

REFERENCE

- [1] Penyelenggara Jasa Internet Indonesia)APJII (Asosiasi, “Internet Indonesia,” *Survei Penetrasi Internet Indones.*, pp. 1–90, 2024, [Online]. Available: <https://survei.apjii.or.id/survei/group/9>
- [2] APJII, “Jumlah Pengguna Internet di Indonesia Tembus 221 Juta Orang,” 2024. <https://apjii.or.id/berita/d/apjii-jumlah-pengguna-internet-indonesia-tembus-221-juta-orang> (accessed Apr. 30, 2024).
- [3] [BPS] Badan Pusat Statistik, *Statistik Telekomunikasi Indonesia*. Jakarta: Badan Pusat Statistik, 2023. [Online]. Available: <https://www.bps.go.id/id/publication/2023/08/31/131385d0253c6aae7c7a59fa/statistik-telekomunikasi-indonesia-2022.html>
- [4] H. Tjoa and A. Hidayatno, “Evaluating the Current Policies’ Impacts on the 5G adoption in Indonesia using a systemic framework,” pp. 524–531, 2023, doi: 10.46254/na07.20220157.
- [5] O. Putriani, S. Priyanto, I. Muthohar, M. Rizka, and F. Amrozi, “Millimetre Wave and Sub-6 5G Readiness of Mobile Network Big Data for Public Transport Planning,” 2023.
- [6] L. Mamushiane, L. Mboweni, H. Kobo, M. Mudumbe, J. Mwangama, and A. A. Lysko, “4G RAN Infrastructure Sharing by 5G Virtualized Mobile Network Operators : A Tutorial,” *2021 IEEE AFRICON*, no. September, pp. 1–7, 2021, doi: 10.1109/AFRICON51333.2021.9570937.
- [7] M. H. Panjaitan and C. Apriono, “Valuation of 5G mmWave Fixed Wireless Access in Residence Area: Analysis of Real Option for Wireless Broadband Service in Kota Wisata Cibubur Using Decision Tree and Black Scholes Model,” *J. Ilm. Tek. Elektro Komput. dan Inform.*, vol. 8, no. 2, p. 226, 2022, doi: 10.26555/jiteki.v8i2.23626.
- [8] G. Soos, D. Ficzer, and P. Varga, “User Group Behavioural Pattern in a Cellular Mobile Network for 5G Use-cases,” *Proc. IEEE/IFIP Netw. Oper. Manag. Symp. 2020 Manag. Age Softwarization Artif. Intell. NOMS 2020*, no. April, 2020, doi: 10.1109/NOMS47738.2020.9110427.
- [9] G. Soos, D. Ficzer, and P. Varga, “Towards traffic identification and modeling for 5g application use-cases,” *Electron.*, vol. 9, no. 4, 2020, doi: 10.3390/electronics9040640.
- [10] R. N. Esa, “5G NR Planning at Frequency 3 . 5 GHz : Study Case in Indonesia Industrial Area,” no. July, 2021, doi: 10.1109/ICIEE49813.2020.9277427.
- [11] G. Fahira, “5G NR Planning at mmWave Frequency : Study Case in Indonesia Industrial Area,” pp. 205–210, 2020.
- [12] A. Sukarno, T. Engineering, A. Hikmaturokhman, T. Engineering, D. Rachmawaty, and T. Engineering, “Comparison of 5G NR Planning in Mid-Band and High-Band in Jababeka Industrial Estate,” pp. 12–17, 2020.
- [13] F. K. Karo, A. Hikmaturokhman, and M. A. Amanaf, “5G New Radio (NR) Network Planning at Frequency of 2.6 GHz in Golden Triangle of Jakarta,” *2020 3rd Int. Semin. Res. Inf. Technol. Intell. Syst. ISRITI 2020*, no. January, pp. 278–283, 2020, doi: 10.1109/ISRITI51436.2020.9315504.
- [14] S. B. Barutu, A. Hikmaturokhman, and M. P. K. Praja, “Planning of 5G New

- Radio (NR) mmWave 26 GHz in Karawang Industrial Area,” *2020 IEEE Int. Conf. Commun. Networks Satell. Comnetsat 2020 - Proc.*, no. January 2021, pp. 42–49, 2020, doi: 10.1109/Comnetsat50391.2020.9329010.
