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Bill of Quantity Analysis for GPON-Based FTTH Network Planning in Taman Asri 8 Residential Area Padang

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***Abstract*— The increasing demand for high-speed broadband internet services requires reliable and efficient access network infrastructure. The Taman Asri 8 residential area in Padang City has the potential for broadband service development; however, MyRepublic has not yet deployed a Fiber to the Home (FTTH) network in this area. This study aims to design a Gigabit Passive Optical Network (GPON)-based FTTH network and develop a Bill of Quantity (BoQ) as an estimation of the network equipment required for deployment. The materials used in this study include the residential site plan, field survey data, and geographic information obtained from Google Earth Pro, while AutoCAD was employed to develop the network layout. The proposed network was designed using the Network Planning Process (NPP), which consists of requirement analysis, desktop survey, field survey, network design, and BoQ calculation. Based on the planning results, the designed FTTH network is capable of serving 212 homepass distributed across the residential area. The network design includes the determination of feeder and distribution routes, placement of Optical Distribution Cabinets (ODCs), Optical Distribution Points (ODPs), and other supporting optical components. Furthermore, the BoQ provides a comprehensive list of the required network devices and materials, including fiber optic cables, OLT, ODC, ODP, splitters, ONTs, and supporting accessories required for network deployment. The resulting BoQ can serve as a practical reference for network implementation planning and material procurement in similar FTTH deployment projects, thereby supporting more efficient broadband infrastructure development in residential areas.**

***Keywords*— FTTH, GPON, Bill of Quantity, Network Planning Process, Optical Distribution Points.**

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I. INTRODUCTION

a. *Background*

The rapid growth of information and communication technology has significantly increased the demand for high-speed broadband internet services with reliable performance and large bandwidth capacity. The widespread adoption of digital services, including video streaming, online learning, cloud computing, Internet of Things (IoT), and remote working, requires an access network capable of delivering stable, high-capacity, and low-latency communication. Therefore, broadband infrastructure has become an essential component in supporting digital transformation across various sectors [1].

Fiber to the Home (FTTH) has emerged as one of the most suitable broadband access technologies because it utilizes optical fiber as the transmission medium, offering high bandwidth, low attenuation, and immunity to electromagnetic interference compared with conventional copper-based access networks[2], [3]. Among various FTTH architectures, Gigabit Passive Optical Network (GPON) has been widely adopted due to its capability to provide high transmission capacity while reducing infrastructure and operational costs through passive optical splitters. GPON supports downstream and upstream

transmission rates of up to 2.488 Gbps and 1.244 Gbps, respectively, making it suitable for modern broadband services [1], [4], [5].

The Taman Asri 8 residential area in Padang City is a rapidly developing housing complex with increasing broadband service demands. Although several internet service providers have already deployed FTTH infrastructure in this area, MyRepublic has not yet established an FTTH network. Based on the residential site plan, the housing complex comprises 367 planned housing units, and 212 completed houses were selected as the target homes for this study. Consequently, a comprehensive FTTH network planning is required to support broadband deployment for future service expansion.

Several previous studies have investigated GPON-based FTTH network planning and performance evaluation using Link Power Budget, Rise Time Budget, Bit Error Rate (BER), and Q-Factor analysis[6], [7]. However, most of these studies mainly focused on network performance evaluation without providing a comprehensive estimation of network equipment requirements required for practical implementation. In actual FTTH deployment, estimating the quantity of network devices and materials is essential for procurement planning, budgeting, and implementation scheduling.

Therefore, this study proposes a GPON-based FTTH network planning using the Network Planning Process (NPP). The NPP method provides a systematic framework for requirement analysis, desktop survey, field survey, network design, and implementation planning. Previous studies have demonstrated that systematic network planning can improve project organization, scheduling, and resource allocation efficiency [8], [9]. In addition, GPON-based FTTH planning has been widely adopted to support efficient broadband deployment in residential areas [6], [10][11]. The resulting Bill of Quantity (BoQ) summarizes the required network components, including fiber optic cables, Optical Line Terminal (OLT), Optical Distribution Cabinet (ODC), Optical Distribution Point (ODP), splitters, Optical Network Terminal (ONT), and supporting accessories. The resulting BoQ is expected to serve as a practical reference for material procurement and FTTH network deployment in residential areas with similar characteristics..

b. *Literature Review*

a. *Fiber Optic*

Fiber optic is a telecommunication transmission medium made of glass or plastic that transmits data in the form of light signals. Compared with conventional copper cables, optical fiber provides higher bandwidth, lower attenuation, and greater immunity to electromagnetic interference, making it suitable for high-speed broadband communication over long distances. Modern optical fibers typically exhibit attenuation of less than 20 dB/km, enabling efficient and reliable data transmission for Fiber to the Home (FTTH) networks [12], [13]. An optical fiber consists of four main components: the core, cladding, coating, and outer jacket.

