The advantage of blown fiber technology for out site plan network deployment than conventional cabled optical fiber system in Depok apartment project

Sri Priyo Hutomo¹ and Gunawan Wibisono²*

¹Postgraduate Program of Telecommunication Management, Indonesia
²Department of Electrical Engineering, Universitas Indonesia

*gunawan@eng.ui.ac.id

Abstract. The current deployment of optical fiber networks in several major cities in Indonesia is intensive. Development of fiber as the backbone or last mile for special services and almost all of us have encountered. Maybe one of them is a network deployment studio in one of the Apartment Projects in Depok City. The population of Depok reaches 4% per year higher than the national growth, the number of students and students who reach more than 80 thousand who live in Depok from only 2 campuses namely the University of Indonesia and Gunadarma University make the residential business growth both in the form of residential horizontal (boarding rooms) or vertical residential (Apartment). Developers are competing to build Apartments which, of course, are potential new revenue and new markets for Internet & Pay-TV Providers. The problem of the length of time the deployment of network infrastructure, traffic is not taken into account and still prioritizes the quality and cost that remains efficient become an issue of concern to the Provider. Blown Fiber is a new technology with four main components namely products, blowing devices, optical fiber bundles, and terminating/connecting hardware. This technology results in more cost-efficient, more flexible designs, better work costs in installation, termination and cheaper testing compared to conventional optical fiber deployment technology. The implementation of Blown Fiber in a deploying studio in one of the Apartments in Depok specifically on the Out Site Plan (OSP) turned out to provide convenience and acceleration in terms of network deployment.

1. Introduction
Depok is a buffer city of the capital city of Jakarta turns out to have a variety of potentials that are very attractive to investors to invest their capital. According to Depok BPS data for 2019, that in 2018 the population of Depok will reach 2,330,333 people, growing 3.36% or increasing 75,820 people from 2017. This growth is far above the national population growth which is under 2%. Population density also continues to increase with 11,635 people per km² in 2018 compared to 2017 amounting to 11,256 people / km² [1].

With Gross Regional Domestic Product (GRDP) which reached 7.28% in 2017 even above Bekasi City and Karawang which incidentally is the City of Industry. Depok has economic growth that continues to increase from 6.65% to 6.83% higher than the national economic growth which only reached 5.17%.
As a city that is also an education city, Depok is a destination for urbanization, especially for students and academics. The existence of several campuses made major contributions including the University of Indonesia, Gunadarma University, Jakarta State Polytechnic (PNJ), Jayabaya University, and STIE Fajar. In 2017, new students from the five tertiary institutions reached 25,698 people with a total of 5327 lecturers. From commuter line data for Jakarta-Bogor commuters in 2018 which rose from stations close to the campus including the University of Indonesia Station reaching 3,160,424 or 8,659 passengers per day, and Pondok Cina Station reaching 6,956,452 or 19,059 passengers per day.

The area of Depok City is represented by the Beji District with an area of 14.56 km² and Pancoran Mas 18.06 km² which is located along the Margonda road as far as 5 km. Topology with the existence of wide road infrastructure along Margonda with each row of roads can fit 3 four-wheeled vehicles. The road made of a concrete foundation with the asphalt layer is neatly laid out. This has made several local and national developers invest their capital to make residential vertical residential (apartment) and currently 7 apartments are already up and running and some are in the process of operational finalization.

Along with the growth of Apartments, the need for High-Speed Internet facilities using WIFI in Rooms and Public Areas Units, Pay TV Services, and CCTV for Managers. This makes the Internet Provider get new revenue potential with various profitable business models with Management. It's just that the condition of road infrastructure in Depok City that has been built is good, of course, it requires a network deployment methodology both Out Side Plan or In Building that does not interfere with heavy traffic, which still gives a sense of aesthetics and does not seem patchy and of course the deployment time rapid and normalized the results of a neat and certainly efficient deployment in terms of cost of deployment.

Depok City Regional Regulation Number 02 of 2012 concerning the Implementation of Transportation Sector [2], Second Paragraph on Use and Equipment of Roads in particular Articles 11 and 12 which discusses the excavation of land and materials that have the potential to cause traffic disruptions that must obtain recommendations from the Dinas. Even if negligent, it is possible to be imprisoned or fined according to Law Number 22 of 2009 concerning Road Traffic and Transport.