- [15] P. Rahmawati, M. I. Nashiruddin, and M. A. Nugraha, “Simulation of 700 MHz Spectrum Deployment in Indonesia’s Urban Area for 5G New Radio Network,” *2022 10th Int. Conf. Inf. Commun. Technol. ICoICT 2022*, no. 11, pp. 293–298, 2022, doi: 10.1109/ICoICT55009.2022.9914873.
- [16] M. I. Nashiruddin, P. Rahmawati, and M. A. Nugraha, “Assessment of 5G Non-Stand Alone Network Deployment Using 700 MHz for Urban Scenario,” *2022 10th Int. Conf. Inf. Commun. Technol. ICoICT 2022*, pp. 299–304, 2022, doi: 10.1109/ICoICT55009.2022.9914879.
- [17] Kominfo, “Jaringan 5G Resmi Beroperasi, Transformasi Digital Melesat,” *3 Juni 2021*. [Online]. Available: <https://www.kominfo.go.id/berita/artikel/detail/jaringan-5g-resmi-beroperasi-transformasi-digital-melesat>
- [18] Sekretariat Direktorat Jenderal Penyelenggaraan Pos dan Informatika, “Laporan Kinerja 2022 Direktorat Jenderal Penyelenggaraan Pos dan Informatika Kementerian Komunikasi dan informatika republik indonesia,” p. 24, 2022.
- [19] KOMINFO, “Siaran Pers No. 14/HM/KOMINFO/01/2022 Tentang Menkominfo Tegaskan Frekuensi 5G di Indonesia Tak Ganggu Penerbangan,” *19 Januari 2022*. <https://www.kominfo.go.id/berita/siaran-pers/detail/siaran-pers-no-14-hm-kominfo-01-2022-tentang-menkominfo-tegaskan-frekuensi-5g-di-indonesia-tak-ganggu-penerbangan> (accessed Oct. 27, 2024).
- [20] I. Spectrum, “3GPP Release 15 Overview: 3rd Generation Partnership Project (3GPP) members meet regularly to collaborate and create cellular communications standards,” 2018. <https://spectrum.ieee.org/3gpp-release-15-overview> (accessed Apr. 28, 2024).
- [21] ITU-R, “IMT Vision – Framework and overall objectives of the future development of IMT for 2020 and beyond,” *Recommendation Itu-R M.2083-0*. <https://www.itu.int/rec/R-REC-M.2083/en> (accessed Apr. 15, 2024).
- [22] Qualcomm, “Global 5G spectrum update and innovations for future wireless systems,” 2023.
- [23] I. Fogg, “Benchmarking the Global 5G Experience — June 2023,” *June, 2023*. <https://www.opensignal.com/2023/06/30/benchmarking-the-global-5g-experience-june-2023> (accessed Oct. 28, 2024).
- [24] R. Dangi, “Study and investigation on 5g technology: A systematic review,” *Sensors*, vol. 22, no. 1. 2022. doi: 10.3390/s22010026.
- [25] H. Fehmi, M. F. Amr, A. Bahnasse, and M. Talea, “5G Network: Analysis and Compare 5G NSA/5G SA,” *Procedia Comput. Sci.*, vol. 203, pp. 594–598, 2022, doi: 10.1016/j.procs.2022.07.085.
- [26] ITU-R, “International Telecommunication Union Recommendations Radiocommunication Sector Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-2020 (IMT-2020),” vol. 2. 2024. [Online]. Available: <https://www.itu.int/publ/R-REC/en>
- [27] T. Specification, “TS 138 101-1 - V15.2.0 - 5G; NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone (3GPP TS

- 38.101-1 version 15.2.0 Release 15),” *3GPP TS 38.101-1 version 15.2.0 Release 15*, vol. 0, pp. 0–244, 2018. [Online]. Available: <https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx>
- [28] Network, “Low to High 5G Bands Explained,” May 2023. <https://nybsys.com/5g-bands/> (accessed Oct. 28, 2024).
- [29] G. Dlodla and F. Mekuria, “Dynamic spectrum sharing for future wireless networks: Regulators perspective,” *2021 IST-Africa Conf. IST-Africa 2021*, 2021.
- [30] V. Agelliza, S. Larasati, and A. Hikmaturokhman, “Analysis on the Impact of Implementing Inter-band Carrier Aggregation (CA) on the 5G-NR Networks,” *J. Inf. Technol. Its Util.*, vol. 6, no. 1, pp. 9–16, 2023, doi: 10.56873/jitu.6.1.5106.