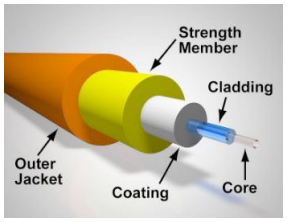

Figure 1. Fiber Optic Structure

b. *Fiber To The Home (FTTH)*

Fiber to the Home (FTTH) is a broadband access technology that delivers high-speed internet services directly to end users through optical fiber cables. FTTH employs single-mode optical fiber with operating wavelengths of 1310 nm for upstream and 1490 nm for downstream transmission, providing high bandwidth, low attenuation, and reliable long-distance communication [3]. In this study, the FTTH network adopts the Gigabit Passive Optical Network (GPON) architecture, which consists of an Optical Line Terminal (OLT), Optical Distribution Cabinet (ODC), Optical Distribution Point (ODP), and Optical Network Terminal (ONT). This architecture enables efficient signal distribution from the central office to multiple subscribers using passive optical splitters, making FTTH an effective solution for modern broadband network deployment [7], [12][11], [14].

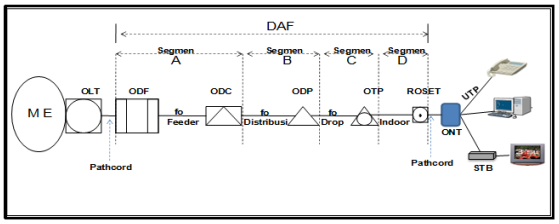

Figure 2. GPON-Based FTTH Network Architecture.

c. *Gigabit Passive Optical Network (GPON)*

Gigabit Passive Optical Network (GPON) is an evolution of Passive Optical Network (PON) technology standardized by ITU-T G.984. GPON provides high-capacity broadband services using passive optical splitters, enabling a single Optical Line Terminal (OLT) to serve multiple Optical Network Terminals (ONTs). The system supports downstream and upstream transmission rates of 2.488 Gbps and 1.244 Gbps, respectively, while utilizing ATM/GEM protocols for efficient data transmission. In GPON architecture, optical signals transmitted from the OLT are distributed through passive splitters to multiple ONTs, allowing efficient network deployment with reduced infrastructure costs [1]. The main specifications of GPON adopted in this study are presented in Table I

TABLE 1 GPON STANDARDIZATION

Karakteristik	GPON
Standarisasi	ITU-T G.984
Frame	ATM/GEM

Speed Upstream	1.2 G/1.2 Gbps
Speed Downstrem	1.2 G/2.4 Gbps
Layanan	Data, suara, video
Jarak Transmisi	10 Km/20Km
Maksimum Jumlah Cabang	64
Wavelength Upstream	1310
Wavelengt Downstream	1510
Splitter	Passive

d. Bill of Quantity (BoQ)

Bill of Quantity (BoQ) is a document that lists the quantities and specifications of materials, equipment, and components required for project implementation. In GPON-based Fiber to the Home (FTTH) network planning, the BoQ is prepared based on the final network design to estimate the required network devices, including Optical Line Terminal (OLT), Optical Distribution Cabinet (ODC), Optical Distribution Point (ODP), optical splitters, fiber optic cables, Optical Network Terminal (ONT), and supporting accessories. The resulting BoQ serves as a reference for material procurement, implementation planning, and resource management, ensuring that network deployment can be carried out efficiently and systematically [15], [16].

II. The Materials and Method

A. Requirement Analysis

The requirement analysis stage was conducted to identify the network requirements for GPON-based FTTH planning in Taman Asri 8 Residential Area, Padang City. The analysis utilized the residential site plan provided by the housing developer and field observations using Google Earth Pro to obtain information regarding the number of houses, geographical conditions, and residential layout.