In this Journal, the discussion will focus on how the methodology of deploying fiber optic networks, especially by using Blown Fiber Solution compared to Conventional Deployment, so that it is still able to provide quality from the network, but can provide efficiency both in terms of deployment costs or the length of implementation time, not too disturbing traffic and ease of network development in the future.

2. Literature Study

2.1. Gigabit Passive Optical Network (GPON)
It is one of the technologies from ITU-T via G.984 as Figure 1. Currently, it is quite dominating the market because the realization of deployment or roll out when compared with other technologies such as GEPON is much faster.

GPON uses WDM techniques for upstream and downstream and those that use TDMA as multiple access upstream (wavelength 1310) technique with a data rate of 1.2 Gbps and uses broadcasts downstream (wavelength 1490 & broadcast wavelength 1550) with a data rate of 2.5 Gbps [3].
Mahmoud M Al-Quzwini [5] said that the design and implementation of GPON B-based FTTH access networks to serve 1000 customers, using a bottom-up procedure where the size of the network and components are adjusted to the conditions of location, geographical separation, and supporting infrastructure which exists. This is to get the OSP design through physical surveys for each root to strengthen the initial survey desk. So that there will be no waste in terms of time and costs later. Illustration of OSP (Out Side Plan) architectural design from GPON as presented by Figure 2 below:

2.2. Blown Fiber Technology
Relative is still not widely used in the current Optical Fiber deployment process. The existence of fiber deployment development and at the same time minimization of traffic disruptions along with the many fiber projects both by providers, operators or institutions. Starting with the many local regulations that highlight the potential disruption and the length of the process of deploying fiber optic networks, making this technology an alternative method of deployment that has the potential to provide efficiencies both in terms of material and service costs [9]

There are 4 main things related to blown fiber technology [8] including:
1. Products of Blown Fiber
   a. For Burial InstaTellation
      • TWD (Thicwalled Duct) such as Figure 3.
      • DB (Direct Burial)
      • FD (Folding Duck) and LD (Linked Duct)
b. For Aerial Installation
   • AD (Aerial Duct)

c. The PVC/PE Pipeline
   • DI (Duct Instal) such as Figure 4.

d. In-Building Network
   ❖ LSZH (Low Smoke Zero Halogen) such as Figure 5.

2. Blowing Devices, namely Fiber Blower Motors with various models and powers of Power
   The power which is tailored to the needs in the process of deploying Blown Fiber such as
   Figure 6 and Figure 7 below:

   a. Figure 6. Plumettaz Minijet with installation for 0-100 m per minutes
   b. Figure 7. Plumettaz PRM 196 with installation 0-50 m per minutes

3. Fiber Optic Bundle. The differentiation of the type of duct and microduct such as Figure 8.

   a. Figure 8. Differentiation of Sum of Support Cables between Conventional Duct (cable) and Microduct (Air Blown Cable)

4. Terminating/connecting hardware. Some closure hardware such as Figure 9 dan Figure 10.
3. Survey and Comparison Design

3.1. Hard Survey & Desk Survey

Based on field surveys several things are obtained regarding the condition of the apartment, in terms of market potential, targeted segmentation, number of towers and units sold including price estimates and field conditions related to the need for network deployment such as tower configuration, network to be used, the cable drop and wiring methods used, as well as existing provider potentials, as shown in Figure 11.

Create a High-Level Design (HLD) where several important things are seen are the potential for OSP deployment from the Head Office Provider to the Handhole in front of the Apartment near 2000 m, and in the Building from the Handhole in the front of the Apartment to the ODF Room The 200m ODT Provider is provided as follows.

