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Analyze the Loss of Electricity in Palestine. Case Study: Ramallah and Al-Bireh Governorate

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ABSTRACT

The study aimed to investigate the factors leading to the loss of electricity in Ramallah and Al-Bireh Governorate in Palestine. In order to achieve the objectives of the study, descriptive and quantitative analysis was used in this study. Based on the data of the Jerusalem Electricity Company, and the data of the Palestinian Central Bureau of Statistics for 2010-2018, the ordinary least squares method was used in regression analysis, and by granger causality test the hypotheses were tested using EViews. The study found that there is a causal negative relationship between wages, the number of pre-paid electricity meters, fines imposed on violators, and the number of participants on the loss of electricity. While there was no causal relationship between the price of electricity, the unemployment rate, the rate of education, and spending on maintenance on the loss of electricity.

Keywords: Electricity Losses, Electricity Theft, Non-technical Loss
JEL Classifications: B41, C13, C22, Q49

1. INTRODUCTION

The electricity sector is one of the most important elements of the infrastructure that attracts investment and social welfare. The electricity sector consists of a number of basic elements, namely: power stations, transport, distribution, power grid, and the existing institutions, and all the previous elements affect the efficiency of this sector (MAS, 2014).

The loss of electricity is one of the biggest problems facing the sector (MAS, 2014), Where the loss of electricity is divided into technical loss and non-technical loss. The technical loss is due to the deterioration of the status of the network and transmission lines due to poor equipment level, unbalanced loading, and heating insulation materials between conductors as a result of turning part of the electrical energy in the conductors into thermal energy and kinetic (vibration conductors) (Navani et al., 2012). While non-technical losses are the result of illegal connections to the network, manipulation of electricity meters, unpaid bills, and errors in meter reading by employees (Nizar et al., 2006).

Electricity losses have negative effects not only on the electricity sector but on the economy as a whole. Loss of electricity means a drain on electricity companies' assets, and therefore the infrastructure to attract investments. In addition, electricity theft is a crime, Which leads to the inability of electricity companies to estimate the electricity needed to supply consumers, and thus reduces the efficiency of the work of electricity companies as a whole (Depura et al., 2011).

The Palestinian economy is in a special situation since it is an economy under occupation. Since 1967, the Israeli occupation has imposed a series of restrictions, these restrictions included the confiscation of land, the establishment of settlements, the diversion of water, the seizure of land and sea crossings, and make the Palestinian economy dependent on the Israeli economy, since Palestine imports most of its electricity from Israel. In 2017,

Palestine imported 91.8% of its electricity from Israel, while it imported 0.91% from Jordan, 1% from Egypt, and the Palestinian power station produced 6% electricity in Palestine (Palestinian Central Bureau of Statistics, 2017).

According to the data of the Palestinian energy balance in the Palestinian Central Bureau of Statistics (PCBS) 2016, the domestic sector uses 59.6% of the electricity imported and produced in Palestine, while the industrial sector consumes 11.6% and the services sector 24.7%.

It is worth mentioning that 99.9% of the households in Palestine are connected to the public electricity network, 58.3% of the households use the normal meter, and 41.7% of households use a pre-paid meter (Palestinian Central Bureau of Statistics, 2015).

In the West Bank, there is five electricity distribution companies operate: The Jerusalem Electricity Company, the North Electricity Distribution Company, the Tubas Electricity Company, the Hebron Electricity Company, and the South Distribution Company, and the percentage of local authorities affiliated to the distribution companies reached about 48%, and 64% of the population is included within the distribution companies in the West Bank (Palestinian Electricity Regulatory Council, 2012).

According to the annual performance report of Palestinian Electricity Regulatory Council (2017), the percentage of electricity loss in the distribution companies was 23%, at a cost of 370 million NIS, knowing that Israel is deducting the prices of electricity sold by the Israeli companies to the Palestinian areas from the clearing funds, Which is a burden on the budget of the Palestinian authority.

