Digital Village: Modelling of Public Wireless Internet Development using Supply Chain Structure Approach

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Abstract. This study aims to describe the design of rural public wireless internet development based on a supply chain structure approach. Now, many new internet services have sprung up in the private, public, business, education, health, and even governmental sectors until considered as the leading global system. Especially in rural areas, the provision of cable internet networks and cellular internet networks have not been able to reach all rural areas, so a new breakthrough is needed, one of which is a public wireless internet network. This research was conducted with a Design-Based Research approach that combines scientific design methods with the problems that occur for internet development in rural areas of Indonesia. The finding that the development of wireless internet in rural areas can be carried out with the concept of a supply chain structure consisting of suppliers (ISP providers of internet sources), manufacturers (local government or village-owned enterprises managing and transmitting wireless internet to wholesaler), wholesaler (installed 5GHz wireless repeater in people residential areas), retailers (installed 5GHz wireless receiver devices from wholesaler and convert to 2.4GHz wireless transmitters installed in every resident's house) and customers (each resident's smartphones or notebooks device connected by wireless).

1. Introduction
A Digital Village is an idea that allows developers to reach undeveloped internet-connected village areas [1]. Now, many new internet services have emerged such as the private, public, business, academic, healthcare, and also governmental sector till considered as a leading global system [2]. The Digital Platform's general purpose is to present an accessible, user-friendly, modern and approach that will facilitate any village representative to improve their smartness [3]. Therefore, many of the government’s intended to create digital villages by linking all schemes with internet [4].

In several projects about digital village, electrical infrastructure, sites vary by geographical location, and target population determine the kinds of devices that may be implemented in the field also amount of cost [5]. Now, the backbone of Access Point (AP) dominant still uses Unshielded Twisted Pair (UTP) cable media resulting in significant problem when to locations that are difficult to reach by cables as well as villages that have long distances from the City Center and quite difficult natural conditions [1]. Nonetheless, recent developments in wireless technologies are raising new hopes in rural areas of the developing world for sustainable Internet diffusion [6]. A wireless network is one of the best alternatives to build a practical, flexible, and high-mobility computer network [1].
Meanwhile, the availability of public Wi-Fi access was rarely found in poor residential areas and remote rural areas [7]. No need to be in doubt, the improvement of wireless communication technology is essential to use it for public safety, which could greatly increase the effectiveness of the exchange of information between emergency responders [8]. As soon as possible, it is necessary to develop a public wireless model that is easily accessible by rural communities in accordance with the characteristics of the village. This research aims to develop model of wireless public internet in rural areas using supply chain approach. Supply chain management used integrated one-way manufacturing process, in which the raw material from suppliers then delivered to the customer [9] like as send internet connection from provider to users.

2. Conceptual Basic
The increased uptake of the internet is seen as a vital part of strategies to avoid rural decline [10]. Effects of IT investment only achievable through a strong investment in internet infrastructure that provides IT adoption and application to support people to take advantage of the internet age in order to achieve increased well-being [11]. The geographical conditions of Indonesia's rural villages do not all have internet connections [12], even some of its inhabitants are in areas that are not yet affected by land network infrastructure via cable or fiber optics so that the need for the internet can reach remote villages is very important [13]. For this reason, it is necessary to have an integration between the internet supply process, internet distribution so that it can be consumed by the village community such as the supply chain process. These supply chain stages consist of suppliers, manufacturers, distributors, retailers, and customers [9] shown in Figure 1. It is inevitable for the sustainable supply chain to meet the aggressive change in customer requirements [14], similar with ensuring internet availability in rural areas have many challenges resulting in limited internet infrastructure wired or non-wired[15] due to disparities geographical and electricity access [16][17]. Thus required, research is carried out using a Design-Based Research (DBR) that combines scientific design methods with the problems about internet development in rural areas of Indonesia. DBR stages consist of (1) focusing on observing problems in building internet networks in digital villages, (2) understanding of problems in building internet network infrastructure in digital villages, (3) define solutions to problems, (4) conceive the needs for tools and materials, (5) making prototype solutions offered and (6) testing the prototype [17].

