I. INTRODUCTION

1.1. Background

Transportation and pollution has become a severe problem in many big cities in developing countries. In most cases, the development process has increased the need for mobility as there are changes in land-use. Eventually, the increasing needs for mobility has driven the transport system towards an unsustainable path. This can be seen for example how the development of roads and highways has ignored the development of public transport and the use of alternative energy for transport modes. At the end, the development of transportation sector in many cities has benefited only the have society and at the same time has dropped off those in lower class.

Over usage of petroleum, pollution and heavy traffic problem in Jakarta has become a more complicated case in the daily life. It is assumed that the whole problems were initiated from oversight policy of establishing transportation system for the city. Many studies have been conducted to solve the transportation problem in Jakarta, such as the mass-transit corridors, different types of mass rapid transit and even a transport master plan. However, after several delays, the local government of Jakarta launched the Transjakarta busway on January 15th, 2004.

Earlier in April 2006, in compliance with the implementation of Bylaw No. 2/2005 on air pollution control endorsed in February 2006, local government, state oil and gas company PT Pertamina and gas distributor PT PGN have signed a Memorandum of Understanding regarding the CNG supply to the Transjakarta busway. This MoU is indicating the efforts to gradually replace high emission-vehicles using gasoline with CNG-powered ones, which have lower emissions in order to reduce air pollution in Jakarta (the world's third-most polluted city after Mexico City and Bangkok).

All aspects of human life are mostly related with the energy consumption, such as for power stations, industry, and a various means of railroad, sea, and air transportation. Most of these energies are generated from coal and oil. Meanwhile, compressed natural gas (CNG) is a clean burning, high energy, alternative energy
source that enables us to safely continue to build on and improve our current lifestyle in the future.

Gas price is considered as more competitive than other fuel prices currently at 30% discount of the subsidized diesel price. The Indonesian Government is likely to increase the fuel subsidy (meaning that diesel prices could increase by up to 40% over the present cost), making gas looking even more attractive and providing some higher pricing power (Soejachmoen, 2004).

Four private companies had shown some interests in building gas networks connecting the city's existing CNG pipeline to the two planned CNG stations called SPBG (Stasiun Pengisian Bahan Bakar Gas) on Jl. Perintis Kemerdekaan in North Jakarta and at Kramat Jati, East Jakarta. The two CNG stations will cater for 200 buses on routes linking Pulo Gadung in East Jakarta to Harmoni in Central Jakarta and from Kampung Melayu to Kampung Rambutan in East Jakarta.

Transjakarta Busway is currently preparing to meet the challenges of the proposed Jakarta Gas Pipeline Mapping System by creating a user-friendly, Intra and Internet-based geographic information system (GIS) from existing digital map sources. These digital sources were developed as part of an ongoing pipeline classification study aimed at determining population trends and density surrounding the existing CNG pipeline. The use of CNG is a final for the Transjakarta Busway project and will expand to other public transportation vehicles in the city.

Determining the shortest path through an area is a simple spatial problem. Although this is just like sketching lines, contemporary routing problems involve resolving complex interactions of engineering, environmental and social concerns. Gas transmission pipeline requires advance consideration of possible paths, followed by assessment of the best route feasibility. Natural gas mostly consists of methane, which is also greenhouse gas that may contribute to global climate change when it is leaky. Beside its characteristics, such as flammable, lighter than air, and has a higher ignition temperature also require further consideration regarding environmental, community and safety factors, other than merely determining the shortest path.
GIS is explicitly designed to manage and combine large amounts of spatially distributed data. In fact, gas transmission pipeline network can be thought of as a special case of land suitability analysis that drove much of GIS' early development. Quantitative methods for GIS model calibration and weighting are needed for model clarity, consistency, objectivity, and defensibility. Thus, the responses from the experts are combined to calibrate the criteria and the weighting responses are kept separately to represent a community and an environmental perspective.

1.2. Problem Statement

GIS-based approaches for piping gas transmission lines utilize relative rankings and weights in considering factors affecting potential routes. The weights for numerous factors, such as slope, proximity to existing roads, proximity to existing utilities and population density, are established for each grid cell location then being analyzed for the overall “most preferred path” in a project area. In practice, the criteria rankings and sub-model weighting are altered to identify a set of alternatives to evaluated for the best route.

1.3. Objective

The objective of this research is to determine the best route for a gas transmission pipeline network that considers various criteria for minimizing adverse. Thus, this objective is divided into three sub goals:

1. To develop spatial model based on criteria given to obtain suitable area
2. To establish relative score among map layers for comparing decision criteria.
3. Plotting the map of optimal gas transmission pipeline network

1.4. Research Scope

The scope of this research is in corridor VII of Transjakarta Busway which link Kampung Rambutan and Kampung Melayu in East Jakarta. The start point or source of the gas transmission pipeline is branched from the existing main gas pipeline for household and industry. Afterwards, the model is developed using
GIS spatial analyst to obtain suitable area based on criteria and Analytical Hierarchy Process (AHP) to establish relative scores among alternatives.

An earlier study was conducted by PGN in 2004 stated six criteria for determining gas transmission pipeline based on stakeholder judgment as shown below:

1. SPBG must close to the busway corridor
2. SPBG must be at bus terminal or busway pool
3. The route should minimize areas having high housing density
4. The route should align with the main roads
5. The route should minimize areas within or near public services (hospital, shopping centre, industrial area, etc)
6. The route should align the existing utilities (power line, telecom line, water pipeline, etc)

The sixth criteria above are also applied in this research study.