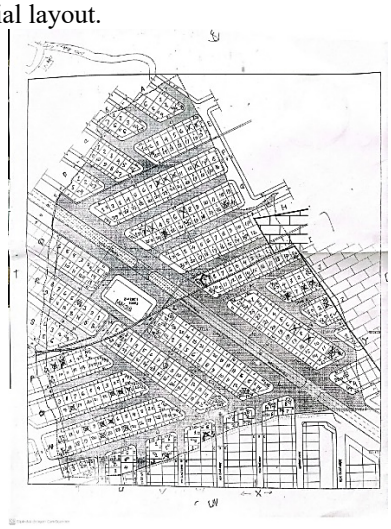

Figure 3. Site Plan of Taman Asri 8

Based on the site plan, the residential area consists of 367 planned housing units, while 212 completed houses were selected as the target homepass for network planning. These data were used to determine network capacity, service coverage, and equipment requirements. The proposed network adopts a two-stage splitting configuration consisting of a 1:4 splitter at the Optical Distribution Cabinet (ODC) and a 1:16 splitter at the Optical Distribution Point (ODP), resulting in an overall split ratio of 1:64. Based on this configuration, four GPON ports are required to serve the planned subscribers, providing sufficient capacity for current demand while allowing future network expansion. The output of this stage serves as the basis for determining the FTTH network topology, equipment placement, and cable routing in the subsequent design process.

B. Desktop Survey

The desktop survey was conducted using secondary data, including the residential site plan and Google Earth Pro, to identify the geographical characteristics of the study area before field verification. This stage involved analyzing the residential boundary, road network, housing distribution, and potential fiber optic cable routes. In addition, the existing MyRepublic feeder network was identified to determine the most suitable interconnection point for the proposed FTTH network. The information obtained from the desktop survey was used as the basis for estimating feeder and distribution cable routes, determining equipment placement, and developing the GPON-based FTTH network design.

Figure 4. Study Area Boundary

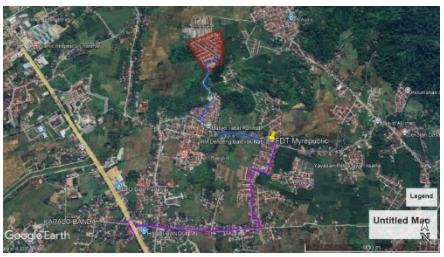

Figure 5. Existing MyRepublic

C. Network Desain

The network design stage was carried out based on the results of the requirement analysis, desktop survey, and field survey. The proposed GPON-based FTTH network includes homepass mapping, feeder route planning, Optical Distribution Cabinet (ODC) and Optical Distribution Point (ODP) placement, distribution cable routing, and drop cable planning. Google Earth Pro was used to determine the

feeder route from the existing MyRepublic network, while AutoCAD was employed to develop the network layout, including customer locations, equipment placement, and distribution routes. The network design considered the residential layout, existing utility poles, and road access to ensure efficient network coverage for all 212 homepass. The resulting network design served as the basis for preparing the Bill of Quantity (BoQ) required for FTTH network implementation.

a. Homepass Mapping

Homepass mapping was conducted to identify the residential units to be served by the proposed GPON-based FTTH network. The mapping process was performed using AutoCAD based on the residential site plan, where each completed house was identified according to its block and house number. A total of 212 completed houses were selected as the target homepass. The mapped homepass distribution served as the basis for determining the network coverage, equipment placement, and distribution cable routing.

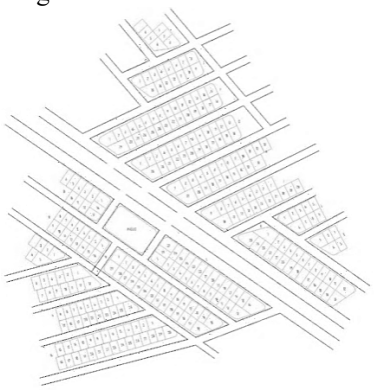

Figure 6. Homepass Mapping

b. Feeder Router Planning

The feeder route was designed to connect the existing MyRepublic network with the proposed FTTH network in Taman Asri 8 Residential Area. The route was determined using Google Earth Pro based on the existing network infrastructure, geographical conditions, and road accessibility. The selected feeder route follows the available road network to facilitate network deployment and maintenance. A 24-core single-mode aerial fiber optic cable was selected to provide sufficient capacity for the current network demand while allowing future expansion. The total feeder cable length obtained from the route measurement was approximately 1,265 m, which was used as the basis for estimating material requirements in the Bill of Quantity (BoQ).