As per Figure 12, it is said that each floor will be placed massing each ODP (Optical Distribution Point), while with Microduct to each floor with 48 ports. This is related to the condition of the Apartment as many as 1300 home pass, with 650 home pass each. With the height of the apartment reaching 21 floors, so there are 31 floors per floor. The placement of the ONT (Optical Network Terminal) will be placed in each room later.
3.2. Comparison Deployment OSP by Conventional vs Microduct (Blown Fiber Application)

The OSP distance that reaches 2000 m is a very busy road and has a physical contour road that is relatively straight with concrete rebates coated by asphalt. Regarding OSP design, there are 2 conditions that can be assessed in terms of efficiency, namely:

A. Conventional OSP Design with OSP Design that uses Blown Fiber Technology
B. Standard OSP design using either Duck or Microduct

There are 4 main components in identifying Costs in this OSP deployment, namely:
1. Manhole / Handhole & Related Cost
2. Duck Installation Cost
3. Fiber Cable Installation Cost
4. Fiber Splice & Related Cost

3.2.1. Design of OSP FTTH Conventional. The OSP concept and Distribution design for deploying Optical Fiber with Conventional Methods as presented in Figure 13 and Figure 14 as below:

![Figure 13. Conventional Design Assumptions for Feeder (OSP) and Distribution (Access) for 1300 subscribers](image)

![Figure 14. Conventional OSP Network Design for support 1300 subscriber](image)

3.2.2. Design by OSP FTTH by Blown Fiber Solution (Microduct Application). The OSP concept and Distribution design for deploying Optical Fiber with Blown Fiber Methods as presented in Figure 15 and Figure 16 below:

![Figure 15. Blown Fiber Design Assumptions for Feeder (OSP) and Access for 1300 subscribers](image)

![Figure 16. Blown Fiber OSP & Access Network Design for 1300 subscribers.](image)
Based on the evaluation of each Cost Component incurred, the following table is obtained: First calculation, with network engineering from the OSP and Access Network Design side. This is by seeing that there are many other potential targets around the intended apartment. There are 3 other apartments at a distance of less than 1 km from the location of the Central Office that allows it to be optimized as well, as well as several potentials such as several large cafes, hospitals, and government offices that also allow being explored. This is expected to further improve efficiency in capital costs and also allow for a shorter payback period. The calculation results as presented in Table 1 below:

Table 1. Result of First Calculation OSP Conventional vs OSP Blown Fiber Technology

| Scope of Work | Work | Quantity | Material per Unit | Labor per Unit | Material Cost | Labor Cost | Conventional Cost Total | Blown Fiber Cost Total |
|---------------|------|----------|-------------------|---------------|--------------|-----------|-------------------------|-----------------------|
| **Manhole & Related** | Handhole Installation per 1000 m | 3 pcs | 12.149.514 | 3.624.786 | 36.448.542 | 10.874.358 | 47.322.900 |
| | Manhole Installation per 250 m ODC | 16 pcs | 12.149.514 | 3.624.786 | 194.392.224 | 57.996.576 | 252.388.800 |
| | Installation ODP | 1 pcs | 14.323.070 | 5.444.822 | 14.323.070 | 5.444.822 | 19.767.892 |
| | Installation | 8 pcs | 1.385.880 | 131.885 | 11.087.040 | 1.055.080 | 12.142.120 |
| **Duct Installation** | Microduct Laying DB 7 way 12/10 mm | 4000 meters | 54.929 | 4.469 | 219.716.000 | 17.876.000 | 237.592.000 |
| | Microduct Laying DB 7 way 12/10 mm | 900 meters | 54.929 | 4.469 | 49.436.100 | 4.022.100 | 53.458.200 |
| | Microduct Laying DB 7 way 12/10 mm | 10000 meters | 54.929 | 4.469 | 549.290.000 | 44.690.000 | 593.980.000 |
| | PVC Duct Laying 100 mm | 5700 meters | 54.900 | 4.000 | 312.930.000 | 22.800.000 | 335.730.000 |
| | Inner Duct Laying 4x | 5700 meters | 18.000 | 4.000 | 102.600.000 | 22.800.000 | 125.400.000 |
| | PVC Duct Laying 50 mm | 10000 meters | 54.900 | 4.000 | 549.000.000 | 40.000.000 | 589.000.000 |
| | Microduct Connection 5/2.5 mm | 6 pcs | 25.172 | 502 | 151.032 | 3.012 | 154.044 |
| | Microduct Connection 12/10 mm | 4 pcs | 25.021 | 468 | 100.084 | 1.872 | 101.956 |
| | Tube Connector | 210 pcs | 16.000 | - | 3.360.000 | - | 3.360.000 |
| | End Cap | 300 pcs | 13.044 | 468 | 3.913.200 | 140.400 | 4.053.600 |
| **Fiber Cable Installation** | Air Blown Cable (ABC) blowing 144 core | 4000 meters | 35.500 | 3.500 | 142.000.000 | 14.000.000 | 156.000.000 |
| | Air Blown Fiber (ABF) blowing 24 core | 4000 meters | 11.296 | 3.297 | 45.184.000 | 13.188.000 | 58.372.000 |
| | Air Blown Fiber (ABF) blowing 2 | 10000 meters | 2.204 | 2.327 | 22.040.000 | 23.270.000 | 45.310.000 |
FO Cable Pulling 144 core
5700 meters 45.100 4.000 257.070.000 22.800.000 279.870.000
FO Cable Pulling 24 core
1700 meters 15.500 4.000 26.350.000 6.800.000 33.150.000

