

**Pre-paid Domestic Gas Metering System in Bangladesh: A Case Study of
Titas Gas Transmission and Distribution Company Limited.**

Submitted by

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MPSM, Batch VII

ID No. 14282005

Masters in Procurement and Supply Management

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BRAC Institute of Governance and Development (BIGD)

BRAC University, Dhaka, Bangladesh

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Dissertation Submitted in the Partial Fulfillment of the
Requirements for the Degree of
Masters in Procurement and Supply Management (MPSM)

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Statement of the Author

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Muhammad Abul Kawser

Abstract

Titas Gas Transmission and Distribution Company Limited (TGDTCL) is the largest gas transmission and distribution Company of Bangladesh. The organization established in 1964 and started its commercial operation on 1978 by providing domestic gas connections in Dhaka city. There are different types of customers and tariff rates for natural gas in Bangladesh. All types except the un-metered Domestic customers are billed on meters. Un-metered domestic customers are billed at flat rates. They pay a fixed amount, whatever may be their actual gas consumption. As they need not pay for every unit of gas they use, they utilize gas for drying clothes, keeping room warm in winter and saving the expenses of match sticks. For this reason, most of these domestic customers use this non-renewable fossil fuel inefficiently and they do not use efficient gas appliances to reduce the wastage of gas. This group of customers consumes about 13% of the total gas. Thus, there is a scope for wasting a significant amount of gas. Pre-paid metering may reduce such wastage and also eliminate the problem of unpaid dues. **Titas Gas Transmission & Distribution Company Ltd. (TGTDCL)** undertook a pilot project in July 2005 to implement pre-paid metering on a limited scale. The outcomes of the pilot project are analyzed and presented in this paper. It is found that most of the customers under the project appear to be indifferent to the new system. The revenue of TGTDCL was less compared to the same number of un-metered customers. The pilot project was not designed adequately. Calculations are therefore made with assumed parameters. Clear and conclusive results regarding reduction of gas wastage and financial benefits cannot be obtained. More carefully designed pilot projects must be conducted before deployment of metering in a large scale.

Keywords: Natural Gas, Metering, Pre-paid, Domestic Consumption, Wastage.

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CHAPTER ONE

INTRODUCTION

1.1 Background and context

Titas Gas Transmission and Distribution Company Limited (TGDTCL) is the largest gas transmission and distribution Company of Bangladesh. The organization established in 1964 and started its commercial operation on 1978 by providing domestic gas connections in Dhaka city. Now-a-days, there are different categories of customers in its franchise areas. In its categories, there are industrial customers, commercial customers, independent power producers, fertilizers, domestic and so on. It buys gas from the government owned organization PETROBANGLA. From the national grid, it distributes gas towards its customers. All the customer's gas uses are metered before entering the customer's side. But no metering system for the domestic customers. Up to June 2014, it has near about 1.3 million domestic connections by which users consume 13% of the total gas sales. From several studies, it has been observed that the domestic customers within Dhaka Metropolitan Area uses gas inefficiently. This causes wastage of gas. As in prepaid metering arrangement they will have to pay their gas bill in advance, they will be well aware about the wastage of gas. The dishonest customers tamper the meters and use gas whatever they wish in extra and unauthorized appliances. They never care about the wastage of gas. So the gas metering was necessary for the domestic customers. So that Ministry of Power, Energy and Mineral Resources, PETROBANGLA and TGDTCL decided to take a project of pre-paid gas metering system for the domestic customers considering that this prepaid metering arrangement will place a block against fulfilling their dishonest motives. Thus this Pre-paid gas metering system will enhance supply efficiency, reduce system loss and wastage of gas so as to contribute to the conservation of energy vis-a-vis national energy security. TGDTCL already installed 4500 no's pre-paid gas meters in the customers' gas regulating areas with the collaboration of Bangladesh University of Engineering and Technology (BUET).

