation from local government with long bureaucracy.

Vertical industry baby step is about the big decision of that industry to adopt new technology to help their operational being. This is, of course, huge investment with less proves due to the early state of 5G implementation. The industry might hesitate to involve with long term investment scheme. The first step is also about the translation of industry needs compared to the capability of technology. Finally, whether or not that translation is successful or able create new powerful applications for that specific industry. Equally for that, innovation ecosystem who will also take part in translation and creation of use cases might not massively exist yet. The open lab and technopark existence are imperfect tripe-helix with long administration, broken networking and less business sense (Dhewanto et al., 2016). In university, for example, the bank of resources and knowledge in that institute is not used utterly for 5G innovation ecosystem like in other pioneer countries (Huang, et al., 2017).

Table 4

| Uncertainties of 5G Deployment in Indonesia. |
|----------------------------------------------|
| Uncertainties | Rep. | Uncertainties | Rep. |
| 1. Global Unpredictability | 5 | 4. Vertical Industry Baby Step | 12 |
| Pandemic Condition of Covid-19 | 2 | Technology Translation | 6 |
| Starlink Project by SpaceX | 1 | Application & Use Cases | 3 |
| Global Spectrum Frequency Harmonization | 2 | Business Case Calculation | 3 |
| 2. Government Indecision | 54 | 5. Ecosystem Queries | 7 |
| Government willingness & Strategic Policies and Regulations | 9 | Ecosystem Existence | 4 |
| Infrastructures Solution | 39 | Support Availability | 3 |
| Digital Talent Literacy | 5 | 6. Social Vagueness | 13 |
| e-government Application | 1 | Social Impact | 10 |
| 3. MNO Hesitancy | 38 | New Lifestyle & Culture | 3 |
| Business Case Calculation | 14 | 7. End Users e-MBB Variability | 17 |
| Business Model & New Revenue Streams | 7 | New Useful Use Cases | 4 |
| Approaching Vertical Industry | 4 | Security & Privacy | 5 |
| Internal Capability | 9 | Willingness to Migrate | 3 |
| New Competition | 4 | Personal Economic Benefit | 5 |
The end-users, in this case, human for the use case of enhanced mobile broadband, have variability. It is related to the adoption of 5G, which influenced by usefulness and easiness of the technology (Davis, 1989). The other factors might consider security and privacy threat of using that new technology and personal economic benefits such as price and cost. This variability is closely related to social vagueness. For example, social impact such as unemployment and addiction due to 5G implementation. Another vagueness is about new lifestyle formed post 5G implementation. The vivid change of lifestyle can be seen in previous experience from 1G, 2G, 3G until 4G; in which people are more digitalized and instant nowadays.

6. Analysis

Based on the data collection, the first thing to analyse is understanding the 5G actors and aspects involved. The 5G actors are identified as end-user, vertical industry, government, content creator, application creator, device maker, technologies integrator, MNOs, Network vendors and infrastructure provider. On the other hand, aspects that related and involved in 5G deployment in Indonesia are security & data privacy, the ecosystem for both infrastructure and innovation, enhanced & digitalized workforces, socio-economic impact and law & regulation umbrella. The 5G building blocks are described in Fig. 1.

The 5G building blocks explain the relationship between each 5G actors into seven layers, which connected as a ladder. Infrastructure provider can be regulator, land & building owner and tower provider. Network provider includes data centre, vendor and MNO. Solution Integrator is the new actor who can do technology integration such as 5G, IoT, AI, Big Data, Robotic and AR/VR, to create a solution for applications. Not many studies previously include this technology in wireless technology building blocks. This new layer is added following many standalone technologies can be combined now to create new values. The device maker is the supplier of no longer just mobile phone or pad but grow to the supplier of IoT devices, sensors, robot, autonomous car and other 5G connected devices. Application innovator is those companies which create applications for end-users. Next is the content creator who creates the content of those applications. The last are the end-users that can be human, government, industry and thing (Haq, 2020).

The aspects are vertically stood across those seven layers, which means they are related to each of the layers. Security and data privacy, for example, the physical security on the network site is as important as data privacy of the end-users when using fintech application. The fail of securing any of the layers could bring a negative impact. Based on the received data, the ecosystem of 5G can be divided into two, which are the infrastructure ecosystem and innovation ecosystem. Infrastructure ecosystem is the entire community who provide the layer infrastructures in 5G building blocks like tower company, local government, building owner. On the other hand, the innovation ecosystem is related to all 5G actors who cooperate to invent new application or business use cases for 5G. The example of 5G actors included in the innovation ecosystem are start-ups, university, MNOs and even the advertiser for the content owner. The workforce is something that needed across all layers. In 5G society Indonesia, the workforce should be upscaled, enhanced and digitalized. The other aspect is socio-economic, which measure the impact of 5G in the social and economic matter. The last is law and regulation, which needed to put everything in order.

