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Analysis of ODP point placement using algorithm K-means in RW. 01 Gendongan village (case study: PT. Indomedia)

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ABSTRACT

This study discusses the placement of ODP points for designing Fiber To The Home (FTTH) networks in RW. 01 Gendongan Village using the K-Means algorithm. The purpose of this study is to facilitate the determination of the optimal location of the Optical Distribution Point (ODP) without the need for manual determination by the network designer. The initial stage of the study began with five stages, namely Determining the location of the study, Conducting surveys and data collection, Determining the location of the ODP placement using K-Means, Network design, Finished. The K-Means algorithm is used to determine the best ODP placement point after the study was conducted. The results of this study are divided into two stages, namely determining the location of the ODP placement and creating an FTTH access network scheme using Google Earth Pro software. The results obtained from using the K-Means algorithm with a value of K = 8 need to be adjusted. ODP adjustments are made to ODPs located in houses or in the middle of the road which will later be shifted to the shoulder of the road. Distribution cable design is carried out at the location of the ODP point that has been adjusted. The design of this distribution cable has 4 paths, each path has 2 ODPs. Previous research has focused on residential areas with relatively small coverage, while the current research covers a wider area, namely RW. This significant difference shows a shift in focus from a small scale to a larger scale so that it can optimize the deployment of FTTH networks in wider areas and improve more services.

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1. INTRODUCTION

The development of Information and Communication Technology (ICT) has changed connectivity in society, with the internet becoming a basic need in various aspects of life, including work, education, entertainment, and business. Therefore, the development of internet network infrastructure is a must to support this increasingly digital technology [1].

PT. Indomedia, a company engaged in the field of internet service providers and telecommunications infrastructure is committed to expanding the reach of the internet network, one of which is in RW. 01

Gendongan Village. This is a potential for the existence of FTTH Network in RW. 01 Gendongan Village because in this area has the potential to be owned by the community.

Fiber to the Home (FTTH) uses Fiber Optic media because it is very efficient, fiber optic can transmit data stably [2]. FTTH is a very important facility in society because the need for internet is very high. This FTTH technology provides benefits from both the consumer and service provider perspectives. In FTTH there is one network architecture that can be used, namely Gigabit Passive Optical Network (GPON) [3].

GPON is a communication technology that most of its transmission components use fiber optic cables [4]. Fiber optic is a type of cable made of fine plastic and glass fibers, which functions to connect between devices and users within a region. This cable usually uses light sourced from a laser or Light Emitting Diode (LED) and has a very small size of approximately 120 mm. Fiber optic is one of the transmission media that has a large bandwidth and can overcome the bandwidth problems experienced [5].

The FTTH network design process in RW. 01 Gendongan Village experienced obstacles in determining the location of the ODP point manually. To overcome this problem, the K-Means algorithm is used to facilitate the determination of the ODP point. With this algorithm, the ODP can be directly placed at the centroid point of the closest house group, without the need for manual determination by the designer.

Previous research conducted by Ridho, et al. entitled Design of Fiber to The Home (FTTH) Network in Housing in Urban Areas, discusses the design of FTTH in Urban Housing areas, this design uses aerial and duct-aerial cabling systems. The design analysis is carried out based on the parameters of link power budget, rise time, Bit Error Rate (BER). The calculation results show that the design has met the required parameters so that the designed network can be implemented [6].

According to research by Rahman, et al. entitled Design and Analysis of Fiber to The Home Networks with GPON (Gigabit Passive Optical Network) Technology in the Sragen Tengah Village Area, discussing the design of FTTH (Fiber To The Home) networks using GPON, the results of which are tested for system feasibility by looking at parameters including Link Power Budget and Rise Time Budget. The parameter values are calculated manually and will be compared with the simulation results using OptiSystem software. Then the other parameter is the Bit Error Rate (BER) for system performance. The results of manual link power budget calculations are the total attenuation produced for the furthest distance of 19.91096 dB for downstream and 4.78096 dB for upstream [7].

According to research by Fahmi Pahlawan, et al. entitled Design of Fiber To The Home (FTTH) Access Network Using Gigabit Passive Optical Network (GPON) Technology, a case study of Graha Permai Ciputat Housing, discusses Network Design using Gigabit Passive Optical Network (GPON) with the aim of modernizing the network to increase bandwidth capacity by considering the parameters of good access network feasibility such as power link budget, rise time budget and bit error rate analysis. The method used in this design is a field survey and data collection from the relevant provider to determine the type of device to be used. And in this design using auxiliary software in the form of Google Earth, AutoCAD, and OptiSys [8].