In order to reduce the bleeding of money due to the loss of electricity and its negative effects on the economy, the specific factors of loss in Palestine must be studied, and make recommendations and policies to reduce the loss of electricity. Due to the difficulty of studying the loss of electricity in all areas of Palestine, the determinants of the loss of electricity will be studied in the governorate of Ramallah and Al-Bireh, as it is the economic capital of Palestine, a gathering of ministries and state institutions, and its average location among governorates.

2. LITERATURE REVIEW

Several studies have focused on the loss of electricity. These studies have been concentrated in developing countries due to the high percentage of electricity losses in these countries, which are due to several reasons, including technical, economic and social reasons.

In the study (Gaur and Gupta, 2016) explored the social, economic and governmental factors that may affect electricity theft. Among the factors analyzed by the study are: Electricity price, average per capita income, poverty rate, illiteracy rate, population, unemployment rate, urbanization ratio, government corruption represented by accepting bribes to provide electricity at a lower price, the efficiency of government performance represented by the proportion of taxes observed for the output of each state and the percentage of electricity bills that distribution units can recover. The study took into consideration the infrastructure of electricity, taking variables such as the capital used in the network, length of wires, the number of transformers in each state, and the share of electricity for industry in each state, and the data were taken for the previous variables in 28 states in the form of a time series from 2005 to 2009, using the ordinary least squares (OLS) method and the FGLS method. The main findings of the study are that with the increase in per capita income, the decrease in poverty and unemployment, and the decrease in the illiteracy rate, the amount of stolen electricity is decreasing, and with the efficiency of government performance, the loss will be reduced. The results of the study also show that the greater the use of electricity in industry, the lower the loss of electricity.

In a similar study (Jamil and Ahmad, 2014) in Pakistan, investigated the effect of electricity price, per capita income, fines on electricity grid offenders, heat, and the number of cases of electricity theft, on the amount of electricity loss. The study used annual data from 1988 to 2010, the source of which was electricity distribution companies, since GMM and LSDV were used in the analysis. The study found that both the increase in the price of electricity and the heat have a positive effect on the theft of electricity, whereas when the average per capita income increases, electricity theft decreases, while fines have no statistically significant impact on electricity theft, due to pervasive corruption.

While in (Yurtseven, 2015) to analyze the economic and social determinants of the illegal use of electricity in Turkey, the impact of real GDP per capita was studied. Education consisted of the number of high school graduates, population in rural and urban areas, agricultural production per capita, Net migration rate, weather index, and electricity price, for the South-East region of Antalya from 2002 to 2010, and by using 3SLS and IVM-GMM to estimate the effect of the previous variables on electricity theft. The study found that both the level of education and income have a negative impact on the theft of electricity, while both the rural population and the net migration rate and temperature have a positive impact on the theft of electricity.

In a study (Kwakwa, 2018), in Ghana, to examine the determinants of electricity theft, time series data from 1971 to 2013 were taken for variables: educational level, electricity price, income, capital investment, population, number of manufacturing companies, variable of the political conditions and expressed by periods of democratic rule, periods of coups, and years of elections, where these variables are taken as dummy variables. The source of this data was the World Development Indicators 2015, and by using FMOLS method and the CRR method, and the study found that the increase in income, the level of education, and Investment in electricity grid have a negative impact on electricity theft, while the increase in the population, the price of electricity, and the number of manufacturing companies have a positive impact on the theft of electricity, while periods of democratic rule and the years of the election are not statistically significant.

While the (Mimmi and Ecer, 2010) study in Brazil on the possibility of illegal access to electricity in poor urban areas,

cross-sectional data were used (10/2006-10/2007), and the unit of study was households, Where the research was conducted on the impact of income, average monthly consumption of electricity, and dummy variables are: Do families pay a social tariff? Does the family have non-energy appliances? Does the family use electricity for business (commercial or industrial) in their homes? Do families follow behaviors that reduce electricity consumption? On the possibility of illegal access to electricity. The variables were estimated in three ways: Probit, IV probit, and biprobit. The study found that rising incomes and following electricity saving behaviors would reduce the likelihood of illegal access to electricity, while the use of non-electricity-saving devices and the use of electricity in the business or industrial in the dwelling increases the probability of theft of electricity, while the discount on bills according to monthly average monthly consumption leads to reduce the probability of theft of electricity.