3. Results and Discussion
The next discussion will be discussed concerning the supply chain structure approach in providing internet infrastructure in order to realize digital village shown Figure 2.

3.1. Suppliers
The Supplier performance has the most effect [18] and plays important role on the successful supply chain management [19]. Therefore, process supplier selection is show a sophisticated, application oriented, decision-making (DM) problem and has received considerable attention [20]. Especially in the implementation of internet infrastructure, Internet Service Provider (ISP) and Mobile Network Operators (MNOs) is the main supplier to provide internet to the customers. However, challenges arise
in the spread and expansion of the internet network in remote or rural areas caused like geographical, weather conditions, and infrastructure cost [21]. Wireless Internet Service Provider (WISP) networks as the solution connecting remote and rural areas to the internet [22] and potential building a low-cost sustainable Internet service [23].

Figure 2. Design rural public wireless internet development use supply chain structure approach

3.2. Manufacturer
The Industrial Internet is often understood as the implementation of the general concept of Cyber Physical Systems (CPSs), through which data is closely collected, tracked from physical space and synchronized with cyber space [24]. Manufacturing services are more frequently shared among multiple stakeholders as various Industrial Internet platforms emerge, so that both the shared Manufacturing Service Composition (MSC) are optimally selected and promised [25]. In the rural areas, both the industrial internet and local government can working together [26] as manufacturer to increase internet service in there. In addition, rural local governments can also establish village-owned enterprises (BUM Desa) as manufacturer to provide their internet so that they can potentially play a vital role in the economic and community growth of villages to support community issues by mobilizing local resources that are difficult for profit-oriented businesses [27].

3.3. Wholesaler
Manufacturers usually distribute their products or services through a group of distributors who are approved to sell their products or services [28]. Under the leadership of the wholesaler who re-sells these goods to the customer through retailers, the manufacturer's profit perspective can be optimized [29]. The role of wholesalers is critically important in the supply chain, to choose the most suitable market [30]. Wholesalers play a role in distributing the system deployed in different geographical locations for internet networks to be closer to the end user, thereby reducing network congestion and accelerating distribution [31].

3.4. Retailer and customer
A retailer must produce value for its customers and acquires value from the markets in the business model [32]. In addition, this is important in the retail business model for directly customer interaction [33] well personal or family use and the last stage link among manufacturers and consumers [34]. This retailer concept can use to provide wireless internet network infrastructure for rural citizens so that easy to access it. Because of its fast data speed transmission and high coverage area, Wi-fi supports their to direct connection without having a central access point and more applicable to implement in disasters
condition than other technologies [35]. Therefore, rural citizens as end consumers can connect their devices directly to internet access point in the home or rural public areas.

From this model shown in Figure 2, the stakeholders involved consist of ISP as internet connection supplier and rural local government or village-owned enterprises (BUM Desa) which is in charge of manage and control the internet network from the manufacturer stage to the customers. This model supports the implementation of digital villages in terms of infrastructure, while the issues of digital skills and literacy are that rural local government can build village-owned enterprises (BUM Desa) as digital telecentre. The digital telecentre must have aspect (1) as a social enterprise engaged in the application of acceptable ICT technologies, the establishment of telecentres must have this mission, (2) telecentres in the form of village-owned enterprises legal bodies, so that they have the ability to obtain external (CSR) and internal (village funds) financial capital and (3) in order to help the ensure the sustainability of ICT adoption, telecentre must include human resources the village community of origin [36].