1.2 Statement of the problem

Domestic customers use a significant amount of gas in the Titas franchise area. The number of customers is huge. They are paying a fixed amount of gas bill. In our domestic customers there is phenomenal wastage and misuse of gas. They pay gas bill amounting to 450 taka per each double burner for whatever quantity of gas they use. It is found that the pattern of gas consumption by consumer is 99 cubic meter per

month. If prepaid meters are installed, the customers will have to pay for each volume of gas they consume. This fact will make them concerned against wastage and misuse of gas. This arrangement will also help in eliminating system loss incurred due to use of gas in unauthorized gas appliances. For even in this anomaly the company will not be deprived of the revenues. Not only this, according to the Annual Report of 2012-2013 of TGTDCCL, domestic outstanding dues are 4.94~5.00 months. Installing prepaid meters will enable to take the price of gas before uses of it. This will also help to improve customer service as well.

1.3 Significance of the proposed research

From the research we want to investigate the following question answers:

- Does the project envisages the reduction in system loss by means of reducing wastage of gas in domestic customers, combating gas pilferage and enhancing awareness in using gas efficiently?
- Is there any adverse effect on the company's revenue earning?

1.4 Research Questions

From the research we want to investigate the following question answers:

- Does the project envisages the reduction in system loss by means of reducing wastage of gas in domestic customers, combating gas pilferage and enhancing awareness in using gas efficiently?
- Is there any adverse effect on the company's revenue earning?

1.5 Objectives of the Study

The main objective of this research is to assess the reduction of system loss of gas caused by its wastage by domestic end users within Dhaka Metropolitan Area. This in turn will have a significant contribution towards conservation of natural gas and a nonrenewable source of energy. The specific objectives of this research are:

- To examine the gas use of the domestic customers which will help us to calculate the reduction of system loss.
- To assess the improvement of management efficiency and customer service by introducing automation.
- To assess the revenue nearing due to pre-paid metering.
- To suggest recommendations for further improvement of the existing pre-paid gas metering system.

1.6 Scope of the Study

Natural gas is a limited resource for any country of the world . As a third world country, it is very important to use natural gases efficiently and effectively. Low cost of natural gas invites the foreign direct investment into the country and the it facilitate the development of the country. So that the proper use of natural gas has an direct impact on it. Domestic use of gas is ultimately the loss of natural resources. There are a very few examples of using pipe line gas for domestic purposes in the world. They are using pre-paid gas metering system. Because the customer management is very tough with respect to the other categories. Bill collection, customer ledger management with collaboration of different banks, customer vigilance etc require huge man power engagement and time constraining. So that the pre-paid gas metering system may be the better options for the domestic customers from the both sides. From this research study, the examination of the gas use of the domestic customers will help the company to reduce the system loss. The assessment of the improvement of management efficiency will provide customer satisfaction and many more.

1.7 Limitations of the study

This research study will have core intention to the domestic customers of TGTDCCL whose gas consumptions have already been metering and they are paying gas bill before use. They will not educated and conscious. For the technical purpose, the pre-paid gas metering project of TGTDCCL selected those customers for installing meters. This study will go survey randomly in those customers. This study is an exploratory one and will use qualitative and quantitative data. They will be collected from both the primary (surveys, questionnaires, interview checklists etc) and secondary (printed and unprinted materials, websites etc) sources. A purposive sampling technique will be adopted to attain the research objectives. TGTDCCL installed 4500 Pre-paid gas metres in area of Lalmatia and Mohammmadpur under the Dhaka Metropolitan City pilot project basis. There were so many assumptions. We have collected data from the customer's premises and try to find out the socio-economic impact on the customers the company as well.

1.8 Organization/Structure of the study

The study has been comprised in six broad headings: Introduction, Literature Review, Methodology, Results and Discussion, Conclusion and Recommendations and References.

Introduction chapter, the areas which have been covered are the background and context, problem statement, significance, research questions, objectives, scopes and limitations of the study.

The second chapter; **Literature Review** starts with a brief view on **Natural Gas, Metering, Pre-paid, Domestic Consumption, Wastage** etc.

In the **Methodology** chapter which is the third chapter, sampling method, selection of study area, study period, sample size and data processing & analytical framework of the study have been described.

The **Results and Discussion** chapter starts with the demographic overview of the respondents followed by an overview of the survey questionnaire. Then the findings of the questionnaire survey have been presented with an analysis and in-depth discussion.