The literature review has pointed to the need to take a number of factors to study the loss of electricity. These factors include electricity price, number of participants, income, unemployment rate, poverty ratio, education ratio, the infrastructure of the electricity grid, weather, maintenance expenditure, fines for violators.

The previous studies have agreed to take the data in the form of a time series to study the effect of change in independent variables on the loss of electricity, with the possibility of using the OLS method in regression analysis. Table 1 summarizes previous studies:

3. METHODOLOGY AND DATA

3.1. Methodology

To achieve the objectives of the study, and based on previous studies, the descriptive and quantitative method was used in this study, using the OLS method, in estimating the model coefficients, and by using the EViews. 10 program, data were analyzed and results obtained. And the study variables are as follows:

Loss=f(price, customer, fineperviolent, maintenance, prepaid, wage, education, unemployment)

Where variables represent the following:

Loss	The loss of electricity, a dependent variable, is the subject of this study
Price	Price per kilowatt. Hour of electricity
Customer	The number of subscribers to the Jerusalem Electricity Company
Fineperviolent	The rate of fines imposed on all cases of assault on the electricity grid
Maintenance	Maintenance expenses for the electricity grid
Prepaid	Number of prepaid meters
Wage	Average daily wage
Education	Percentage of individuals with a high school diploma or a higher scientific qualification
Unemployment	Unemployment rate in Ramallah and Al Bireh governorate

The price of electricity is expected to have a positive effect on electricity losses. According to (Gaur and Gupta, 2016), (Jamil and Ahmad, 2014), (Yurtseven, 2015) and (Kwakwa, 2018), the increase in the price of electricity, will increase the theft of electricity by citizens, because the high prices, which consumers see as unfair to them, which weaken their ability to pay their electricity, drives them to risk and theft from the electricity grid, because risk and theft will be useful to them.

While Wage is expected to have a negative impact on electricity losses. According to (Gaur and Gupta, 2016), (Jamil and Ahmad, 2014), (Yurtseven, 2015), (Kwakwa, 2018) and (Mimmi and Ecer, 2010) increased income will lead to a reduction in electricity theft, this is because households are able to pay their electricity without risking electricity theft and legal accountability. On the other hand, increasing wages have a direct impact on income growth, which leads to the obligation to pay bills, which will allow increased investment in the electricity grid at the general level.

Unemployment may have an interrelated effect on wages on electricity losses. According to the (Gaur and Gupta, 2016) study, unemployment has a positive effect on electricity losses, because unemployment reduces the ability to pay bills and increases the rate of crime, including theft of the electricity grid.

The education level is expected to have a negative impact on electricity losses. (Gaur and Gupta, 2016) and (Kwakwa, 2018) agreed on the importance of education in reducing electricity losses. By increasing the level of education for citizens, they will become increasingly aware of the importance of preserving the electricity sector and the consequences of electricity theft, making them more disciplined and in compliance with the laws. Increasing the level of education for workers in the electricity sector will increase their efficiency, which will generally reduce electricity losses.

As for the number of customers, studies (Gaur and Gupta, 2016), (Yurtseven, 2015) and (Kwakwa, 2018) have agreed that increasing subscriber numbers lead to increased electricity losses. This because as subscriber numbers increase, the ability to monitor and track meter manipulation becomes more difficult, thus increasing the chances of electricity theft.

The installation of prepaid meters is expected to have a negative impact on electricity losses. According to (Chauhan and Rajvanshi, 2013), one of the ways to reduce electricity losses is to install prepaid meters, because they are difficult to manipulate and steal.