According to the research of Jasmine Firja Salsabila, et al. entitled Design of Fiber To The Home Access Network With K-Means Clustering Algorithm in Taman Anggrek Graha Padma Housing, discusses the planning of FTTH access network using K-Means algorithm in Taman Anggrek Graha Taman Padma Housing. In its analysis, the parameters observed are the correction of ODP placement location, determination of ONT grouping adjustment, length of fiber optic cable, the highest link power budget value obtained is 21.878 dB which has met the link power budget requirements [9].

According to the research of Nicholas Audric Adriel, et al. entitled Design of Fiber To The Home Access Network for Harmony Residence Jangli Housing Using K-Means Clustering Algorithm, discussing the design of FTTH access network which still has constraints in determining the location of ODP placement manually without symmetric method, and there is no membership list of prospective customer houses of an ODP based on the closest distance. The use of the K-Means algorithm in FTTH network design to group prospective customer houses into several groups of K. The results obtained are the use of the K-Means Clustering algorithm with a value of K = 4 is the most appropriate design to be implemented based on ODP occupation [10].

Based on previous studies related to the analysis of Fiber To The Home (FTTH) network design using GPON technology, a study will be conducted that discusses the Analysis of ODP Point Placement Using the K-Means Algorithm in the RW. 01 Gendongan Village Area.

2. METHOD

FTTH network is an access network that uses fiber optic as a transmission medium to be distributed to home customers with architecture and a Local Fiber Access Network (Jarlokaf) that allows the laying of optical cables very close to customers [11]. The FTTH Network Architecture can be shown in Figure 1.

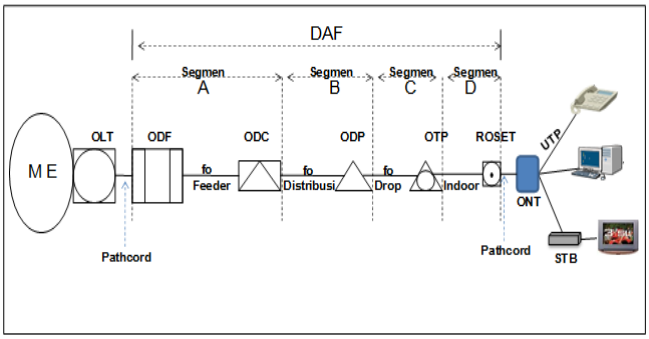

Figure 1. FTTH Network Architecture

In FTTH, optical fiber is used as a transmission medium to transfer data in the form of light. FTTH offers high speed and large capacity in the symmetrical data transfer process (download and upload) depending on the service infrastructure [12]. In addition to FTTH, there are also other technologies that utilize optical fiber to provide efficient communication services, namely GPON (Gigabit Passive Optical Network) [13].

GPON (Gigabit Passive Optical Network) is a communication network technology with high-speed fiber optic media that functions to access various communication services such as the internet, Voice over Internet Protocol (VOIP), Video Call, Internet Protocol Television (IP TV) and others [14]. GPON itself has the International Telecommunication Union of Telecommunication (ITU T) standard [15]. GPON is also known as Passive Optical LAN which has a range and internal speed exceeding Gigabit Ethernet in a LAN or Local Area Network [16].

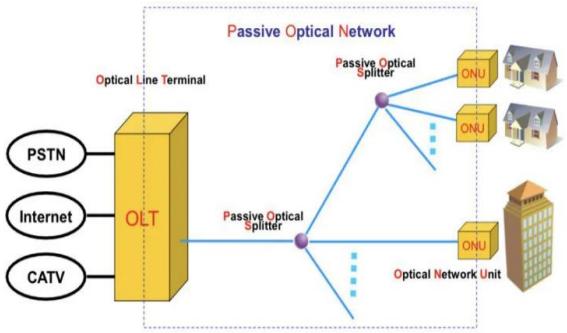

Figure 2. GPON Technology

GPON is a high-speed communication network technology that transmits data through optical fiber. The data analysis process, the K-Means algorithm is used to group data into several clusters based on similarity.