From above 5G building blocks, key drivers to change, trends related to 5G and uncertainties for Indonesia case, this study later build two scenarios to describe the possible states (Kublik et al., 2017). They are also built based on two-axis analysis of the two most uncertain parameters. The most uncertain things are infrastructure and use cases, based on the number of exact repetitions by respondents (Schoemaker, 1995). The naming of the scenarios is contemplation of excitement of respondents during the interview, FGD and Webinar. The two scenarios name are the optimistic champion and the wait and respond. The two-axis analysis can be seen in Fig. 2.

As can be seen from Fig. 2, the scenarios simply took from the most favourable quadrant compare to the least favourable quadrant (Schoemaker, 1995). This is to make it easier to picture, view and

![Fig. 1. 5G Building Blocks.](image-url)
compare the possible states for 5G deployment in Indonesia to the next 15 years span. The other two scenarios in 2nd and 3rd quadrant are not included because the ultimate goal of this study is to provide a simultaneous list of action points for the whole 5G actors so that Indonesia can move from 4th quadrant to 1st quadrant. The readers of this study can effortlessly guess that the optimistic champion scenario is the winning, proactive, inventing, innovating, high energy scenario, while the wait and respond scenario is reactive, adjusting and following condition.

The optimistic champion scenario is the possible future condition with following imaginary situation. As a nation, this country chases its lag to implement 5G in a timely manner. This is to equate with other countries such as Philippines, Thailand, Singapore, Malaysia and Vietnam in the same region. Due to the proactiveness of implementing efficient technology, and high level of consumerism, it is expected that many multinational companies want to invest more in Indonesia. It might be possible as well for those giant companies to build factories in Indonesia since they found competitive advantages. The proactive manner to prepare infrastructures from both central government and local government enables the spectrum frequency to be ready by 2022 (Atkearnry, 2019). The total bandwidth that can be provided by the regulator is 100 MHz in 26 GHz, 100 MHz in 28 GHz, 190 MHz in 2.6 GHz and 200 MHz in 3.5 GHz. This can be supported by Cipta Kerja Law which is proposed by the government nowadays to People House of Representatives. With that law being approved, network players can do sharing frequency without being accused even for the coexistence of mobile network and satellite (Mikail et al., 2018). With the investment mentality, the government will also let the frequency cost remain the same, even though two MNOs share it. Which means those two MNOs can share the spectrum frequency cost equally. The new capital city will be built as smart city with 5G as the base network. Industry 4.0 in Indonesia will flourish, especially in telehealth, manufacturing and tourism, as targeted by the government. The total GDP growth for mmWave will be around 0.72% from 2022 to 2034 or around 11.4 trillion IDR in value (GSMA, 2018). And 0.8% from mobile broadband penetration or around 126.7 trillion IDR (Edquist et al., 2018) in six years.

From the end user’s perspective, the optimistic champion scenario could invent and innovate new applications and uses cases which solve daily problems. This problem usually attached to country-specific of Indonesia and eventually could be spread across the region or global (e.g. Gojek case in 4G). Through those novel applications and use cases, the rising needs for data will also be followed until the whole society is digitally revolutionized. The end goal is for 5G to enhance human life with maintaining the safety, security and data privacy. For example, in this pandemic covid-19 situation case, 5G is expected to enhance the virtual social interactions. 5G is also foreseen as a solution for local social problems such as traffic jam, flood, pollution and even climate change. It is also trusted to increase social equality, especially for health and education, for example, between densely populated area such as Java Island compare to Papua.