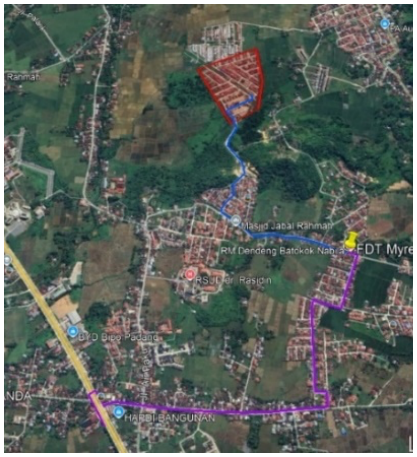

Figure 7. Feeder Cable Route

c. ODC Placement

The Optical Distribution Cabinet (ODC) was positioned near the center of Taman Asri 8 Residential Area to provide balanced distribution coverage and minimize the length of distribution cables. This location enables efficient interconnection between the existing MyRepublic feeder network and the proposed FTTH distribution network. The designed network employs one ODC connected through a 48-core single-mode aerial feeder cable, providing sufficient capacity for both current deployment and future expansion. The ODC accommodates five 1:4 PLC splitters, generating 20 distribution ports. Of these, 15 ports are assigned to serve 15 Optical Distribution Points (ODPs), while the remaining five ports are reserved for future network expansion. This configuration ensures flexible network deployment and simplifies future capacity upgrades.

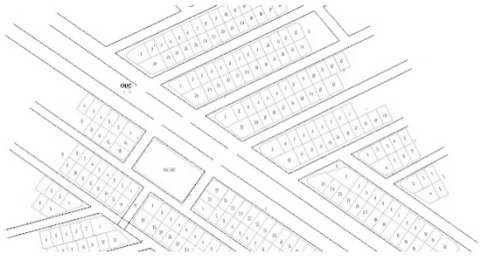

Figure 8. ODC Placement

d. ODP Placement

The Optical Distribution Points (ODPs) were strategically placed based on the distribution of homepass, distribution cable routes, and the locations of existing utility poles to minimize the required drop cable length. A total of 15 ODPs were deployed throughout Taman Asri 8 Residential Area to provide complete coverage for the 212 homepass. Each ODP was equipped with a 1:16 PLC splitter, enabling efficient optical signal distribution from the distribution network to subscribers. The selected ODP locations ensure balanced service coverage, simplify

network installation and maintenance, and provide sufficient capacity to accommodate future subscriber growth.

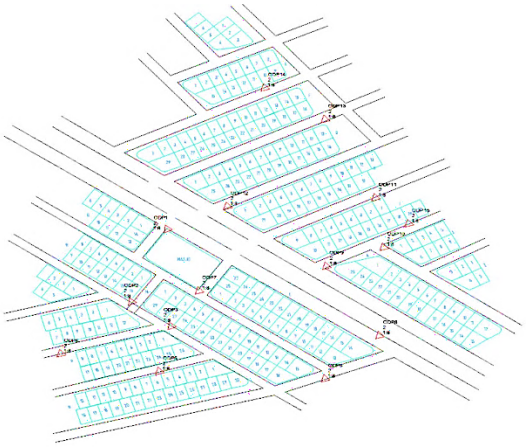

Figure 9. ODP Placement

e. Distribution Route

The distribution cable network was designed to connect the Optical Distribution Cabinet (ODC) with the 15 Optical Distribution Points (ODPs) throughout Taman Asri 8 Residential Area. The routing was developed based on the desktop survey, field survey, and the predetermined ODP locations. Aerial single-mode fiber optic cables were routed along the residential road network to facilitate installation and maintenance while utilizing the existing utility pole locations. Based on the AutoCAD design, the total distribution cable length required was approximately **1,270 m**. The designed distribution routes were used as the basis for estimating cable requirements, determining pole placement, and preparing the Bill of Quantity (BoQ) for the proposed FTTH network.

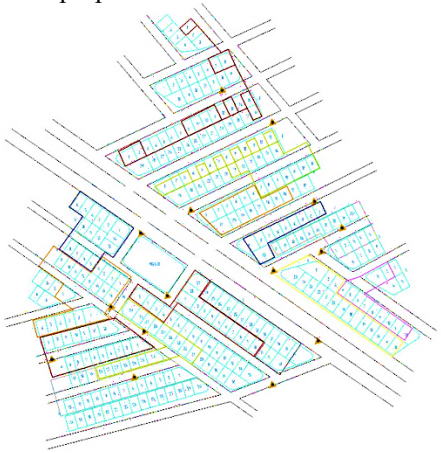

Figure 10. Distribution Cable Routing

f. FTTH Topology

The proposed network adopts a point-to-multipoint (P2MP) topology based on the Gigabit Passive Optical Network (GPON) architecture. The network consists of one Optical Distribution Cabinet (ODC) connected to the existing MyRepublic feeder network through a 1,265 m feeder cable. Five 1:4 PLC splitters installed in the ODC distribute optical signals to 15 Optical Distribution Points (ODPs) via a distribution network with a total cable length of 1,270 m. Each ODP is equipped with a 1:16 PLC splitter to distribute the optical signal to subscribers through G.657A drop cables. The proposed topology is capable of serving 212 homepass while providing an efficient network structure for future service expansion. The completed network topology was subsequently used as the basis for preparing the Bill of Quantity (BoQ) of the proposed FTTH deployment.