Thereafter, **Conclusion** of the study has been drawn with some specific recommendations. Finally, **References and Appendices** have been stated for a clear understanding of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Natural Gas: An overview

In the 19th century, natural gas was usually obtained as a by-product of Producing Oil, since the small, light gas carbon chains came out of solution as the extracted fluids underwent pressure reduction from the reservoir to the surface, similar to uncapping a soft drink bottle where the carbon dioxide effervesces. Unwanted natural gas was a disposal problem in the active oil fields. If there was not a market for natural gas near the wellhead it was virtually valueless since it had to be piped to the end user.

In the 19th century and early 20th century, such unwanted gas was usually burned off at oil fields. Today, unwanted gas (or stranded gas without a market) associated with oil extraction often is returned to the reservoir with 'injection' wells while awaiting a possible future market or to depressurize the formation, which can enhance extraction rates from other wells. In regions with a high natural gas demand (such as the US), pipelines are constructed when it is economically feasible to transport gas from a well site to an end consumer.



In addition to transporting gas via pipelines for use in power generation, other end uses for natural gas include export as liquefied natural gas (LNG) or conversion of natural gas into other liquid products via gas-to-liquids (GTL) technologies. GTL technologies can convert natural gas into liquids products such as gasoline, diesel or jet fuel. A variety of GTL technologies have been developed, including Fischer–Tropsch (F–T), methanol to gasoline (MTG) and STG+. F–T produces a synthetic crude that can be further refined into finished products, while MTG can produce synthetic gasoline from natural gas. STG+ can produce drop-in gasoline, diesel, jet fuel and aromatic chemicals directly from natural gas via a single-loop process.

Natural gas can be "associated" (found in oil fields), or "non-associated" (isolated in natural gas fields), and is also found in coal beds (as coal bed methane). It sometimes contains a significant amount of ethane, propane, butane, and pentane—heavier hydrocarbons removed for commercial use prior to the methane being sold as a consumer

fuel or chemical plant feedstock. Non-hydrocarbons such as carbon dioxide, nitrogen, helium (rarely), and hydrogen sulfide must also be removed before the natural gas can be transported.

Natural gas extracted from oil wells is called casing head gas (whether or not truly produced up the annulus and through a casing head outlet) or associated gas. The natural gas industry is extracting an increasing quantity of gas from challenging resource types: sour gas, tight gas, shale gas, and coal bed methane.

Because natural gas is not a pure product, as the reservoir pressure drops when non-associated gas is extracted from a field under supercritical (pressure/temperature) conditions, the higher molecular weight components may partially condense upon isothermal depressurizing—an effect called retrograde condensation. The liquid thus formed may get trapped as the pores of the gas reservoir get depleted. One method to deal with this problem is to re-inject dried gas free of condensate to maintain the underground pressure and to allow re-evaporation and extraction of condensates. More frequently, the liquid condenses at the surface, and one of the tasks of the gas plant is to collect this condensate. The resulting liquid is called natural gas liquid (NGL) and has commercial value.

Natural gas dispensed from a simple stovetop can generate temperatures in excess of 1100 °C (2000 °F) making it a powerful domestic cooking and heating fuel. In much of the developed world it is supplied through pipes to homes, where it is used for many purposes including ranges and ovens, gas-heated clothes dryers, heating/cooling, and central heating. Heaters in homes and other buildings may include boilers, furnaces, and water heaters.



Both North America and Europe are major consumers of natural gas. But in Bangladesh, the most use of natural gas is for cooking. Natural gas in Bangladesh mostly supplied by TGTDC.