- [31] TSGR, “TS 138 300 - V17.6.0 - 5G; NR; NR and NG-RAN Overall description; Stage-2 (3GPP TS 38.300 version 17.6.0 Release 17),” *3Gpp*, vol. 0, 2023, [Online]. Available: https://www.etsi.org/deliver/etsi_ts/138300_138399/138300/17.06.00_60/ts_138300v170600p.pdf
- [32] A. Yazar, “Flexible Multi-Numerology Systems for 5G New Radio,” vol. 14, pp. 367–394, 2018, doi: 10.13052/jmm1550-4646.1442.
- [33] T. Specification, “TS 138 101-1 - V15.2.0 - 5G; NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone (3GPP TS 38.101-1 version 15.2.0 Release 15),” *3GPP TS 38.101-1 version 15.2.0 Release 15*, vol. 0, pp. 0–244, 2018, [Online]. Available: <https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx>
- [34] ITU-R, “Methodology for the Calculation of IMT-2000 Terrestrial Spectrum Requirements,” *Recomm. Itu-R M.1390*, pp. 1–23, 1999, [Online]. Available: https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.1390-0-199901-1!!PDF-E.pdf
- [35] A. R. P. Octasyilva and J. Rurianto, “Analisis Industri Telekomunikasi Seluler di Indonesia: Pendekatan SCP (Structure Conduct Perfoemance),” *INOBIJ. Inov. Bisnis dan Manaj. Indones.*, vol. 3, no. 3, pp. 391–408, 2020, doi: 10.31842/jurnalinobis.v3i3.146.
- [36] B. Tekno, “Axiata Ungkap Dampak Merger FREN - EXCL, Tambah Spektrum hingga Pangsa Pasar,” 2024. [Online]. Available: <https://teknologi.bisnis.com/read/20240613/101/1773925/axiata-ungkap-dampak-merger-fren-excl-tambah-spektrum-hingga-pangsa-pasar>
- [37] Leo Dwi Jatmiko, “GSMA Ramal Penetrasi 5G Indonesia Meroket, dari 3% jadi 32% pada 2030.” <https://teknologi.bisnis.com/read/20240912/101/1799254/gsma-ramal-penetrasi-5g-indonesia-meroket-dari-3-jadi-32-pada-2030> (accessed May 25, 2025).
- [38] P. Rahmawati, M. I. Nashiruddin, and M. A. Nugraha, “Capacity and Coverage Analysis of 5G NR Mobile Network Deployment for Indonesia’s Urban Market,” *Proc. - 2021 IEEE Int. Conf. Ind. 4.0, Artif. Intell. Commun. Technol. IAICT 2021*, pp. 90–96, 2021, doi: 10.1109/IAICT52856.2021.9532574.
- [39] W. W. Priambodo, H. Wijanto, and N. M. Adriansyah, “Techno-Economics Analysis of RAN-Spectrum Sharing Scheme Use Sensitivity Analysis

- Method,” *ICCoSITE 2023 - Int. Conf. Comput. Sci. Inf. Technol. Eng. Digit. Transform. Strateg. Facing VUCA TUNA Era*, pp. 679–684, 2023, doi: 10.1109/ICCoSITE57641.2023.10127697.
- [40] 3GPP TR 38.901 version 16.11.0 Release 16, *Study on channel model for frequencies from 0.5 to 100 GHz*, vol. 0. 2020.
- [41] Huawei, “5G Link Budget.”
- [42] M. A. Affandi, M. A. Riyadi, and T. Prakoso, “Throughput and Coverage Evaluation on The Use of Existing Cellular Towers for 5G Network in Surakarta City,” *J. Ilm. Tek. Elektro Komput. dan Inform.*, vol. 10, no. 1, p. 54, 2024, doi: 10.26555/jiteki.v10i1.27719.
- [43] TSGR, “TS 138 306 - V16.1.0 - 5G; NR; User Equipment (UE) radio access capabilities (3GPP TS 38.306 version 16.1.0 Release 16),” vol. 0, pp. 0–35, 2020, [Online]. Available: <https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx>
- [44] I. R. Mukhlis, U. Hayam, W. Perbanas, S. J. Pipin, and U. Mikroskil, *BIG DATA (Mengenal Big Data & Implementasinya di Berbagai Bidang)*, no. February. 2024.
- [45] R. Buyya, R. N. Calheiros, and A. V. Dastjerdi, *Big Data: Principle & Paradigms*, vol. 1, no. 69. 2016.