| Fiber Cable Installation | FO Cable Drop Pulling 2 core | 10000 meters | 6.500 | 4.000 | 65.000.000 | 40.000.000 | 105.000.000 |
|--------------------------|-----------------------------|--------------|-------|-------|------------|------------|-------------|
| Fiber Splice 144 core     |                             |              |       |       |            |            |             |
| Fiber Splice 24 core      |                             |              |       |       |            |            |             |
| Fiber Splice 144 core     |                             |              |       |       |            |            |             |
| Fiber Splice 144 core     |                             |              |       |       |            |            |             |
| Fiber Splice 13-24 core   |                             |              |       |       |            |            |             |
| FO Closure Installation 1 pcs |                         | 2.750.000 | 75.000 | 2.750.000 | 75.000 | 2.825.000 |
| FO Closure Installation 17 pcs |                     | 2.750.000 | 75.000 | 46.750.000 | 1.275.000 | 48.025.000 |
| Installation OTP          |                             | 100 pcs      | 1.840.000 | 150.000 | 184.000.000 | 15.000.000 | 199.000.000 |
| Installation Water Block Plug |                         |              |       |       |            |            |             |
| Installation Optical termination outlet Rowset | | 64 pcs | 2.750.000 | 75.000 | 275.000.000 | 7.500.000 | 282.500.000 |
| Pigtail                   |                             | 414 pcs      | 65.000 | 26.910.000 | - | 26.910.000 |
| Pigtail                   |                             | 296 pcs      | 65.000 | 19.240.000 | - | 19.240.000 |
| Jumper Cord               |                             | 100 pcs      | 156.000 | 15.600.000 | - | 15.600.000 |
| Jumper Cord OFD Installation OFD | | 100 pcs | 156.000 | 15.600.000 | - | 15.600.000 |
| Installation Splice Termination 24 core | | 1 pcs | 13.620.000 | 75.000 | 13.620.000 | 75.000 | 13.695.000 |
| Installation Splice Termination Splice Termination | | 1 pcs | 13.620.000 | 75.000 | 13.620.000 | 75.000 | 13.695.000 |
| Splice Termination 24 core |                             | 208 pcs      | 65.000 | 13.520.000 | - | 13.520.000 |
| Splice Termination 144 core |                             | 144 pcs      | 65.000 | 9.360.000 | - | 9.360.000 |
| Splice Termination 12 core |                             | 200 pcs      | 65.000 | 13.000.000 | - | 13.000.000 |
| Splitter 1:8               |                             | 1 pcs        | 682.000 | 682.000 | 682.000 | 5.456.000 | 5.456.000 |
| Splitter 1:8               |                             | 8 pcs        | 682.000 | 5.456.000 | - | 5.456.000 |
| Splitter 1:8               |                             | 16 pcs       | 682.000 | 10.912.000 | - | 10.912.000 |

Total Conventional vs Blown Fiber (Microduct) Technology - OSP Deployment Cost 2,168,750,800 1,529,192,712