Distribution Companies Four national companies are responsible for distribution and marketing of natural gas in Bangladesh [2]. These are i) Titas Gas Transmission and Distribution Company Limited (TGTDC), ii) Bakhrabad Gas Systems Limited (BGS), iii) Jalalabad Gas Transmission and Distribution Company Limited (JGTDC), and iv) Pashchimanchal Gas Company included, about 57% of the total

gas is consumed for power generation alone. The industrial sector has fewer than 5 thousand customers, yet it consumes about 19% of the total gas. The captive generation is mainly carried out by/for the industrial customers, thus the total consumption in this sector is about 37%. The commercial sector, despite having relatively high tariff, is very small. It might be worthwhile re-defining this sector and widen the scope of revenue from this sector. CNG is now an important fuel for the transportation sector, accounting for about 5% of total gas consumption. Table 3: Gas customer status of TGTDCCL (As of June 30, 2010)

Fig 1. Percent Share of Gas Sales by TGTDCCL to different Types of Customers (2009-10)

Table 3: Gas customer status of TGTDCCL (As of June 30, 2014)

Sl. No.	Customers Type	Number of Customers
1	Power-Public	11
2	Power- Private 23	23
3	Fertilizer 4	04
4	Captive power 1,043	1043
5	Industry 4,557	4557
6	Commercial 10,893	10893
7	Seasonal 12	12
8	CNG 329	329
9	Domestic 1,539,691	1539691
10	Total 1,556,563	1556563

2.2 Pre-paid Metering



The project implementation started in 2012, with pre-paid meters installed in 8500 kitchens in the Lalmatia residential area of Dhaka city. The desired properties of the meters were meticulously laid out in the project plan. Some important desired properties and features of the meters were:

- i. Intrinsic Safety
- ii. Security Sealing
- iii. Automatic Turning on/off gas supply valve according to the situation of pre-paid amount
- iv. Card Reader (IC-Chip) with high resistance to magnetic interference
- v. Real time calculation and display of the balance
- vi. Mechanical counter for direct reading in Nm³
- vii. LCD display for information of the IC card, messages, etc.
- viii. Index Box to be secured and sealed against any illegal access.
- ix. Back Stop device to prevent the reverse flow of gas.

The IC Chip would generate alarm and make the system inoperative to protect it from pre-set minimum and maximum gas flow rates. It should store information such as cumulative gas consumed, last prepaid volume, volume of gas left, card number, meter number etc. The valve would close instantly to stop the flow of gas when there is no balance from the pre-paid amount. The IC card cannot be pulled out until the storage of card value. After completion of storage the IC card value it would be ejected automatically. When the remaining volume of gas is less than 6 m³ the meter will issue an alarm, then continue to issue alarms for each 1

m³ and for every 0.1 m³ intervals for the last cubic meter of gas left. In case of illegal gas use or meter bypassing the gas flow will be stopped automatically. The meter will have outlet pressure sensor. If the meter is dismantled, the motor valve inside the meter will be closed automatically and store the record in the meter. The meter would not be reusable without the help of Gas Company personnel. Specifications of the meters used in the project:

Type Diaphragm meter Model G-1.6 A

Q_{max}: 2.50 Nm³ /hr

Q_{min}: 0.16 Nm³ /hr

P_{max} :100 KPa

The meters had both digital and analogue display.

CHAPTER THREE

METHODOLOGY

3.1 Methods of collecting data/Sampling method

A questionnaire for survey was developed and adopted for this study. Survey method was used as this is considered as the best method available to the social scientists interested in collecting original data. Also, the interview method was used as this is helpful to gather clear idea on the issue providing insight into the conversation. Both qualitative and quantitative methods were followed in this study.

The questionnaire was used for this study which is given in the **Appendix B**. The questionnaire survey was adopted for collecting primary data from the project area. Before asking for filling the questionnaire, the general idea of the research objectives were exchanged with them. After the exchange of general idea of the research objectives, the questionnaire was given to them. They were requested to fill the questionnaire based on the practical experience they had regarding the pre paid metering. Both open end and close end questions were set in the questionnaire to reveal the real perception of the respondents.

3.2 Selection of Study Area

Due to time constraint and convenience of the present study, selected for collection of data in the questionnaire in addition to few respondent provide data through e-mail. Also, data for questionnaire was were collected from the Office of the Project Director, Newly started project where procurement activities is slowly or has not yet started were excluded from the study to get more reliable data.

3.3 Study Period

Survey was conducted at different customer's premises and the project office in 2014-15.

