Analysis of Land Potential for Infrastructure Development of Natural Gas Distribution Pipeline for Households in Bekasi Regency, Indonesia

L. Rosmayati¹, M. Eviani¹, D. Kurniawan¹, L. Lusyana¹, M. D. Atmanto¹

¹Pusat Penelitian dan Pengembangan Teknologi Minyak dan Gas Bumi, Indonesia

Email: lisna.rosmayati@esdm.go.id

Abstract. Priority locations and land for the construction of households natural gas connections in Bekasi Regency are determined based on considerations of regional topography, potential number of household customers (population or household density), proximity to gas tapping point and the absence of installed Jargas, and Bekasi Regency Regional Regulation No. 12 of 2011 concerning Spatial Planning (Rencana Tata Ruang Wilayah) for Bekasi Regency. Prior to the technical design of natural gas pipeline, land mapping was carried out with a geographic information system containing surface spatial data. Geospatial data analysis is used to identify potential locations as natural gas tapping points, locations to place Metering Reduction Stations (M/RS) and Regulating Sector (RS), as well as potential crossing locations in the design of natural gas distribution pipelines. Subsequently, a verification survey was conducted on the results of the geospatial data analysis which was compared with conditions in the field.

Keywords: Land potential, natural gas pipeline, Bekasi

1. Introduction

The availability of gas infrastructure is an important policy in maintaining energy security and supporting the implementation of national development. To accelerate the development of such infrastructure, it is necessary to take comprehensive and appropriate steps according to the characteristics of the area to be built [1]. The construction of gas lines by the Ministry of Energy and Mineral Resources (ESDM) has been started since 2009. Gas distribution pipelines or gas distribution pipelines are one of the most important components in development activities, especially equitable development in the territory of Indonesia 8, including in Bekasi Regency. The plan to build a gas network in Bekasi Regency is carried out in an effort to support the government's program in realizing a natural gas energy mix of up to 33% in 2025 [2]. In addition, the construction of a natural gas network is carried out to realize national energy security and support energy diversification programs in reducing dependence on imported LPG [3].

Bekasi Regency has a topography which is divided into two parts, namely lowlands which cover part of the northern part and undulating plains in the southern part [4]. The southern part includes Setu District and Serang District. Most of Bekasi Regency is on a slope of 0-25%, while the elevation of the northern part is flatter, starting from the north of the toll road to the
coast having a height of ± 20 m to 0 from the average sea level. Thus, with this topography, Bekasi Regency is still possible for the development of various types of infrastructure activities [5].

Geospatial technology continues to grow and is very useful for development purposes related to geographic location and infrastructure [6]. The natural gas network is able to provide regional spatial information through an approach that can be described in the form of several layers or geospatial data coverage [7]. In the planning stage, a preliminary study is carried out with the scope of discussion, one of which is a needs analysis related to the plan for the natural gas pipeline to be built and its requirements. In the planning stage of gas network infrastructure development in Bekasi district, primary and secondary data are needed, where primary data will be obtained by surveying the destination location for gas network development. Survey and mapping of the situation at the planned location must be clear and measurable to provide a clear picture of the pipeline plan [8]. The survey was conducted to measure the length of the road, identify the number of crossings and the number of houses to be mapped. The mapping carried out is in the form of high-resolution imaging that makes it easy for users to recognize objects in the field. The mapping produces a clear picture of the building parcels, roads, and land use at the survey site [9].

A map is a picture of natural elements and/or artificial elements, which are above or below the earth's surface depicted on a flat plane with a certain scale. A village map is a basic thematic map containing elements and information on regional boundaries, transportation infrastructure, toponyms, waters, infrastructure, land cover and land use presented in image maps, maps of facilities and infrastructure, as well as land cover and use maps. While the image map is a map that displays some of the elements of Indonesia's earth on an upright image which includes aerial photos or high-resolution satellite imagery [10].

2. Data and Methods

Spatial data needs in Bekasi Regency include high-resolution image data, regional administration maps, topographic maps, regional spatial planning maps, and maps of gas pipelines that have been installed. Primary data acquisition by conducting a survey to the Bekasi Regency area aims to identify locations that have the potential as natural gas tapping points, the location of the placement of Metering Reduction Stations (M/RS) and Regulating Sector (RS), as well as locations that have the potential for crossing in the design of distribution pipelines. Natural gas. Subsequently, a verification survey was conducted on the results of geospatial data analysis with conditions in the field.