According to (Jamil and Ahmad, 2014), the fines imposed on aggressors on the electricity grid have a negative impact on electricity losses, since according to the study (Obafemi and Ifere, 2013), one of the ways to reduce the loss of electricity is to impose fines on the aggressors on the electricity grid, in order to intimidate them from paying fines.

3.2. Data

The study data were annual, covering the years 2010-2018, for Ramallah and Al-Bireh Governorate of the West Bank in Palestine.

The source of the data is the Jerusalem Electricity Distribution Company, where the company distributes electricity to all the

Table 1: Summary of key studies on the loss of electricity

Study	Country	Variables	Methodology	Main results
Gaur and Gupta, 2016	India	Price, income, population, poverty, unemployment, illiteracy, urbanization, the efficiency of government performance, the infrastructure of the electricity grid	Annual data (2005-2009) 28 states, OLS and FGLS	The amount of loss is reduced with increased income, lower poverty, unemployment and illiteracy, higher efficiency of government performance, and increased industrial share of electricity
Jamil and Ahmad, 2014	Pakistan	Price of electricity, income, fines for violators, temperature, number of cases of abuse on the electricity grid	Annual data (1988-2010) data source: Electricity Distribution Companies GMM and LSDV	When the price of electricity, income, and heat increased, the theft of electricity will be increased, while the fines did not have a statistically significant impact
Yurtseven, 2015	Turkey	GDP per capita, education, the population in rural and urban areas, agricultural production per capita, net migration, weather index, electricity price	Annual data (2002-2010) South-east of Antalya. 3SLS and IV-GMM	The level of education and high income has a negative impact on electricity theft, while the price of electricity, rural population, migration rate, and heat have a positive impact on electricity theft
Kwakwa, 2018	Ghana	Education level, electricity price, income, investment in electricity grid infrastructure, population, number of manufacturing companies, political conditions	Annual data (1971-2013) data source: World Development Indicators 2015. FMOLS and CCR	The increase in income, the level of education and investment in the fixed capital of the electricity grid have a negative effect on the loss of electricity, while the increase in the population, price of electricity, and the number of manufacturing companies have a positive impact on losses
Mimmi and Ecer, 2010	Brazil	The monthly consumption rate of electricity, income, energy-saving behaviors, availability of energy saving devices, payment of social tariffs, use of electricity in domestic businesses	Cross-sectional data (10-2006-10/2007). The study unit is households, probit, IV probit, biprobit	High income and energy saving behaviors reduce the likelihood of electricity theft, While the use of devices that do not save electricity and the use of electricity for the business inside the dwelling, increases the possibility of theft of electricity

villages and towns of Ramallah and Al-Bireh. Where annual data were taken for the following variables: Price per kilowatt. Hour, number of subscriptions, average fines for each case of theft from the electricity grid, maintenance expenses, and the number of pre-paid meters. The second source of data is the PCBS, where annual data on unemployment, education, and daily wage rates were taken in Ramallah and Al-Bireh governorates.

3.3. Description of Study Variables

To achieve the objectives of the study, and to give a clearer sight of the variables of the study, a statistical description of the variables of the study was made Table 1 shows this.

It is evident from Table 2 that the average wage for the daily wage in Ramallah and Al-Bireh is NIS 108. This wage is considered large if compared to the daily wage in the other governorates. While the average annual unemployment rate was 16.3%, which is lower than the average unemployment rate in the West Bank for 2018. The percentage of individuals (17 years and above) with a high school certificate for the years 2010-2018 is 44.5%, and the illiteracy rate among the Palestinian population in Ramallah and Al-Bireh Governorate reached 3.5% in 2017.

Table 2 shows that the average annual number of subscribers in the electricity grid in the governorate of Ramallah and Al-Bireh for the period 2010-2018 is about 107450 subscribers. The Jerusalem Electricity Company is replacing the regular meters with pre-paid meters since the average number of pre-paid meters is about 39960, which about 37% of total subscriptions. The reason for the installation of prepaid meters is due to the electricity company's desire to collect previous debts from subscribers and reduce electricity losses, as the ability to manipulate pre-paid meters is lower.