The second calculation is to use the OSP Design Standards only to bridge one apartment only, in accordance with the High-Level Design in the Figure above. Based on these data finally, the
calculation results can be obtained by referring to the number of 1300 home pass which will be supported later. Detailed calculation results as in Table 2

| Table 2. Result of Second Calculation Conventional Cost vs OSP Blown Fiber Technology |
|---------------------------------------------------------------|
| **Scope of Work** | **Work** | **Quantity** | **Material per Unit** | **Labor per Unit** | **Material Cost** | **Labor Cost** | **Conventional Cable Cost** | **Blown Fiber Cost** |
|---------------------------------------------------------------|
| **Manhole & Related** | Manhole/Han dhole Installation 145x145x145 | 8 pcs | 3.500.000 | 3.000.000 | 28.000.000 | 24.000.000 | 52.000.000 | 52.000.000 |
| | Manhole/Han dhole Installation ODC Installation | 16 pcs | 3.500.000 | 3.000.000 | 56.000.000 | 48.000.000 | 104.000.000 | 104.000.000 |
| | Manhole/Han dhole Installation ODP Installation | 1 pcs | 14.323.070 | 5.444.822 | 14.323.070 | 5.444.822 | 19.767.892 | 19.767.892 |
| | Duct Installation | 8 pcs | 1.385.880 | 131.885 | 11.087.040 | 1.055.080 | 12.142.120 | 12.142.120 |
| | Manual Boring (Rojog) Installation | 2000 metres | 145.000 | - | 290.000.00 | 0 | 290.000.00 |
| | Manual Boring (Rojog) Installation | 2000 metres | 215.000 | - | 430.000.00 | 0 | 430.000.00 |
| | Manual Boring (Rojog) Installation | 2000 metres | 115.444 | - | 230.888.51 | 4 | 230.888.51 |
| | Manual Boring (Rojog) Installation | 2000 metres | 120.722 | - | 241.444.00 | 0 | 241.444.00 |
| | Manual Boring (Rojog) Installation | 2000 metres | 54.929 | 4.469 | 109.858.000 | 8.938.000 | 118.796.000 |
| | Manual Boring (Rojog) Installation | 2000 metres | 54.929 | 4.469 | 10.985.800 | 893.800 | 11.879.600 |
| | Microduct Laying for Feder (OSP) Microduct Laying for Distribution | 2000 metres | 25.021 | 468 | 100.084 | 1.872 | 101.956 |
| | Microduct Laying for Feder (OSP) Microduct Laying for Distribution | 2000 metres | 16.000 | - | 3.360.000 | - | 3.360.000 |
| | Microduct Connection | 300 pcs | 13.044 | 468 | 3.913.200 | 140.400 | 4.053.600 |
| | Microduct Connection | 210 pcs | 16.000 | - | 3.360.000 | - | 3.360.000 |
| | Microduct Connection | 300 pcs | 13.044 | 468 | 3.913.200 | 140.400 | 4.053.600 |
| | Air Blown Cable (ABC) blowing & Installation | 2000 metres | 35.500 | 3.500 | 71.000.000 | 7.000.000 | 78.000.000 |
| Fiber Cable Installation | Air Blown Fiber (ABF) blowing & Installation 200 metres | 11.296 | 3.297 | 2.259,200 | 659.400 | 2.918,600 |
|-------------------------|----------------------------------------------------------|--------|-------|-------------|---------|-----------|
| Fiber Cable Installation | Air Blown Fiber (ABF) blowing & Installation 100 meters | 2.204 | 2.327 | 220.400 | 232.700 | 453.100 |
| FO Cable Pulling & Installation 2180 metres | 45.100 | 4.000 | 98.318,000 | 8.720,000 | 107,038,000 |
| FO Cable Pulling & Installation 1870 metres | 15.500 | 4.000 | 28.985,000 | 7.480,000 | 36,465,000 |
| FO Cable Pulling & Installation 10000 metres | 6.500 | 4.000 | 65.000,000 | 40,000,000 | 105,000,000 |