- [46] A. Ababneh, N. Al-shanableh, and M. Alzyoud, “A Review of Algorithms and Techniques for Analyzing Big Data,” *Int. J. Emerg. Trends Eng. Res.*, vol. 9, no. 6, pp. 695–702, 2021, doi: 10.30534/ijeter/2021/14962021.
- [47] J. Sistem, A. Cucus, R. Y. Endra, Y. Aprilinda, and Y. Y. Dharmawan, “Lapisan Arsitektur Big Data dalam Kajian Studi Pustaka,” vol. 12, no. 1, pp. 22–27, 2021.
- [48] F. Rachmawati, J. Jaenudin, N. B. Ginting, and P. Laksono, “Machine Learning for the Model Prediction of Final Semester Assessment (FSA) using the Multiple Linear Regression Method,” *J. Tek. Inform.*, vol. 17, no. 1, pp. 1–9, 2024, doi: 10.15408/jti.v17i1.28652.
- [49] S. Chaube *et al.*, “An Overview of Multi-Criteria Decision Analysis and the Applications of AHP and TOPSIS Methods,” *Int. J. Math. Eng. Manag. Sci.*, vol. 9, no. 3, pp. 581–615, 2024, doi: 10.33889/IJMEMS.2024.9.3.030.
- [50] A. Hikmaturokhman, H. Nafi’ah, S. Larasati, A. Wahyudin, G. Aripawira, and S. Pramono, “Deep Learning Algorithm Models for Spam Identification on Cellular Short Message Service,” *J. Commun.*, vol. 17, no. 9, pp. 769–776, 2022, doi: 10.12720/jcm.17.9.769-776.
- [51] A. C. Sari, Jason, E. Lansky, and M. A. Ferdiansyah, “Challenges and obstacle to implementing 5g in Indonesia,” *J. Theor. Appl. Inf. Technol.*, vol. 99, no. 22, pp. 5232–5240, 2021.
- [52] S. Hutajulu, W. Dhewanto, and E. A. Prasetio, “Two scenarios for 5G deployment in Indonesia,” *Technol. Forecast. Soc. Change*, vol. 160, 2020, doi: 10.1016/j.techfore.2020.120221.
- [53] Zein Hanni Pradana, Hanin Nafi’ah, and Raditya Artha Rochmanto, “in Chatbot-based Information Service using RASA Open-SourceFrameworkin Prambanan Temple Tourism Object,” *J. RESTI (Rekayasa Sist. dan Teknol. Informasi)*, vol. 6, no. 4, pp. 656–662, 2022, doi: 10.29207/resti.v6i4.3913.
- [54] A. Journal and O. N. Business, “PYTHON FOR DATA ANALYTICS : A SYSTEMATIC LITERATURE REVIEW OF TOOLS , TECHNIQUES ,

- AND APPLICATIONS,” vol. 04, no. 04, pp. 134–154, 2024.
- [55] A. Kalbande, “Best Python Libraries For Machine Learning,” 2020. <https://www.fireblazeaischool.in/blogs/python-libraries-for-machine-learning/> (accessed Nov. 17, 2024).
- [56] A. Wulandari, M. Hasan, H. Widhi Santoso, P. Studi Broadband Multimedia, J. Teknik Elektro, and P. Negeri Jakarta, “Pengembangan Coverage 5G Wilayah Depok Memanfaatkan Analisis Big Data Multi-Parameter,” *Pros. Semin. Nas. Tek. Elektro dan Inform. 2022-Teknik Telekomun.*, pp. 116–122, 2022.
- [57] S. H. Komariah, R. R. Saedudin, R. Y. Arumsari, and U. Y. Ksp, “Implementation of 5G Telecommunication Network Services in Indonesia based on Techno-economic Analysis,” *Int. J. Informatics Vis.*, vol. 7, no. 4, pp. 2569–2577, 2023, doi: 10.30630/joiv.7.4.2447.
- [58] D. Rianti, A. Hikmaturokhman, and D. Rachmawaty, “Techno-Economic 5G New Radio Planning Using 26 GHz Frequency at Pulogadung Industrial Area,” *2020 3rd Int. Semin. Res. Inf. Technol. Intell. Syst. ISRITI 2020*, no. January, pp. 272–277, 2020, doi: 10.1109/ISRITI51436.2020.9315455.
- [59] XL Annual Report, “Fast-Tracking with Resilience with Agility,” 2023.
- [60] Telkomsel Annual Report, “Unity in Convergence The Spirit of Indonesia.”