K-Means is an iterative clustering algorithm. K-Means has a function to group data into cluster data. This algorithm begins with a random selection of the value of K, K here is the number of clusters to be formed. The value of K is determined randomly and the value becomes the centroid point. The centroid is a random value from the entire initial data set, then k-means will select the components of all data and separate the data into one centroid based on the closest distance between the components and each centroid [17]. In addition to the K-Means algorithm used for data analysis, companies such as PT. INDOMEDIA also plays an important role in the field of Information and Communication Technology (ICT) which provides products and services that support internet access and network solutions.

PT. Indonesia Media Komunikasi Masyarakat Salatiga is one of the companies engaged in the field of Information and Communication Technology. Indomedia's main service products are internet access and network solutions. Indomedia has a wide and stable network to provide fast and reliable internet access. Indomedia also provides network solutions that can be used to improve the connection and security of company data. Indomedia provides various internet access packages that can be adjusted to the needs of companies or individuals through access to various types of Fiber Optic, Wireless connections [18].

The research conducted was completed through research stages which were divided into five stages, namely (1) Determining the research location, (2) Conducting surveys and collecting data, (3) Determining the location for placing ODP using K-Means, (4) Network design, (5) Finished.

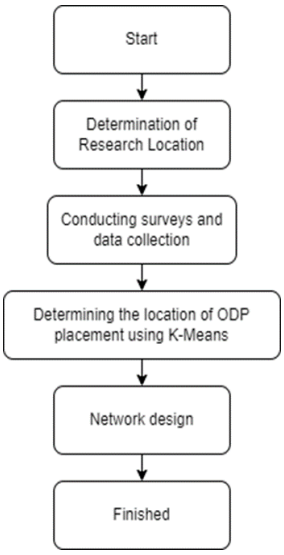

Figure 3. Research stages

The research stages in Figure 3 are explained as follows, the first stage is determining the location of the FTTH network design, the second stage is conducting a location survey and collecting data related to consumer potential, consumer location maps, and FTTH device placement points, the third stage is determining the ODP placement point using the K-Means Algorithm. The fourth stage is designing the network consisting of determining the location of the device point.

The K-Means clustering algorithm is a data grouping method that divides data into several clusters based on similarities. Here are the steps of the K-Means algorithm.

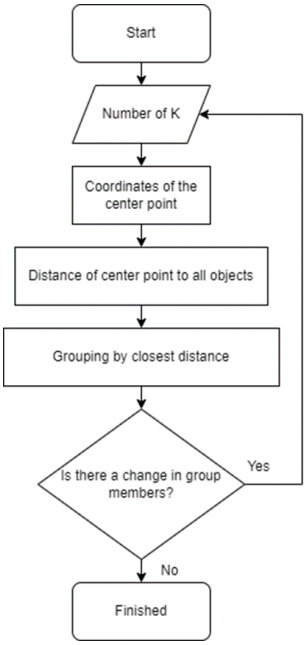

Figure 4. K-Means algorithm flow

The K-Means clustering algorithm is a data grouping method that divides data into several clusters based on similarity [8]. Here are the steps of the K-Means algorithm: the first process begins with initialization, which is determining the cluster value (K) and randomly assigning the cluster center point. Next, in the clustering stage, each data point is assigned and the distance between the data point and each centroid is calculated. The centroid point is then recalculated by taking the average of all data points that enter the cluster. In the cluster refinement stage, the clustering step is repeated until the centroid point does not change or the change is very small. The end result is a K value with each data point assigned to one of the clusters.

3. RESULTS AND DISCUSSIONS

The design of the FTTH access network is carried out using the K-Means Clustering algorithm. The steps for using the K-Means algorithm are shown in Figure 4. The design consists of two stages, namely determining the location of the ODP placement and creating an FTTH access network scheme using Google Earth Pro software. The boundaries of RW 01 can be seen in Figure 5.

Figure 5. Boundaries of RW. 01

Figure 5 is the determination of boundaries in Google Earth carried out so that in the process of designing the FTTH network it does not deviate from the design path and so that the area to be designed can be limited. Determining this location is also a reference in determining the boundaries of the FTTH access design process.