The technique used in determining the length of the pipeline is a Geographic Information System (GIS) which consists of hardware, software, geographic data, and human resources that work together effectively to enter, store, repair, update, manage, manipulate, integrate, analyze and display data in a geographic-based information.

In the selection of land locations that are the targets for the construction of household gas connections, MRS, and hospitals, a mapping of the gas grids that have been built and the villages/villages that are close to the gas grids is carried out, as well as counting the number of households that have the potential to build gas grids in the selected location. Figure 1 shows the following scheme showing the method of selecting a location in a Regency or City that will be the target of developing a gas connection for households. The first stage is to choose the location of the sub-district closest to the installed gas line using a layer model. The first layer is the location of the sub-district that is in direct contact with the installed gas line. The next layer is the layer directly adjacent to the district in the first layer, and so on. If the number of household connections in the first layer meets the targeted number of household connections, then the sub-district location will be taken only in the first layer. However, if in the first layer the number of household connections has not met the target, the sub-district will be taken in the second layer and so on. The collection of potential household connections per layer is of course
also carried out by considering several criteria, namely considerations of topography, household density and the absence of installed natural gas pipeline.

![Site Selection Method](image1.png)

**Figure 1.** Site Selection Method

Based on these considerations, there are 9 sub-districts (covering 41 villages/kelurahan) which are the main priorities in the construction of gas pipelines in Bekasi Regency, namely Central Cikarang, East Cikarang, North Cikarang, West Cikarang, South Cibitung Tambun, Sukatani, Karang Bahagia, and North Tambun. The potential number of house connections from these sub-districts is 404,865 SR, as shown in Figure 2.

![Map of Potential Locations for Household Jargas Development in Bekasi Regency](image2.png)

**Figure 2.** Map of Potential Locations for Household Jargas Development in Bekasi Regency
2.1 Measurement of Low-Pressure Distribution Pipe Length

Low pressure natural gas distribution network, supplied from medium pressure distribution network, through RS. From the RS, the pressure of natural gas is lowered from 4 Barg to 100 mBarg. Table 1 below is the result of measuring the length of the low-pressure distribution pipe using the following formula:

\[
\text{Panjang Pipa} - i = \left( \frac{\text{Kepadatan} - i}{\text{Kepadatan} - r} \right)^{\text{Selesaikan}} \times \frac{i}{\text{Jumlah KK} - r} \times \text{Panjang pipa} - r
\]

| Districts       | Village            | Number of Neighbourhood | Area (km²) | Household Density | Pipe Length |
|-----------------|--------------------|-------------------------|------------|------------------|-------------|
| Cikarang Pusat  | Pasirtanjung       | 2760                    | 5          | 552              | 31291.26    |
|                 | Hegarmukti         | 5328                    | 7          | 761              | 36791.19    |
| Cikarang Utara  | Wangunharja        | 3747                    | 4.44       | 844              | 37601.18    |
|                 | Harjamekar         | 6837                    | 4.3        | 1590             | 85220.18    |
|                 | Pasirgombong       | 13431                   | 4.9        | 2741             | 166502.24   |
|                 | Simpangan          | 12758                   | 3.1        | 4115             | 157517.66   |
|                 | Tanjungsari        | 2088                    | 2.9        | 720              | 26233       |
|                 | Cikarang Kota      | 4720                    | 1.48       | 3189             | 58424.64    |
|                 | Karangbaru         | 4008                    | 1.4        | 2863             | 49665.01    |
|                 | Karangasih         | 10240                   | 2.7        | 3793             | 126532.31   |
|                 | Karangharja        | 6883                    | 3.9        | 1765             | 85704.08    |
|                 | Waluya             | 7953                    | 3.1        | 2565             | 98657.51    |
| Cikarang Timur  | Hegaranah          | 1708                    | 6.13       | 279              | 21663.49    |
|                 | Jatireja           | 9376                    | 5.59       | 1677             | 116805.26   |
| Cikarang Barat  | Gandamekar         | 3338                    | 6.08       | 549              | 63077.72    |
|                 | Gandasari          | 5274                    | 3.2        | 1648             | 32857.2     |
|                 | Sukadanau          | 11050                   | 6.28       | 1760             | 137593.88   |
|                 | Telagaasih         | 14245                   | 3.5        | 4047             | 175906.59   |
|                 | Telagamurni        | 23395                   | 4.38       | 5341             | 288096.12   |
|                 | Kalijaya           | 6973                    | 3.88       | 1797             | 86808.98    |
| Tambun Selatan  | Jatimulya          | 24194                   | 5.67       | 4265             | 17964.03    |
|                 | Lambangsari        | 3391                    | 3.65       | 929              | 4249.53     |
|                 | Lambangjaya        | 1486                    | 2.56       | 580              | 1870.9      |
|                 | Tambun             | 6275                    | 2.98       | 2106             | 77.995.69   |
|                 | Setiadarma         | 4897                    | 1.61       | 3042             | 60644.29    |
|                 | Setiamekar         | 15876                   | 5.67       | 2799             | 196771.7    |
|                 | Mekarsari          | 8674                    | 2.08       | 4167             | 107080.91   |