The optimistic champion scenario assumes that MNOs in Indonesia will find sustainability by implementing 5G in the next 15 years. It means that MNOs can create a proven business case of deploying 5G across Indonesia. The investment mentality until 2025 (around USD 6 billion) might initially bring revenue streams up to only USD 1.8 billion (Atkearnry, 2019). The cost per-Gb could be reduced up to $0.3 only with end to end network thoroughly (Madden, 2017). However, in this scenario, MNOs could translate the business needs and innovate applications and use cases towards vertical industries. In the meantime, MNOs could carefully choose its partners and keep densifying the networks with 4G nodes, until the 5G spectrum frequency ready. This action is with the knowledge that vendors have the capability of using the same equipment for 4G and 5G, and it can be changed easily by software upgrade. At some selected area, MNOs could launch 5G using Mm Wave frequency in 26 GHz and 28 GHz which are currently available. The vendor is also expected by MNOs to be the source of knowledge and consultancy during the early 5G phases towards the vertical industry. The goal is to digitalized vertical industry with efficient, higher productivity and automated processes. This scenario also assumes the 5G ecosystem and lab are built years before 5G becomes commercial in this country, just like the 5G Forum in Korea (Korea, 2018). This is to agitate innovation by start-ups, universities, incubators and others by having an open playground and open lab that are accessible and a little stimulation by innovation competition (Mamarradlo et al., 2020).

The wait and respond scenario, on the other hand, is the other condition compare to the previous scenario. In this scenario, the government is a bit reactive to wait and see other countries deploying 5G. Government don’t see 5G as the competitive advantage and be more focus on physical infrastructures such as road, bridge, airports and others. The giant multinational companies remain to perceive Indonesia as a medium rising country. The spectrum availability might be available in 2024 for 2.6 GHz with only 100 MHz after the contract with satellite is over. The additional bandwidth might come from 2.3 GHz for around 65 MHz. The sharing frequency might not be possible due to omnibus law might not be approved yet. Smart city is built with 4G and Wifi network. Some local government does not think 5G as a good investment to their area, and the coordination with other ministries might slow down the deployment. The total GDP growth by 2034 might be

![Fig. 2. Two-Axis Analysis 5G Deployment in Indonesia.](image-url)
The use cases for end-users might stay in enhanced mobile broadband until the next 4–5 years since launching, with significant future demand rise from end-users due to technological upgrade between the two scenarios can be seen in Table 5.

| Key Drivers                  | The Optimistic Champion                                                                                       | The Wait and Respond                                                                                       |
|------------------------------|---------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| Global Competition           | Respond quickly by implementing 5G More investment come to Indonesia due to Tech Savvy                         | Categorized as the late adopter Less investment come to Indonesia                                         |
| Government & National Interest| Leveraging competitive advantage with big population, cheap labour and industry efficiency. 5G-IoT deployment included in National Strategic Projects Industry 4.0 thrives faster Secure 5G spectrum Frequency by 2022, with compensation benefit to Satellite. | Build in 4G and WiFi communication 5G-IoT deployment is not included in National Strategic Projects Industry 4.0 comes moderately following late adopter Provide Spectrum Frequency 5G by 2024 |
| Economic Benefit             | Frequency Sharing is legal under the ‘Cipta Kerja’ Law GDP growth for mmWave increase 0.72% during 2024–2034 Total revenue 5G until 2025 is around $1.8 Billion, with investment value of $6 Billion | ‘Cipta Kerja’ Law has not approved yet GDP growth for mmWave increase 0.54% during 2024–2034 Total revenue 5G until 2025 is around $1 Billion with investment value of $4 Billion |
| End-Users Demand            | New applications country-specific are spread used National applications go international                      | End Users prefer to stay in 4G or Wifi Applications usually adopt from global adjusted for country condition |
| Solving Social Problems      | Cheap 5G Devices (< 1 mio IDR) when the 5G implemented Better quality of life with 5G (Smart home, Education, Telemedicine, Communication) 5G can solve social problem such as traffic jam, flood, emergency warning. | Expensive 5G Devices (> 3 mio IDR) when the 5G implemented 5G is focused more on eMBB |
| MNO needs                   | Social Equality in urban and remote area for education and health Sustainable Business after 5G deployment, with proven business case Optimum average cost per Gb (around $0.3) MNO could create killer applications for end-users & vertical Industry Start early & build partnership & consultation towards vertical industry | Social equality is reached partially Hardly sustainable, with defect business case Non optimum average cost per Gb (around $1) MNO is dumb pipe provider only Incompetent to translate business needs of vertical industry |
| Technology Influence from Vendor | Together with MNOs to keep densifying network as 5G pre-requisite. Innovative 5G equipment to reduce deployment cost Involve in new disruptive era such as OPEN RAN | Wait 5G commercialization until Mid band is ready. Slowly densifying network Disrupted by new competition such as OPEN RAN |
| Digitalization of Vertical Industry | Higher and Early adoption of Industry 4.0 Successfully increase efficiency and productivity through digitalization | Low and late adoption for Industry 4.0 Remain inefficient and less productive |
| Evolution Ecosystem         | Start early due to collaboration of all 5G actors Innovate powerful country-specific applications and business use cases High participations from Universities, Start-Ups, Incubator, etc. Dynamic, lively and fruitful ecosystem Could suggest technologies integration between 5G, IoT, AI, AR/VR, Robotic, Big Data, etc. | Partial automation! Partially exist with less collaboration Limited innovation and grow in small area only Low participations from Universities, Start-Ups, Incubator, etc. Dynamic, lively and fruitful ecosystem Partial integration between technologies |