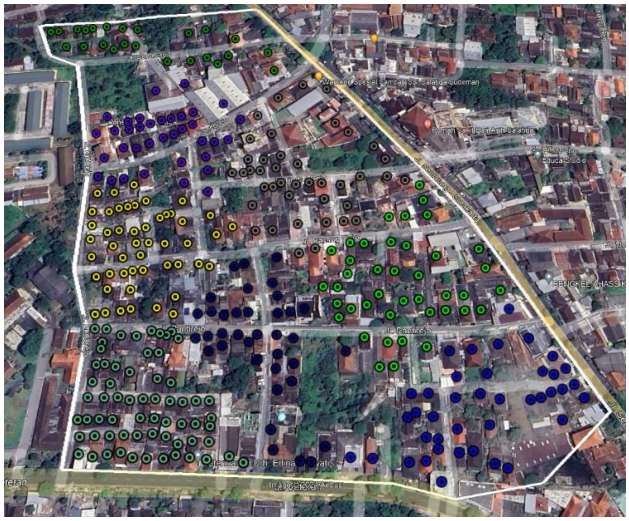

Figure 6. House location point

Figure 6 is the location point of the house in the RW. 01 area of Gendongan Village using Google Earth. The initial step that must be taken to determine the location of the ODP placement is to know the location of all the houses in RW. 01 Village.

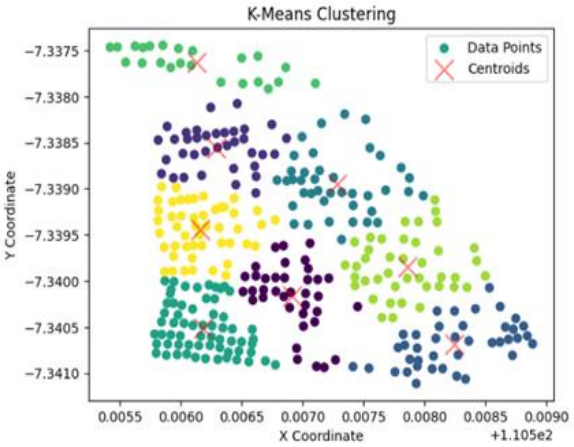

Figure 7. ODP location based on K-Means

Figure 7 is the determination of the ODP location carried out in the design using the K-Means Clustering algorithm with a value of K = 8. Determination of the number of ODPs used is based on the K Value. From the results of the K-Means algorithm, there is an ODP location in the middle of the house so it needs to be adjusted. ODP adjustments are made to ODPs located in the house building or in the middle of the road which will later be shifted to the shoulder of the road according to the ODP placement procedure. In the process of mapping the location of ODP based on the K-Means algorithm.

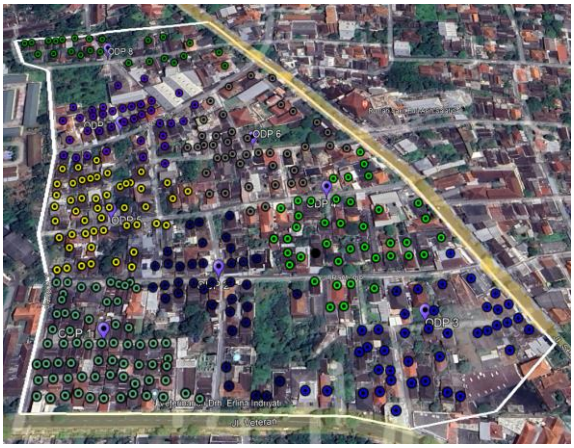

Figure 8. Final result of ODP mapping

Figure 8 is the final result of the ODP mapping process. In this mapping process, adjustments are needed. ODP adjustments are made to ODPs located in houses or in the middle of the road which will later be shifted to the shoulder of the road according to the ODP placement procedure. In the mapping process, 8 clusters are needed which are spread across the FTTH network design area.

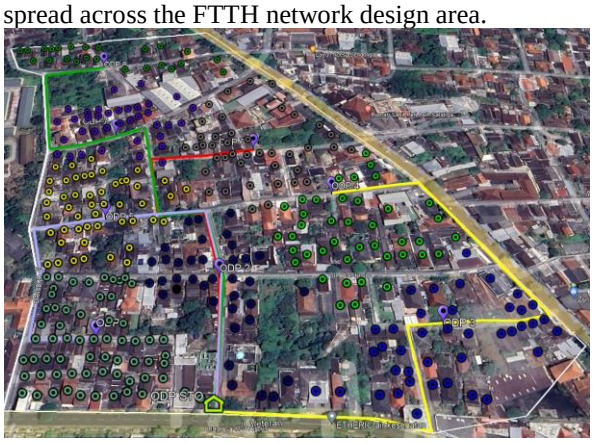

Figure 9. Overall design result

Figure 9 is the result of the distribution cable design carried out according to the layout at the RW location. 01 Gendongan Village, the first step is to border the location by determining the location of the ODP by covering according to the homepass survey in the field. In this design, there are 4 distribution cable paths, the distribution cable design is carried out on the Google Earth application. The results of the mapping of the FTTH network distribution path design in the entire area.