2.2 Medium Pressure Gas Distribution Pipeline

The medium pressure pipe in the household gas network is the PE pipe that connects the M/RS to the RS. The pipe simulation results provide various pipe diameters, namely 90 mm, 180 mm, and 250 mm as shown in Table 2.
Table 2. Simulation Result of Medium Pressure Pipe Length for 106,437 SRT in Bekasi Regency

| Pipe Dimension | (m) | Length/Unit | Number of Connection |
|----------------|-----|-------------|----------------------|
| Length Pipeline (90mm) | 57,771 | 50 m/roll | 1,156 |
| Length Pipeline (180mm) | 24,672 | 6 m/stick | 4,112 |
| Length Pipeline (250mm) | 10,115 | 6 m/stick | 1,686 |
| Length of Whole Pipe | 92,558 | Number of Connections | 6,954 |

3. Results and Discussion

All information related to location or place cannot be separated from geographical position or spatial data. Utilization of spatial or geospatial data is not only limited to use for the field of geography, but also for other fields, especially in fields related to the use of natural resources, territory, and infrastructure. The plan to build a natural gas network in Bekasi Regency also uses geospatial technology in planning the location of the Meter Regulating Station (MRS), Regulating Station (RS), and the placement of medium pressure pipes, as well as low pressure pipes for households (Table 3).

Ease of accessing geospatial data information will facilitate the planning of gas infrastructure development in Bekasi Regency. Geospatial data can be updated in real-time on the progress of the work carried out even though it is far from physically accessible by utilizing remote sensing data.

Geographically, Bekasi Regency is located at 106°48'28” - 107°27'29” East Longitude and 6°10'6” – 6°30'6” South Latitude with the north bordering the Java Sea, the south bordering the Bogor Regency, West bordering DKI Jakarta and Bekasi City, and East bordering Kerawang Regency. Administratively, Bekasi Regency has 23 sub-districts and 187 villages. The number of villages in each sub-district ranges from 6 to 13. The largest sub-district is Muaragembong (14,009 ha) or 11.00% of the district area. The administrative map of Bekasi Regency and sub-district boundaries in Bekasi Regency is shown in Figures 3 and 4.

Soil types in Bekasi Regency are classified into seven groups. The most suitable group for development and has an area of about 16,682.25 Ha (81.25%). Judging from the soil texture, most of this area has a fine soil texture of about 15,555.04 Ha (75.76%) and a medium texture of about 4,755.21 Ha (23.16%) located in the north and south of Bekasi Regency. The level of soil sensitivity to erosion is quite good/stable. This sensitivity level is classified into three parts, namely stable (insensitive), sensitive, and very sensitive. Around 17,220.19 Ha (83.87%) of the land area is stable land that is feasible to be developed for various kinds of urban activities. An area of 3,127.02 Ha (15.23%) of the land has a sensitive condition and is still quite feasible to build. While in the southern part, the land is very sensitive to erosion, which is around 184.79 Ha (0.9%) so it is not suitable for development.
Figure 3. Bekasi Regency Administration Map, West Java Province
Figure 4. District Map in Bekasi Regency
The area that can be built by gas grids for households has several criteria, including being close to the installed gas grid infrastructure and there is a potential market for gas users. Bekasi Regency, in general, has a fairly high household density with a fairly large number of households in each sub-district. In addition, in Bekasi Regency, a gas grid has been built for households. Therefore, Bekasi Regency is used as one of the locations for the gas pipeline development project, both with the State Budget and Government Cooperation with Business Entities (KPBU). This is of course done with several considerations, including the following:

a. The installed natural gas infrastructure sections, gas transmission pipelines and household gas networks have been built;

b. Availability of natural gas as a source of supply;

c. High population density is a potential market for gas network users;

d. Volume of natural gas distribution needs for households;

e. There is support from local government;

f. It has great potential to develop a commercial gas network, so that it will attract investors to invest.