One of the tools used by the Jerusalem Electricity Company to reduce electricity losses is the imposition of fines on violators and aggressors on the electricity grid, where the average fine for each case of theft is about 10166 shekels.

The Jerusalem Electricity Company is developing the grid through periodic maintenance, and development, since the average maintenance and development costs for the Jerusalem electricity grid amounted to NIS 5.68 million.

It is worth noting that the average annual loss of electricity for the governorate of Ramallah and Al-Bireh is 146.56 MW. An average cost of NIS 57.600 million. This bleeding reduces the ability to develop the electricity grid and thus reduces the quality of the investment-attracting infrastructure.

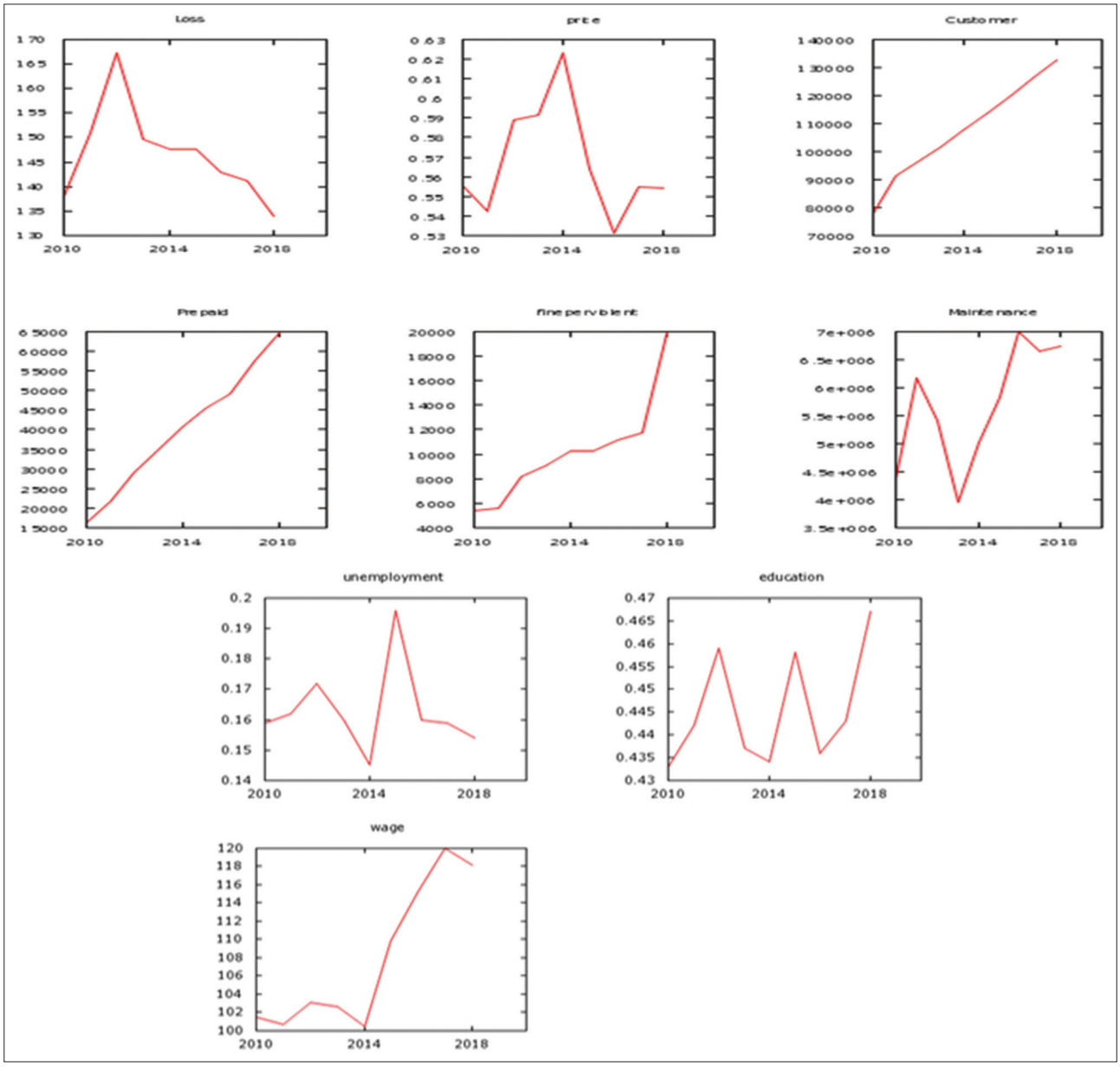
To illustrate the change in the study variables during the period 2010-2018 in Ramallah and Al-Bireh Governorate, Figure 1 shows this.