3.4 Sample Size

For Questionnaire, the respondents were categorized as i) TGTDCCL's employee, ii) Persons who are dealing with pre-paid projects iii) customers who are using these type of meters; they were interviewed with 16+16= 32 Questionnaire.

3.5 Data processing and Analysis/Analytical Framework

As a means of processing, collected data have been cleaned, edited, arranged and coded before statistical analysis. The main statistical analytical tool used in this study was Statistical Package for Social Science (SPSS) to analyze and interpret the subject matter of the study. Microsoft Excel has been used for preparing the frequency table & other tables. Microsoft Word has been used for preparing the report.

CHAPTER FOUR

Results and Discussion

4. FINDINGS FROM THE PROJECT There was no arrangement for measurement of gas consumption, such as a master meter on the supply main, in the area before the project implementation. Therefore no concrete data was available regarding the gas consumption before metering. Thus the savings of gas cannot be established with certainty; rather the analysis had to rely on assumed parameters.

4.1. After a few months into operation, a number of problems were found by a thorough inspection by TGTDCCL representatives. Some randomly selected meters were sent to Institute of Information and Communication Technology (IICT), BUET, for further testing. Their major findings were:

- i. The calibration of the meters was not accurate.
- ii. The quality of the materials used for electronic module was poor.
- iii. Power supply system of the meter was of lower quality.
- iv. LCD display was of poor quality.

4.2. Survey and Inspection Out of the 4500 domestic gas customers, only 1000 were available for survey. Some surveys were done as routine work. Some inspections were conducted due to complain lodged by customers. Complains included display problems, non-functioning meters, gas supply problems etc. Some customers were also inspected by the author for the study. Data were collected regarding different parameters such as flow condition, installation condition such as the locations of the meter and the stoves, verification of any technical fault, customer feedback etc. Some customers were not available while some refused to allow inspection. Tables 4 and 5 show the number of customers and types of residences under the project. It is noted from Table 5 that about 13% of the customers inspected were not ordinary domestic customers. These households were either being used as offices, or being inhabited by foreign citizens. Therefore the gas consumption pattern of these customers was likely to be quite different.

Table 4: Inspection data of pre- paid meters

Visited	848
Owner not available	105
Nobody resides	26
Refused to allow inspection	13
Staying abroad	08

Table 5: Category of the inspected customers

Home	718
Office	94
Foreigner	36
Total	848

4.3. Technical Faults The total number of faulty meters was 503. Some meters had a single problem such as consumption error or battery damage etc, while others had multiple problems. Consumption error is defined as the difference between analogue and digital reading. Types of faults that were detected are shown in Table 6.

Table 6: Technical faults found in the meters

S.L No.	Fault Type	Fault Count
1	Consumption Error	375
2	Battery Damaged	45
3	Meter Damaged	18
4	Negative Digital Reading	4
5	Display Damaged	6
6	Meter Lock	112
7	Card Charging In Meter	178
Total fault count		738

It shows that consumption error is the highest among the different types of faults. About 44% of the meters were faulty in this regard. Significant number of meters also had card charging and meter lock problems. 4.4. Irregular Activities A number of irregular activities were also detected in some meters (Table 7). Although the numbers are not very high, it is a matter of concern given the type of area where the project was implemented. It is likely that such activities would be more frequent in the less affluent areas of the city.

Table 7: Irregular activities

Type of irregularity	Incident
By pass	06
No seal in meter	10
Total	16

4.5. Customer feedback Satisfied customers commented that their bills were reduced with respect to flat rate billing, and that they were billed just for the amount consumed. Dissatisfied customers mostly pointed to the technical problems of the meters, and the associated hassle. Majority of the customers, however, were indifferent. The reason for indifference should be further investigated, however, it may be related to the usage pattern and income levels of the customers. Table 8 shows the summary of customer feedback.

Table 8: Customer Feedback

Overall Assessment	Number of Customers	% of Customers
Satisfied	162	19.01
Not Satisfied	122	14.39
Indifferent	564	66.51

4.6. Financial Statement Revenues earned by selling gas through the pre-paid meters are compared to the equivalent flat rate earnings in Table 9.