| Fiber Splice & Related | Fiber Splice at ODF CO 144 core | 65.000 | - | 9.360,000 | 9.360,000 | 9.360,000 |
|------------------------|-------------------------------|--------|-----|-----------|-----------|-----------|
| Fiber Splice at ODF Apartment 144 core | 65.000 | - | 9.360,000 | 9.360,000 | 9.360,000 |
| Fiber Splice Optical Distribution Point Installation 408 core | 65.000 | - | 26,520,000 | 26,520,000 | 26,520,000 |
| Pigtail 192 pcs | 65.000 | 12,480,000 | - | 12,480,000 | 12,480,000 |
| Jumper Patch Cord 2 m 3 pcs | 83.961 | 2.930 | 251.883 | 8.790 | 260,673 | 260,673 |
| Splice Termination 144 core | 65.000 | - | 9.360,000 | 9.360,000 | 9.360,000 |
| Splice Termination 144 core | 65.000 | - | 9.360,000 | 9.360,000 | 9.360,000 |
| Splice Termination 21 pcs | 65.000 | - | 1.365,000 | 1.365,000 | 1.365,000 |
| Splice Termination 24 pcs | 65.000 | - | 1.560,000 | 1.560,000 | 1.560,000 |
| Splice Termination 36 pcs | 65.000 | - | 2.340,000 | 2.340,000 | 2.340,000 |
| Splitter 6 pcs | 25.172 | 502 | 151.032 | 3.012 | 154,044 |
| Splitter 4 pcs | 25.021 | 468 | 100.084 | 1.872 | 101,956 |
| Splitter 3 pcs | 682,000 | 2,046,000 | - | 2,046,000 | 2,046,000 |
| Splitter 21 pcs | 682,000 | 14,322,000 | - | 14,322,000 | 14,322,000 |

Total Comparison OSP Deployment Cost - Conventional Cable vs Blown Fiber 1,730,415,658 1,264,458,072

4. Implementation Result

4.1. Deployment OSP and In-Building for Depok Apartment
OSP and In-Building Network deployment using Blown Fiber Technology has previously been carried out in a deployment in the city of Depok for backbone especially in Margonda Street. Local regulations in Depok Rule which are quite strict make it necessary to use a clean deployment method, not much garbage, and not too much to disrupt the traffic flow which is quite dense. The type of road is a combination of asphalt-lined concrete roads with dirt roads so the method used is a combination of the use of Trenching Methods and Rojok Methods such as Figure 17 and Figure 18.

**Figure 17.** Rojok Pulling Methods for Deployment at Soil Street at ODC at one of Depok Residential Complex.

**Figure 18.** Trenching Methods for ideal Deployment at Beton with Asphalt Concrete at Depok

While on the Margonda Depok road, the condition of the concrete road with Asphalt layer and very heavy traffic certainly requires the acceleration of planned network deployment treatment. The efficient use of Blown Fiber will later be used as the last mile of internet and multimedia networks in the XYZ Apartment adjacent to University of Indonesia Station.

Performing methods performed include:

a. Microduct Installation, Pulling Withdrawal Cable (Microduct 7 way) with Trenching Methods using Trenching Machine that will cut the asphalt path and make the Trench Area either Mini or Micro Area as in Figure 19 and 20.

**Figure 19.** Pulling cable with Trenching Methods. Cut the asphalt with Trench Machine to build Trench Area and Pull the Duct / Microduct inside

**Figure 20.** Trench Area for width 8010 cm and Depth 30 cm

b. Backfilling with Mortar and road compaction. With this condition process road normalization can run quickly, does not disrupt traffic flow and is clean from earth excavation as presented by Figure 21.

**Figure 21.** Backfilling and normalize Trench Area with Mortar (K250 Concrete) and grout hot/cold Asphalt
4.2. Result of Calculation

Based on the results of identification using Table 1 and Table 2 in page 6-7, the final results of the calculation can be taken as stated below:

**Table 3. Cost Calculation Result with Network Design Engineering**

| Component of Cost         | Conventional Cable | Blown Fiber       | Efficiency of Cost (%) |
|---------------------------|--------------------|-------------------|------------------------|
| Mainhole & Related Cost   | 252,388,800        | 79,232,912        | 69%                    |
| Duct Installation Cost    | 1,050,130,000      | 892,699,800       | 15%                    |
| Fiber Cable Installation Cost | 418,020,000      | 259,682,000       | 38%                    |
| Fiber Splice & Related Cost | 373,643,300       | 297,578,000       | 20%                    |
| **Grand Total**           | **2,094,182,100**  | **1,529,192,712** | **27%**                |

From table 3, each cost component turns out to show the existence of cost efficiency, where the highest is the efficiency on the Manhole & Related Cost side which reaches 69% this is due to the use of handholes that are more efficient in terms of numbers, compared to the use of Manholes which are numerous in the pattern conventional deployment, along with the amount of potential that exists. While the cost efficiency of Fiber Cable Installation is due to the relatively lower price of Microduct due to the far more number of cables from Microduct (can be a maximum of 21 pieces) compared to conventional Duct models which can only be a maximum of 4 cables. While the Duct Installation efficiency is due to the process of manual boring and the normalization of the results of the excavation is assessed using a lot of labor, a relatively long time, and the amount of material for road normalization. This is compared to the efficient trenching method in terms of labor, shorter time, and less excavated cover material due to the not large cutting area of the road such as boring manual/corner. In the fiber splice cost component, there are only a few savings from a large amount of material and splicing costs.