Figure 1 shows that the amount of electricity loss increased sharply until it reached its highest point in 2012, and then the amount

Table 2: Statistical description of study variables

Statistic	Wage	Unemployment	Price	Prepaid	Maintenance	Loss	Education	Customer	Fineperviolent
Mean	107.9556	0.1630	0.5673	39960.5	5684288	146.56	0.4454	107450.6	10166.05
Median	103.1000	0.1600	0.5552	40718.0	5824778	147.54	0.4420	107667.0	10251.57
Max.	120.0000	0.1960	0.6234	64690.0	6994724	167.33	0.4670	132436.0	19886.13
Min.	100.5000	0.1450	0.5314	16390.0	3966607	133.94	0.4330	77762.0	5393.056
Standard deviation	7.969	0.0142	0.0286	16067.8	1073075	9.5805	0.0126	17534.4	4282.077

Figure 1: The change of study variables during 2010-2018



of loss fell, reaching its lowest value in 2018, while the number of subscribers, the number of prepaid meters, and the fine for each theft case of the electricity grid are increasing sharply and continuously. Whereas the percentage of those with a high school diploma, and the unemployment rate fluctuate during this period.

The price per kilowatt. Hour, it began to decline since the beginning of 2010, then began to rise sharply and large, until it reached the highest point in 2014, and then began to decline sharply, reaching its lowest point in 2017.

If we look at the wages of workers in Ramallah and Al-Bireh, we will find that the wages were stable and convergent from 2010-2014, as there was no noticeable change in wages during this period. Then wages began to increase steadily from 2014 to 2017, and then wages fell slightly in 2018.

3.4. Model

After reviewing the literature of the study, and the available data in the Jerusalem Electricity Company, and in the PCBS, the following model was applied:

$$Loss_t = \alpha_0+\alpha_1 Price_t+\alpha_2 Customer_t+\alpha_3 Fineperviolent_t+\alpha_4 Maintenance_t+\alpha_5 Prepaid_t+\alpha_6 Wage_t+\alpha_7 Education_t+\alpha_8 Unemployment_t \quad (1)$$

To determine which of the variables of the study has a causal relationship with the loss of electricity, the researcher did a Granger causality test, and Table 3 shows this. Based on the results of the Granger causality test, the variables with a causal effect on the losses in electricity were taken, and the variables that have no causal effect on the loss of electricity were eliminated. Thus, the form of the model became as follows:

$$Loss_t=\alpha_0+\alpha_1 Wage_t+\alpha_2 Fineperviolent_t+\alpha_3 Customer_t+\alpha_4 Prepaid_t \quad (2)$$

The number of subscribers and the number of prepaid meters are cumulative, and the value of each year affects the value of the following year, so that, the researcher took the difference between the values of each year and the following, in order to find the amount of increase in values, and eliminate the effect of previous years. Thus, the form of the model became as follows:

$$Loss_t=\alpha_0+\alpha_1 Wage_t+\alpha_2 Fineperviolent_t+\alpha_3 \Delta Customer_t+\alpha_4 \Delta Prepaid_t \quad (3)$$