only around 0.56% or around 85.5 trillion IDR in value (GSMA, 2019), on top of additional GDP of mobile broadband 0.8% in six years. This GDP prediction is without calculating the risk of reduction from the competition with Starlink project.

The use cases for end-users might stay in enhanced mobile broadband until the next 4–5 years since launching, with significant future demand rise from end-users due to technological upgrade (Oughton et al., 2018). From there, the other use cases such as tele- health, e-government and FWA might occur. The critical IoT use cases such as self-driving car and smart city will be spread after 2030. The applications and use cases usually adopted from other countries and adjusted with Indonesia’s condition. In this scenario, 5G is assumed to be slow to solve the social problem; it might be after 2030 when the critical IoT is coming. Neither the social non-equality will still happen across east and west Indonesia.

In the wait and respond scenario, MNOs could hardly maintain its sustainability. However, in this situation, the profitability might be limited due to the inability to create revenue streams quick enough and depends on e-MBB or FWA. The forecasted revenue until 2025 from 5G is around USD 1 billion with investment value of USD 4 billion. This is also caused by partial network evolution which brings to the non-optimum low cost per Gb or around $1 (Madden, 2017). MNOs tend to fail to translate the vertical industry needs and might end up as dumb pipe provider only and pr. Vendors don’t have the capability of having 4G and 5G in the same node and dynamic sharing frequency and required MNOs to absorb more cost in deploying the 5G network. The translation of needs from vertical industry is barely happening with MNOs and Vendors. The digitalization of industry might happen later beyond 2030, with somehow bigger growth for late adopters (GSMA, 2019). Ecosystem remains inactive, and the new applications and use cases might come from pioneer country in 5G, such as South Korea for self-driving car.

The wait and respond scenario are pretty much the same with what Indonesia has now learned from 4G adoption in the year 2014. The conditions describe as above match the current condition. It can be inferred that; the optimistic champion is the position this country wants to be to do better compare what we have in 4G. The comparison between the two scenarios can be seen in Table 5.

Based on those two scenarios, 5G deployment in Indonesia can be strategized easily. To follow the scenario, the wait and respond means to do exactly what this country does now and based on 4G experience. Which means, 5G actors in Indonesia should put additional effort just to avoid the same thing happened again with 5G deployment. Luckily, any additional effort from 5G actors translated as additional benefit to 5G.
deployment in Indonesia. Thus, the next discussion of this study will lead to how to shift mentality from wait and respond to optimistic champion.

7. Discussion

Based on presented scenario provided in the analysis section, 5G deployment in Indonesia can be strategized into several phases. These phases are according to the use cases that will be developed along the years and mentality of the 5G actors (HIS Markit, 2019). The first phase is the early deployment phase which also is an investment and learning phase when all 5G actors spend capital and expect small return in several years. Based on the respondents, this investment and learning phase could last for three years, and the dominant 5G use cases are enhanced mobile broadband (SDPPI, Research Team 2018). The second phase is the work and reward phase; it is when all 5G players start to get the reward from their investment and work with massive IoT use cases. The last phase is reaping the benefits when 5G deployment valuation becomes huge, and the critical IoT in Indonesia start to fly (GSMA, 2019). In this phase, the 5G ecosystem will play an important role, especially to introduce new unprecedented applications and use cases. The three phases and their accordance with 5G use cases are as described in Fig. 3.

Looking at the three phases strategy, 5G actors could see the outlook of what might be happening in 5G development in Indonesia throughout the years. They can plan do better planning with knowing which phases they are focus on and what kind of 5G use cases dominantly occur along with the phases.

In order to make sure that Indonesia does not fall into the wait and respond scenario, 5G activity checklist is made. This checklist is some kind like action points that need to be done by each entity in 5G society. It includes tasks that need to be done by government, MNOs, vendor, industry as well as ecosystem. Each task is paired with an indicator to show imaginary progress, where is the current condition of each task. The 5G activity list can be seen in Table 6.