The design of the pipeline network includes determining the length and diameter of the pipes needed by considering the installed gas line infrastructure, the topography of the area, the projected natural gas demand, as well as the mapping structure of the area. The determination of the length of the pipe is carried out using a geospatial information system and the tools used in this study are a set of computers in which there is software consisting of the application of Quantum GIS (QGIS) 2.18, Google Earth and a Web Browser. Other tools, namely an android smartphone equipped with GPS, GPS Essentials application and Open Camera, power bank, data cable, stationery and working papers. While the materials used in this study are printed village maps and high-resolution satellite images.

The determination of the length of the pipe, especially the main pipe, is carried out through the interpretation of GIS mapping and field sampling to verify it, while the determination of the diameter of the pipe is carried out by simulating the pipe. This study also carried out optimization of pipelines to obtain the number of MRS and RS, as well as the minimum length and diameter of the pipe in order to reduce investment costs.

The placement of the MRS location is carried out by considering the location of the installed natural gas distribution pipe and the location of the installed gas tie-in. As for the location of the hospital, it is carried out by considering the number of target household connections, density of settlements, and social facilities owned by the regional government in selected villages, such as government offices, elementary and middle schools, city parks, as well as other social facilities such as mosques or other social facilities. Sports field. The placement of natural gas pipelines, both medium and low-pressure gas distribution pipes, is carried out by considering the road network, installed gas pipelines, and the closest access between the MRS to the hospital, as well as between hospital locations.

In the design of natural gas construction in Bekasi Regency, it is found that to serve and distribute natural gas for 404,865 SRT, 1 MRS and 332 RS are needed. Furthermore, a verification survey on the results of geospatial data analysis with conditions in the field was carried out at 1 MRS and 192 hospitals. This survey was conducted to see the capacity of land availability at a predetermined MRS or Hospital location and to look for alternative locations if the location does not have sufficient land availability (Table 3). This survey also looks at the available capacity of land at a location and looks for alternative locations if the location that has been determined does not have sufficient land availability. The survey data includes location coordinates, addresses, photos of the location and availability of land, as well as land ownership status.

Figure 5 shows a map of potential locations for the placement of MRS and hospitals in Bekasi Regency. Details of the results of the MRS and RS surveys for several sub-districts in Bekasi Regency along with their coordinates are shown in Table 1.
In determining the technical design of the medium pressure pipeline network in Bekasi Regency, the simulation is only carried out for a number of 106,437 SRTs which are referred to as the priority basis for the simulation, which is 26% of all potential SRs in Bekasi Regency, which amount to 404,865 SRTs. As a representative, the Bekasi Regency medium pressure gas network is designed to supply gas from M/RS located in the SKG Tegal Gede area to 108 hospitals, spread over 4 (four) sub-districts, namely North, West, East and Central Cikarang sub-districts. 16 (sixteen villages) namely: Pasirgombong, Simpangan, Tanjungsari, Cikarangkota, Karangbaru, Karangasih, Karangrahjra, Waluya, Wangunharja, Harjamekar, Sukadanau, Kalijaya, Heganmanah, Jatireja, Hegarmuki and Pasirtanjung villages. The following is the layout of the medium pressure distribution pipeline in Bekasi Regency starting from M/RS to RS for all potential SRs in Bekasi Regency, which are 404,865 SRT, 1 M/RS, and 332 RS.

**Figure 5.** Map of M/RS and Hospital Plan Locations
Table 3. Details of MRS and Hospital Survey Results for Several Districts in Bekasi Regency

