

# MCDM Model for Natural Gas Pressure Reducing Station Site Selection

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## ABSTRACT

Considering the increasing scenario of natural gas consumption, it is necessary that all agents in the chain use methods that structure decision-making and problem-solving processes. This paper proposes a multicriteria decision model to solve a site selection problem for a pressure reducing station. A natural gas distribution company was selected to test the model and the preference modeling was conducted through the flexible interactive tradeoff (FITradeoff) approach, according to the preferences of the decision maker (DM). FITradeoff's decision support system was used to assess the alternatives of the model, through the inference of the criteria scale constants. The results proved the robustness of the model and the DM evidenced consistency in its preferences. Also, the FITradeoff method demonstrated to be intuitive to apply, since a smaller effort is required from the DM and this is because the procedure does not require complete information in the scale constants elicitation process.

## KEYWORDS

FITradeoff, MCDM/A, Natural Gas, Pressure Reducing Station, Site Selection

## INTRODUCTION

The energy market has been undergoing changes in supply and demand characteristics as industrial and urban consumption increases, creating new opportunities for economically sustainable energy resources, especially in developing countries such as China, India and Brazil (BP Energy Economics, 2018). In a 2040 projection by BP Energy Economics (2019), natural gas must steal space from more traditional sources, such as oil and coal, due to its increased competitiveness, which is a result of the reduction of the natural gas production cost and because it emits less carbon dioxide (Razi & Ali, 2019).

In the Brazilian energy market, for instance, natural gas use has been growing due to the increase in its supply from the exploitation of fossil fuels in deep waters (pre-salt). (Fioreze et al., 2013) and by government programs that encourage the opening of the natural gas market for global players and by the improvement of processes of exploration, production, transportation, distribution and natural gas trading (MME, 2019).

Moreover, in Brazil, the expansion of gas pipelines is a responsibility of the distribution companies with state regulation, and it is planned to increasingly stimulate natural gas growth, competitiveness in the sector, as well as meet the diverse demands of its stakeholders from the public and private initiative.

These organizations have come across with several difficulties in delivering satisfactory results, an efficient strategic and operational planning process that addresses the varied interests of all their stakeholders. One of these main difficulties is the decision making process of selecting strategic

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sites for the implementation of pressure reducing stations (PRS), which are used to control the outlet pressure of the natural gas in the distribution operations aiming to maintain the necessary flow to meet customer's demand (Hossain, 2009).

Such a decision must consider different financial criteria, technical operating standards, and environmental policies, besides being aligned with the company's expansion plan. Within this context, multiple criteria decision making/aid (MCDM / A) area can be valuable to support the decision process, when it is not possible to represent all the objectives in only one project (Burstein & Holsapple, 2008). They consist in analyzing the possible implementation of an action, assessing its positive and negative characteristics comparatively, side by side (de Almeida et al., 2015), clarifying the decision and usually towards recommending, or simply supporting, a behavior that will increase the consistency between the evolution of the process, the stakeholder's objectives and value system (Roy, 2005).

Thus, this study aims to propose a multicriteria decision model to solve a site selection problem for a pressure reducing station in a natural gas distribution company. For this purpose, the MCDM model is based on a compensatory approach, the Flexible and Interactive Tradeoff method (FITradeoff), which is a value function method (de Almeida, Almeida, Costa & Almeida-Filho, 2016), assisted by means of Decision Support Systems (DSS). An analysis was carried out in a Brazilian natural gas distribution company, since the chosen company is going through an expansion plan of its network and must carry out studies of this nature.

The Brazilian natural gas company in which this application took place operates in the whole state market and distributes natural gas for the following segments: residential, commercial, cogeneration, automotive and industrial. Furthermore, the company serves two thermoelectric plants, which makes it essential in the energy sector, especially in the location of operation.

Thus, the development of an appropriate model to select optimal alternatives for building new natural gas infrastructure can contribute to the company's permanent strategies of increasing client portfolio, network extension and volume of natural gas consumed, improving their quality indicators and providing the opportunity for sustainable growth, considering its constraints to achieve optimal results.

To achieve its results, the paper is structured as follows: after this introduction, there is a theoretical background and a literature review about the natural gas value chain, multiple criteria decision making/aid and the FITRADEOFF method. After this, there are the methodological procedures, which describe the steps to solve the decision problem. The fourth section demonstrates the results from the application of the method and the discussion about the results. Lastly, the fifth topic shows the conclusions of the study.

## **THEORETICAL BACKGROUND AND LITERATURE REVIEW**

The development proposed model is based on the use the FITradeoff method for a site selection decision problem. Therefore, this topic seeks to discuss theoretical aspects about the natural gas physical value chain, multiple criteria decision making/aid and the FITRADEOFF method.

### **Natural Gas**

The natural gas (NG) physical value chain is a very complex technological system and its structure is around a capital-intensive asset base. This system can be divided into upstream, which consists of exploration and production (E&P); midstream, which are the refining and transportation stages and; downstream, which comprises the distribution and consumption phases (Weijermars, 2010).

In Brazil, the exploration and production natural gas stages can be carried in three E&P environments: pre-salt, traditional offshore and onshore. The transport of NG can be carried out through transmission pipelines and the liquid form, which is the liquefied natural gas (LNG). Most



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