Table 9: Revenue Comparison (Oct 10 to April 11)

Month	Cards Sold (Taka)	Flat Rate Basis (Taka)
October 05	2,15,200	4,42,010
November 05	1,68,000	4,42,010
December 05	1,90,400	4,42,010
January 06	2,13,203	4,42,010
February 06	1,62,200	4,42,010
March 06	1,70,800	4,42,010
April 06	1,91,400	4,42,010
Total	13,11,203	3,0,94,070
% Difference	- 57.62%	

It shows that in 7 months the actual earning was less by 57.62% compared to flat rate bill. The probable reasons include error in digital reading (consumption error), and reduced consumption of gas by customers.

5. ESTIMATION OF WASTE GAS The gas load calculation committee of TGTDCCL experimentally determined that gas load for a domestic double burner was 0.6 Nm³ /hr. Independent tests by the author showed that at very low opening, gas consumption was about 0.1 Nm³ /hr [3]. Burning does not occur below this rate. Past surveys by TGTDCCL indicated that, about 6 to 8 hours a day of burner usage is enough to satisfy the cooking needs of an

average domestic customer. This paper made independent calculations based on the following main assumption: i. Burners are kept full open for 6 hours and partially open for 4 hours. ii. Tariff rates are prevailing at the time of the project implementation (2005) iii. Initial calculations are made for a group of 10,000 double burner stoves. Thus, gas consumed per burner per month is estimated to be about 118.93 Nm³. Flat rate for a double burner stove is Taka 400/month, and metered rate for domestic customer is Taka 4.59/Nm³. Thus a flat rate customer actually paid for (400/4.59) about 87.15 Nm³ of gas. The un-paid for gas is (118.93-87.15) about 31.78 Nm³ per customer per month. This amount is termed as the “Wasted Gas”. Annual Wasted Gas for 10,000 customers is about 3.81 MMCM, corresponding to an annual revenue loss of Taka 1.75 crore. If the same assumptions are made for the entire domestic customer base (10,97,478 in 2005), these amounts would be 418.14 MMCM and Taka 30.73 crore respectively.

6. DISCUSSIONS There was no foreknowledge of the gas consumption in the area where the pre paid meters were deployed. If some special arrangement, such as a master meter was installed on the supply main to the said area, a better indication of gas consumption before and after the project could be obtained. That would have helped to establish the amount of gas wasted or saved with more reliability. Some gas is also wasted through leaks, and during the process of lighting the burners. The project was implemented in an area where the income levels of the customers are supposed to be high; and their gas usage pattern was perhaps very similar. Moreover, 13% of the customers were offices and foreign citizens, whose gas usage should be quite different than regular domestic customers. It is easily understood that the usage trends between customers at different income levels would vary significantly. To address this problem, a comprehensive survey could be conducted to cover different types of neighborhoods. The pilot project in a medium to low income level neighborhood would yield more realistic results. The project outcome is also greatly undermined by low quality meters. Reliable, accurate and durable meters are central to the success of such projects. It is also interesting to note that the revenue of the gas company actually reduced after the project. Perhaps that is an indication of reduced consumption and wastage, but it cannot be quantified with certainty. Reduction of revenue may act as a barrier for a gas company to invest in large scale metering projects, and prompt the company towards tariff hikes.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5. The results of the pilot projects are inconclusive, partly due to the design of the project, and partly due to the selection of the area. Diversity of customers is a very important point to consider. Low quality meters had a negative effect on the project. Although made on assumed parameters, calculations show significant amount of gas saving. A comprehensive customer survey covering customers with a wide range of income levels should be conducted to develop a more effective metering program. Real-time measurements at selected points and in households selected at random should be performed. More pilot projects should be undertaken while keeping the above points in mind. Adequate arrangements such as master meters must be incorporated in the project design to reliably estimate the change of consumption before and after the projects. High quality of the meters must be ensured. Large scale deployment of pre-paid meters without sufficient background work would not be a prudent decision.

6. REFERENCES

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7. NOMENCLATURE

Symbol Meaning MMCM Million Standard Cubic Meter Nm³ Standard Cubic Meter