| No. | Subdistrict      | Village          | Location                | Coordinate                  | Photo |
|-----|------------------|------------------|-------------------------|-----------------------------|-------|
| 1   | Cikarang Pusat   | Hegarmukti       | Cikarang Pusat-Hegarmukti | -6.335147, 107.19136        |       |
| 2   | Cikarang Timur   | Hegarmanah       | SDN Hegarmanah 02       | -6.323314, 107.189668       |       |
| 3   | Cikarang Barat   | Gandasari        | Cikarang Barat-Gandasari | -6.271355, 107.08349        |       |
| 4   | Karang Bahagia   | Sukaraya         | SDN Sukaraya 04         | -6.2331, 107.16285          |       |
| 5   | Cikarang Barat   | Telagamurni      | Masjid Jami Al Hidayah  | -6.246696, 107.118615       |       |
| 6   | Tambun Utara     | Jejalenjaya      | Tambun Utara-Jejalen Jaya | -6.226329, 107.063554    |       |
| 7   | Tambun Selatan   | Mekarsari        | Puskesmas Mangun Jaya  | -6.245663, 107.053521       |       |
| 8   | Cibitung         | Wanasari         | Sub District Office Cibitung Wanasari | -6.253009, 107.089863  |       |
| 9   | Tambun Utara     | Karangsatria     | Tambun Utara-Karang Satria | -6.22294, 107.035241       |       |
| 10  | Tambun Utara     | Karang Satria    | SDN Karang Satria 02    | -6.222968, 107.033973       |       |
| 11  | Tambun Utara     | Karangsatria     | Tambun Utara-Karang Satria | -6.22294, 107.035241       |       |
| 12  | Tambun Utara     | Karang Satria    | Kantor Kepala Desa Karang Satria | -6.223033, 107.035237     |       |
| 13  | Tambun Utara     | Karangsatria     | SDN Karangsatria 01     | -6.209549, 107.035236       |       |
| 14  | Sukatani         | Sukarukun        | Sukatani-Sukarukun      | -6.243884, 107.154636       |       |
| 15  | Tambun Utara     | Srianur          | SDN Srianur 02          | -6.165815, 107.053825       |       |
| 16  | Cikarang Selatan | Pasirsari        | Bundaran Welcome To Kota Jababeka | -6.302935, 107.144668     |       |
4. Conclusion

From the description of the writing and the data above, it can be concluded that (1) Geospatial technology can be utilized in planning the construction of gas infrastructure, especially in mapping and determining location coordinates (2) Detailed situation map data and photo images are used as the basis for planning the gas pipeline development in Bekasi Regency (3) The results of surveys and mapping using Geographic Information System (GIS) technology and photo images are analyzed into technical data to predict the number of building parcels that can be built along the Jargas route (4) The results of geospatial data processing are used to identify potential locations as natural gas tapping points, the location of the Metering Reduction Station (M/RS) and Regulating Sector (RS) placements, as well as locations that have the potential for crossings in the design of natural gas distribution pipelines (5) There are 9 sub-districts (covering 41 villages/kelurahan) that are the main priorities in the construction of gas pipelines in Bekasi Regency in this study, namely Central Cikarang, East Cikarang, North Cikarang, West Cikarang, South Cibitung Tambun, Sukatani, Karang Bahagia, and North Tambun.

5. References

[1] Presiden Republik Indonesia 2019 Peraturan Presiden Nomor 6 Tahun 2019 tentang Penyediaan dan Pendistribusian Gas Bumi Melalui Jaringan Transmisi dan/atau Distribusi Gas Bumi Untuk Rumah Tangga dan Pelanggan Kecil
[2] Direktorat Jenderal ESDM 2013 Pembangunan Jaringan Gas Bumi untuk Rumah Tangga
[3] Kementerian Energi dan Sumber Daya Mineral 2018 Neraca Gas Bumi Indonesia 2018-2027
[4] Badan Pusat Statistik Kabupaten Bekasi 2021 Kabupaten Bekasi dalam Angka 2021
[5] Saripudin S 2012 Topografi Kabupaten Bekasi.
[6] Irwansyah E 2013 Sistem informasi geografis: prinsip dasar dan pengembangan aplikasi (DigiBook Yogyakarta)
[7] Badan Informasi Geospasial 2016 Peran Besar BIG Mendukung Percepatan Pembangunan Desa 3 1–44
[8] Bappeda 2005 Rencana Pembangunan Jangka Panjang Daerah (RPJPD) Kabupaten Bekasi 2005-2025
[9] Eddy P 2009 Sistem Informasi Geografis: Konsep-Konsep Dasar (Perspektif Geodesi & Geomatika) Inform. Bandung
[10] Kepala Badan Informasi Geospasial 2016 Peraturan Kepala Badan Informasi Geospasial Nomor 3 Tahun 2016 tentang Spesifikasi Teknis Penyajian Peta Desa