4. Conclusion
A digital village is a great dream for a developing country to demonstrate justice in urban and rural life, especially in the development of technology. The internet has become a technology in recent years that plays an important role in the distribution of information and the economy’s pace. However, there have been many barriers to the growth of internet connectivity in rural areas, such as geographical conditions, high costs of connecting an ISP fiber optic cable, mobile broadband signal has not yet penetrated all areas and fragmented residential areas. The findings of this study explain, the modelling of internet network infrastructure development in the rural areas using a supply chain approach. The process of connecting ISPs (suppliers) to rural citizens (end consumers) through a wireless network is based on this approach. Wireless networks have the advantage that, can connected without the need for a central access point so rural citizens can directly connect to the internet, greater coverage and more likely to be in disaster situations than other technology. Basically, this model involves the ISP as internet supplier and rural local government or village-owned enterprises (BUM Desa) which manage and control internet network from manufacturer until customers. This model can be solution to support digital village in terms of infrastructure, there is also for digital skills and literacy then a digital telecenter can be formed to ensure the sustainability of ICT adoption. For further study, it is necessary to study the performance of this wireless network design in accordance with the heterogeneous geographical conditions of the villages so that the disadvantages and challenges can be analyzed.

Acknowledgments
This study was supported by the Ministry of Science and Technology / National Research and Innovation Agency (Kemenristek/BRIN) of the Republic of Indonesia in 2020

References
[1] Rusdan M 2019 Design of wireless network system for digital village using wireless distribution system J. Informatics, Inf. Syst. Softw. Eng. Appl. 1 pp 51–9
[2] Paul P and Bhumin A 2017 Emerging Internet Services Vis-à-Vis Development: A Theoretical Overview Int. J. Recent Res. Sci. Eng. Technol. 5 pp 19–25
[3] Beranič T, Zamuda A, Brezočnik L, Turkanović T, Lentini G, Polettini F, Lué A, Vitale A C, Martinez-Gil J and Pichler M 2019 Facilitating the digital transformation of villages Proc. of the Central European Conf. on Information and Intelligent Systems pp 281–8
[4] Vijayan A 2019 Digital India – A roadmap to sustainability Int. J. Innov. Technol. Explor. Eng. 8 pp 571–6
[5] Verma S and Ryan J P 2016 A framework for information access in rural and remote communities Int. Symp. Technol. Soc. Proc. 2016-Decem pp 96–9
[6] Pereira J P R 2016 Broadband access and digital divide Adv. Intell. Syst. Comput. 445 pp 363–8
[7] Wang M, Liao F H, Lin J, Huang L, Gu C and Wei Y D 2016 The making of a sustainable wireless city? Mapping public Wi-Fi access in Shanghai Sustainability 8
[8] Xiang W 2017 Applicability of wireless communication techniques in public safety *Int. Conf. on Innovation & Management* pp 653–7

[9] Deshmukh A J and Vasudevan H 2014 Emerging supplier selection criteria in the context of traditional vs green supply chain management *Int. J. Manag. Value Supply Chain.* 5 pp 19–33

[10] Komorowski Ł and Stanny M 2020 Smart villages: Where can they happen? *Land* 9

[11] Evans O 2019 Repositioning for increased digital dividends: internet usage and economic well-being in Sub-Saharan Africa *J. Glob. Inf. Technol. Manag.* 22 pp 47–70

[12] Setiawan T and Padmanyigroben D 2020 Towards the design of village information systems as a villager communication medium *Int. J. Multi Sci.* 1 pp 1–6

[13] Hidayat S, Ramdani T, Alam I F, Sfenrianto S and Kaburuan E R 2019 The role of high throughput satellite as sky highway infrastructure to support the acceleration of internet entry into villages in Indonesia *Int. J. Mech. Eng. Technol.* 10 pp 552–60

[14] Manavalan E and Jayakrishna K 2019 A review of Internet of Things (IoT) embedded sustainable supply chain for industry 4.0 requirements *Comput. Ind. Eng.* 127 pp 925–53

[15] Onitsuka K, Hidayat A R R T and Huang W 2018 Challenges for the next level of digital divide in rural Indonesian communities *Electron. J. Inf. Sys. Dev. Ctries.* 84 pp 1–25

[16] Sujarwoto S and Tampubolon G 2016 Spatial inequality and the Internet divide in Indonesia 2010–2012 *Telecomm. Policy* 40 pp 602–16