The results of mapping the design of FTTH network distribution routes in the entire region can be seen in Table 1.

Table 1. Description of distribution cables

Distribution Channel	Color	ODP
Distribution 1	Blue	1 and 2
Distribution 2	Yellow	3 and 4
Distribution 3	Red	5 and 6
Distribution 4	Green	7 and 8

Table 1 is an FTTH distribution path that has the following characteristics: blue is the path crossed by ODP 1 and 2, yellow is the path crossed by ODP 3 and 4, red is the path crossed by ODP 5 and 6, green is the path crossed by ODP 7 and 8.

Table 2. Latitude and Longitude Data ODP 1-8

ODP Name	Latitude	Longitude
ODP 1	7°20'22.2"S	110°30'22.4"E
ODP 2	7°20'25.6"S	110°30'22.3"E
ODP 3	7°20'26.0"S	110°30'29.7"E
ODP 4	7°20'22.0"S	110°30'28.0"E
ODP 5	7°20'24.3"S	110°30'25.0"E
ODP 6	7°20'20.2"S	110°30'26.2"E
ODP 7	7°20'19.1"S	110°30'22.6"E
ODP 8	7°20'15.8"S	110°30'22.1"E

Based on Table 2 is the sequence of ODP with latitude and longitude points, where each of these points will be used as the location of ODP placement. The K-Means algorithm helps in determining the centroid point by dividing the ODP location optimally. Based on Figure 8, this division is obtained each ODP point is already in the middle of the crowd of prospective customers so that it is easy to place and maintain the network periodically.

Table 3. Result of the distance of change points on ODP

ODP Name	Calculation Result Coordinates K-Means	Adjustment Point Coordinates	ODP Point Change Distance
ODP 1	7°20'22.0"S 110°30'22.2"E	7°20'22.2"S 110°30'22.4"E	10 meters
ODP 2	7°20'25.8"S 110°30'22.3"E	7°20'25.6"S 110°30'22.3"E	7 meters
ODP 3	7°20'26.5"S 110°30'29.7"E	7°20'26.0"S 110°30'29.7"E	15 meters
ODP 4	7°20'23.4"S 110°30'28.3"E	7°20'22.0"S 110°30'28.0"E	45 meters
ODP 5	7°20'24.6"S 110°30'24.9"E	7°20'24.3"S 110°30'25.0"E	10 meters
ODP 6	7°20'20.2"S 110°30'26.2"E	7°20'20.2"S 110°30'26.2"E	0 meters
ODP 7	7°20'18.8"S 110°30'22.7"E	7°20'19.1"S 110°30'22.6"E	10 meters
ODP 8	7°20'15.5"S 110°30'22.1"E	7°20'15.8"S 110°30'22.1"E	10 meters

Based on Table 3 shows the results of k-means calculations and the coordinates of the adjustment points are carried out to evaluate the accuracy of the k-means method. The results of this calculation show the distance of change between the coordinate points calculated using the k-means method and the actual coordinates of the adjustment points. By comparing this distance of change, it can be seen that the k-means method can determine the exact coordinates. The results of the distance of changes in the ODP point are the optimal results for network design after adjusting the ODP point.

4. CONCLUSION

Based on the design and analysis results, it can be concluded that the design of the FTTH network in the RW. 01 area of Gendongan Village, Salatiga using the K-Means algorithm with a value of K = 8 is the right design to be implemented based on the results of the ODP placement location correction analysis. The K-Means algorithm with a value of K = 8 produces an optimal ODP placement point based on the ODP points being in the middle of the crowd of potential customers. In order to support the progress and success of the FTTH network design, the author provides the following suggestions: Determining the location of the next ODP can be done using a grouping algorithm other than K-Means Clustering, and further network design can be done at the Village level with a larger number.

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