8. Conclusion

The 5G deployment in Indonesia is originally planned to be happening in 2020. However, the plan seems very unlikely to meet due to many challenges. In response to that situation, a qualitative study is held to understand the whole stories from different perspectives. Those qualitative data then analysed using scenario planning methodology to create possible future scenarios and respond to them with appropriate strategy.

Two scenarios are created based on data from respondents across organizations which involved in 5G deployment. They are expert, high level and experience people from government, MNOs, Industry, vendor and universities. Those two scenarios represent the current situation of 5G deployment in Indonesia, and another one is the wanted position for the country to improve from 4G deployment experience. The winning scenario describes an alternate and better possible condition in the future instead of still doing what this country been doing.

Three phases strategy constructed to describe mentality needed during 15 years of 5G deployment in Indonesia, as well as in accordance with dominant 5G use cases happening year by year. The three phases are investment & learning phase, work & reward phase and reaping the benefit phase. Activity checklist completed with current status then created, to ease all 5G players to check their current position and wanted position.

This study provides respond strategy with three phases in high-level manner. Future studies can explore specific strategy from each 5G actors answering two scenarios built-in analysis part. This study emphasizes the beauty of qualitative study in scenario planning. An additional quantitative study might strengthen this study in terms of parameters such as key drivers, trends and uncertainties.
Table 6
Activity Check List for 5G Deployment in Indonesia.

| 5G Actor | Action Checklist | Status | 5G Actor | Action Checklist | Status |
|----------|------------------|--------|----------|------------------|--------|
| Government | Include 5G-IoT in National Strategic Projects | √ | MNOS | Learn Best Practice from other countries MNOS | √ |
| | Law & Regulation | √ | Network Planning | √ | |
| | RUI UPTA Gjata Omnibus Law (Infra Sharing & Cost) | √ | E2E Network Evolution | √ | |
| | Compensation Model with Satellite Provider | √ | Strategic Data centre and Edge Computing | √ | |
| | ITEE Law (Content and Security & Data Privacy) | √ | People Development for New Network Complexity | √ | |
| | Price Regulation (No Price War & Monopoly) | √ | Keep Densifying Network with 4G (5G ready node) | √ | |
| | Infrastructure Preparation | √ | Deploy 5G mmWave hot spots | √ | |
| | Spectrum Frequency Low Band (700 MHz) | √ | Switch Off or Reform 2 G or 3G | √ | |
| | Spectrum Frequency Mid Band (2.3 - 5.5GHz) | √ | Innovate to reduce cost per Gb | √ | |
| | Spectrum Frequency High Band (26 - 28 GHz) | √ | New Apps & Use Cases | √ | |
| | Passive Infrastructure Prep. | √ | Build innovative core values, people and organization | √ | |
| | Alignment with Local Government for Low Cost Infrastructure | √ | Vanish wild retribution & gangsterism | √ | |
| | Vanish wild retribution & gangsterism | √ | Actively participate in 5G Ecosystem (Forum) | √ | |
| | Passive Infrastructure Sharing (Tower, Land, etc.) | √ | Create innovation events (e.g. 5G-IoT competition) | √ | |
| | Optical Transport | √ | Explore new business models | √ | |
| | Backbone Palapa Ring | √ | Secure killer applications for EMBB | √ | |
| | Backhaul | √ | Invent new industry business use cases | √ | |
| | fiber-optic to access | √ | Disruptive Resilience | √ | |
| | Ecosystem & People Enrichment | √ | Foresee Stalling | √ | |
| | Early Establishment of 5G-IoT ecosystem (Forum) | √ | Vendor | Expect early phase investment for 5G | √ |
| | New Digital Curriculum | √ | Partnership with MNOS and Vertical Industry | √ | |
| | Literacy Digital Talent | √ | Common Hardware & Spectrum Sharing (4G & 5G) | √ | |
| End Users | Prioritizing quality over price | √ | Industry | Learn Best Practice from other countries | √ |
| | Deep understanding tech is just a tool not for addiction | √ | Expect long term investment | √ | |
| | Consider handset subsidy or data contract bundle | √ | Participate in 5G Forum | √ | |
| | Create sensible, reasonable and educating content | √ | Industry | Learn Best Practice from other countries | √ |
| | Follow the ITE Law | √ | Leverage Automation & Digitalization | √ | |
| | Socializing more in real life | √ | Innovate for better efficiency and productivity | √ | |
| | Parental Guidance | √ | 5G Ecosystem | Create 5G National Roadmap | √ |

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