[17] Nurchim N and Pradana A I 2019 Prototype green internet technology guna mendukung infrastruktur desa pintar *J. Appl. Informatics Comput.* 3 pp 102–6

[18] Valipour P S, Safaei G A and Fallah L H 2019 Resilient supplier selection and segmentation in grey environment *J. Clean. Prod.* 207 pp 1123–37

[19] Liu T, Deng Y and Chan F 2018 Evidential supplier selection based on DEMATEL and game theory *Int. J. Fuzzy Syst.* 20 pp 1321–33

[20] Chai J and Ngai E W T 2020 Decision-making techniques in supplier selection: Recent accomplishments and what lies ahead *Expert Syst. Appl.* 140 112903

[21] Bhuiyan M 2020 *Solutions For Wireless Internet Connectivity in Remote and Rural Areas* Thesis (Oulun Yliopisto: University of Oulu)

[22] Cameron D, Valera A and Seah W K G 2020 ElasticWISP: Energy-proportional WISP networks *Proc. IEEE/IFIP Netw. Oper. Manag. Symp. 2020* Manag. Age Softwarization Artif. Intell. NOMS 2020

[23] Hameed A, Mian A N and Qadir J 2016 Low-cost sustainable wireless internet service for rural areas *Wirel. Networks* 24 pp 1439–50

[24] Li J Q, Yu F R, Deng G, Luo C, Ming Z and Yan Q 2017 Industrial internet: a survey on the enabling technologies, applications, and challenges *IEEE Commun. Surv. Tutorials* 19 pp 1504–26

[25] Zhang Y, Tao F, Liu Y, Zhang P, Cheng Y and Zuo Y 2019 Long/short-term utility aware optimal selection of manufacturing service composition toward industrial internet platforms *IEEE Trans. Ind. Informatics* 15 pp 3712–22

[26] Oh S H and Mardis M A 2019 Rural broadband and advanced manufacturing: research implications for information studies *Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics)* 11420 LNCS pp 265–73

[27] Arifin B et al 2020 Village fund, village-owned-enterprises, and employment: evidence from Indonesia *J. Rural Stud.* 79 pp 382–94

[28] Yang X, Cai G, Ingene C A and Zhang J 2020 Manufacturer strategy on service provision in competitive channels *Prod. Oper. Manag.* 29 pp 72–89

[29] Nielsen I E, Majumder S and Zhang J 2019 Exploring the intervention of intermediaries in a green supply chain *J. Clean. Prod.* 233 pp 1525–44

[30] Tavana M, Amoozad M H, Beheshti M and Abbasi K A A 2020 Optimal strategic alliance in multi-echelon supply chains with open innovation *Manag. Decis. Econ.* 41 pp 1365–84

[31] Antonopoulos A, Kartsakli E, Perillo C and Verikoukis C 2017 Shedding light on the internet:
stakeholders and network neutrality *IEEE Commun. Mag.* **55** pp 216–23

[32] Sorescu A, Frambach R T, Singh J, Rangaswamy A and Bridges C 2011 Innovations in retail business models *J. Retail.* **87** pp S3–16

[33] Jocevski M, Arvidsson N, Miragliotta G, Ghezzi A and Mangiaracina R 2019 Transitions towards omni-channel retailing strategies: a business model perspective *Int. J. Retail Distrib. Manag.* **47** pp 78–93

[34] Bilgin S E and K Yücel E 2020 Distribution network design for e-retailing application: a model suggestion for local retailer in Izmir *J. Bus. Res. - Turk* **12** pp 2205–14

[35] Alnashwan R and Mokhtar H 2019 Disaster management system over Wifi direct 2nd Int. Conf. Comput. Appl. Inf. Secur. ICCAIS 2019 pp 1–6

[36] Nurchim N and Nofikasari I 2018 Analisis model pengembangan telecenter guna mewujudkan desa pintar di Indonesia *Fountain Informatics J.* **3** pp 36–40