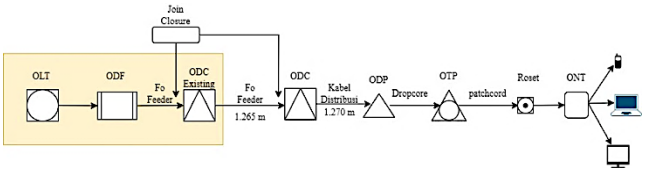

Figure 11 Proposed GPON-Based FTTH Network Topology

III. Results and Discussion

A. FTTH Network

The proposed GPON-based FTTH network was designed to serve 212 homepass in Taman Asri 8 Residential Area, Padang City. The network configuration consists of one Optical Distribution Cabinet (ODC), 15 Optical Distribution Points (ODPs), five 1:4 PLC splitters, and 15 1:16 PLC splitters. The feeder and distribution networks require 1,265 m and 1,270 m of single-mode fiber optic cable, respectively, supported by 28 feeder poles and 37 distribution poles. The proposed two-stage splitting configuration requires four GPON ports, providing a total network capacity of 256 subscribers. Since only 212 homepass are currently served, the remaining capacity of 44 subscribers can accommodate future network expansion. A summary of the proposed network design is presented in Table I, which serves as the basis for preparing the Bill of Quantity (BoQ).

Table 2. SUMMARY OF THE PROPOSED GPON-BASED FTTH NETWORK DESIGN

Parameter	Value
Homepass	212 Units
Optical Distribution Cabinet (ODC)	1 Unit
Optical Distribution Point (ODP)	15 Units
PLC Splitter 1:4	5 Units
PLC Splitter 1:16	15 Units
Feeder Cable Length	1,265 m
Distribution Cable Length	1,270 m
Feeder Poles	28 Units

Distribution Poles	37 Units
Required GPON Ports	4 Ports
Network Capacity	256 Subscribers
Active Subscribers	212 Subscribers
Spare Capacity	44 Subscribers

B. Bill Of Quantity Analysis

The Bill of Quantity (BoQ) was prepared based on the final GPON-based FTTH network design for Taman Asri 8 Residential Area, Padang City. The BoQ summarizes the types, quantities, and estimated costs of the network components required for implementation.

As presented in **Table II**, the major materials include **1,265 m of 24-core ADSS feeder cable** and **1,270 m of 48-core ADSS distribution cable**, which form the backbone of the proposed optical access network. The network also requires **one Optical Distribution Cabinet (ODC)**, **15 Optical Distribution Points (ODPs)**, **five 1:4 PLC splitters**, and **15 1:16 PLC splitters** to distribute optical signals to **212 homepass**. In addition, customer-side equipment consists of 212 Optical Network Terminals (ONTs) and patch cords, while supporting accessories such as pigtails, adapters, joint closures, protection sleeves, connectors, and cable clamps are required to ensure proper fiber termination and installation.

The estimated total cost of the proposed FTTH deployment is **IDR 232,685,624**, indicating that the largest proportion of the investment is allocated to fiber optic cables, utility poles, ONTs, and patch cords. The resulting BoQ provides a practical reference for material procurement, budgeting, and implementation planning, while also supporting future network expansion through the reserved network capacity identified in the proposed design.

IV. CONCLUSION

A GPON-based FTTH network was successfully designed for Taman Asri 8 Residential Area, Padang City, to serve **212 homepass**. Based on the proposed network design, a comprehensive Bill of Quantity (BoQ) was prepared, including the required fiber optic cables, Optical Distribution Cabinet (ODC), Optical Distribution Points (ODPs), optical splitters, Optical Network Terminals (ONTs), and supporting accessories. The Optical Line Terminal (OLT) was excluded from the BoQ because the proposed network utilizes the existing MyRepublic OLT infrastructure. The resulting BoQ provides a practical reference for material procurement, budgeting, and FTTH network implementation in the study area and can be applied as a reference for similar residential FTTH deployment projects.

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