- [61] S. Merat and W. Almuhtadi, “Standard ARPU calculation improvement using artificial intelligent techniques,” *Int. J. Smart Sens. Intell. Syst.*, vol. 8, no. 4, pp. 1917–1934, 2015, doi: 10.21307/ijssis-2017-836.
- [62] M. I. Nashiruddin, P. Rahmawati, M. A. Nugraha, and D. Suherman, “Sensitivity Options of 5G 700 MHz Network Deployment in Urban Models: A Simulation for Emerging Countries,” *J. Commun.*, vol. 19, no. 5, pp. 255–265, 2024, doi: 10.12720/jcm.19.5.255-265.
- [63] M. I. Nashiruddin, M. A. Nugraha, P. Rahmawati, A. T. Hanuranto, and A. Hikmaturokhman, “Techno-Economic Assessment of 5G NSA Deployment for Metropolitan Area: A Greenfield Operator Scenario,” *J. Commun.*, vol. 17, no. 12, pp. 1009–1022, 2022, doi: 10.12720/jcm.17.12.1009-1022.
- [64] JDIH, “Undang-Undang Republik Indonesia Nomor 36 Tahun 1999 Tentang Telekomunikasi,” *Telekomunikasi*, 1999. <https://peraturan.bpk.go.id/Details/45357/uu-no-36-tahun-1999> (accessed Jan. 01, 2024).
- [65] A. Febian, R. Adaniah, S. Ariyanti, D. Kusumawati, E. Kiki, and A. Aziz, *Studi Lanjutan 5G Indonesia 2018 Spektrum Outlook dan Use Case untuk Layanan 5G Indonesia*. 2018. [Online]. Available: <http://balitbangsdm.kominfo.go.id>
- [66] Indonesia, “Undang Undang Republik Indonesia Nomor 11 Tahun 2020 Tentang Cipta Kerja,” *Peraturan.Bpk.Go.Id*, no. 052692, pp. 1–1187, 2020.
- [67] KEMENPU-PR. SPIP. No 4 Tahun, “Berita Negara,” *Peratur. Menteri Kesehat. Republik Indones. Nomor 4 Tahun 2018*, vol. 151, no. 2, pp. 10–17, 2018.
- [68] JDIH, “Peraturan Pemerintah Nomor 43 Tahun 2023,” no. 172158. 2023. [Online]. Available: <https://peraturan.bpk.go.id/Details/264789/pp-no-43-tahun-2023>
- [69] I. PEMERINTAH, “PP no. 80 Tahun 2015,” pp. 1–23, 2016.
- [70] BPS, “Badan Pusat Statistik Kota Bandung,” 2023.

- <https://bandungkota.bps.go.id/> (accessed Apr. 21, 2024).
- [71] R. Supriyatin, A. E. Pravitasari, and D. O. Pribadi, "Pemetaan Karakteristik Wilayah Urban Dan Rural Di Wilayah Bandung Raya Dengan Metode Spatial Clustering," *J. Geogr.*, vol. 12, no. 02, p. 125, 2020, doi: 10.24114/jg.v12i02.17647.
- [72] [BPS] Badan Pusat Statistik, "Luas Wilayah Menurut Kecamatan di Kota Bandung (Km2), 2022-2023," 2024. <https://bandungkota.bps.go.id/id/statistics-table/2/MzQjMg==/luas-wilayah.html>
- [73] P. K. Bandung, "Tentang Kota Bandung," 2022. <https://www.bandung.go.id/profile> (accessed Feb. 18, 2024).
- [74] T. Oktavianto, T. Prakoso, and M. A. Riyadi, "Analisis Jaringan 5G 2300 Mhz Dengan Menggunakan Menara 4G Lte Yang Tersedia Di Kota Semarang," *Transm. J. Ilm. Tek. Elektro*, vol. 26, no. 1, pp. 1–9, 2024, doi: 10.14710/transmisi.26.1.1-9.
- [75] V. Agelliza, S. Larasati, and A. Hikmaturokhman, "ANALYSIS OF THE IMPLEMENTING INTER - BAND CARRIER AGGREGATION (CA) ON THE 5G NEW RADIO (NR) NETWORKS," vol. 6, no. 1, pp. 9–16, 2023.
- [76] A. Hikmaturokhman, L. Anora, S. Larasati, A. Sukarno, R. Syafrullah, and K. Ni'amah, "Performance analysis of 5G stand alone inter-band carrier aggregation," *J. Commun.*, vol. 16, no. 11, pp. 492–499, 2021, doi: 10.12720/jcm.16.11.492-499.