In table 4, data processing uses Standard Design, Manhole and Fiber splice costs because the number and type of materials are the same, so the cost is calculated equally between conventional and blown fiber usage. The biggest difference and efficiency in terms of the difference in cable length and the amount of cable content. Cable length for conventional usually requires a long cable reserve (5-10%) related to the boring boring / contour excavation contour sometimes uneven, while the trenching method can predict the cable length relative to the distance of the CO to the handhole Apartment or for In-Building purposes because the excavation depth can be considered straight because it is only 30-50 cm deep from the height of the road body. Another efficiency is in terms of the majority of Duct Installation due to the normalization process of excavation due to boring excavation on asphalt concrete road with a depth of up to 1.5 m, and this requires expensive normalization and road repair costs because the amount of material for filling the concrete and asphalt coating is back more many.

**Table 4. Cost Calculation Result with Standard Design OSP**

| Component of Cost         | Conventional Cable | Blown Fiber       | Efficiency of Cost (%) |
|---------------------------|--------------------|-------------------|------------------------|
| Mainhole & Related Cost   | 187,910,012        | 187,910,012       | 0%                     |
| Duct Installation Cost    | 909,760,000        | 610,677,714       | 33%                    |
| Fiber Cable Installation Cost | 248,503,000      | 81,371,700        | 67%                    |
| Fiber Splice & Related Cost | 384,242,646       | 384,498,646       | 0%                     |
| **Grand Total**           | **1,730,415,658**  | **1,264,458,072** | **27%**                |

Either using each OSP & Access Design that is adapted to the Conventional Method and the Blown Fiber Method with Network Engineering or using the OSP Standard Design it turns out that both provide relatively the same efficiency figures of 27% for Blown Fiber Technology.
5. Conclusion
Some conclusions based on studies comparing between Conventional Cable and Blown Fibre Solution, that The Blown Fiber Solution is more flexible starting from the Central Office, ODF, ODP (OSP and Inbuilding) does not require too many connectors so it can be more efficient on the material side, more highly efficient infrastructure cause in the same diameter could be support more than 5 times potential customer to support, cost effective in network construction design cause the initial investment value or future development to be smaller and more simple deployment with blowing machine, and reduction the number of distribution and splicing point.

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References
[1] Statistics of Depok Municipalty 2019 *Depok Municipalty in Figure* (Depok: Statistics of Depok Municipality)
[2] Peraturan Daerah Kota Depok 2012 *Penyelenggaraan Bidang Perhubungan* (Depok: Lembaran Daerah Kota Depok) No 2
[3] G. Keiser 2000 *Optical Fiber Communication* (New York: McGraw-Hill)
[4] David F. Edwards 1985 “*Silicon (Si)*” in *Handbook of optical constants of solids* (Orlando: Academic).
[5] Mahmoud M Al-Quzwin 2014 *Design and Implementation of Fiber to the Home FTTH Access Network based on GPON* (Baghdad: International Journal of Computer Applications) vol 92 No 6
[6] A.A.A. Bakar, M.Z. Jamaludin, F. Abdullah, M.H. Yaacob, M.A. Mahdi, and M.K. Abdullah A new technique of real-time monitoring of fiber optic cable networks transmission (Malaysia: Elsevier) Optics and Lasers in Engineering vol. 45, pp. 126-130, 2007
[7] F. Ladouceur and J. D. Love, *Silica-based buried channel waveguides and devices* (Chapman & Hall, 1995), Chap.8.
[8] Hornung, Cassidy, Yennadhiou, Reeve 1986 *The Blown Fiber Cable* (England: IEEE) Vol 4.
[9] KNET 2013 *Microduct Technical Guide* (New Jersey: KNET) ver 2.0
[10] KNET, 2012, *Air Blown Total Solution for Fiber Optic* (New Jersey: KNET)