The units of measurement for the study variables are different. Since the unit of electricity loss is megawatt, the unit of wages and fines for each case of aggression is the Israeli shekel, and the unit of the prepaid meters is the meter, so that, the researcher calculated the logarithm of all the variables, to consolidate units to percentages, as well as to facilitate the interpretation of results. Thus, the study model will be as follows:

$$Log(Loss_t)=\alpha_0+\alpha_1 Log(Wage_t)+\alpha_2 Log(Fineperviolent_t)+\alpha_3 Log(\Delta Customer_t)+\alpha_4 Log(\Delta Prepaid_t) \quad (4)$$

Since the annual loss of electricity will affect the improvement of the electricity grid, and investment in it, which will lead to another loss in the following years, and to control the impact of electricity losses over the past years, the researcher added the difference in the annual loss as an independent variable in the model, so, the study model is as follows:

$$Log(Loss_t)=\alpha_0+\alpha_1 Log(Wage_t)+\alpha_2 Log(Fineperviolent_t)+\alpha_3 Log(\Delta Customer_t)+\alpha_4 Log(\Delta Prepaid_t)+\Delta Loss_t \quad (5)$$

Table 3: Granger causality tests

Null hypothesis	F-statistic	Prob.
Wage does not granger cause loss	6.3999	0.0525
Price does not granger cause loss	0.1867	0.6836
Unemployment does not granger cause loss	0.1983	0.6747
Education does not granger cause loss	0.9090	0.3842
Fineperviolent does not granger cause loss	13.3858	0.0146
Customer does not granger cause loss	6.1031	0.0565
Prepaid does not granger cause loss	9.6822	0.0265
Maintenance does not granger cause loss	0.2563	0.6341

4. ANALYSIS AND RESULTS

4.1. Correlations between Study Variables

To illustrate the nature and strength of the correlation between the independent variables of the study on the one hand, and then the independent and dependent variable of the study on the other, the correlation matrix was done using the EViews program, and Table 4 illustrates this.

Table 4 shows that the loss of electricity is negatively correlated with wages, maintenance expenses, number of prepaid meters, the value of the fine for each case of theft from the electricity grid, and the number of subscribers. These correlations are consistent with the results of previous studies.

While there is a strong positive correlation between the number of subscribers and the number of pre-paid meters, this strong correlation can be explained by the fact that for each new subscriber, a pre-paid meter is installed, so there will be a strong positive correlation.

There is a strong positive correlation between the number of subscribers, and the value of the fine for each case of theft from the electricity grid on the one hand. On the other hand, there is a strong positive correlation between and the number of pre-paid meters, and the value of the fines, this correlation can be explained by the tendency of municipalities and local councils to raise the fines for each case of theft from electricity grid, after replacing the regular electricity meters with pre-paid meters.

4.2. Test the Hypotheses of the Study

The researcher in this section tested the hypothesis of the study, using Granger causality test. Where the test shows the causal relationship between the independent variables and the dependent variable, and Table 3 shows that.

The results of the granger causality test show that the wages, number of subscribers are associated with a causal relationship with the loss of electricity at α=0.1, where Prob. (Wage) <0.1, Prob. (Customer) <0.1.

Table 4: Correlation matrix

	Wage	Unemployment	Price	Prepaid	Maintenance	Loss	Education	Customer	Fineperviolent
Wage	1.0000	0.0422	−0.5140	0.8785	0.7697	−0.5222	0.3935	0.8707	0.7466
Unemployment	0.0422	1.0000	−0.1977	−0.0710	0.0539	0.3366	0.4627	−0.0468	−0.1781
Price	−0.5140	−0.1977	1.0000	−0.1260	−0.6259	0.4234	−0.0929	−0.1537	−0.0713
Prepaid	0.8785	−0.0710	−0.1260	1.0000	0.6467	−0.4507	0.4376	0.9918	0.9080
Maintenance	0.7697	0.0539	−0.6259	0.6467	1.0000	−0.2628	0.3963	0.6989	0.5296
Loss	−0.5222	0.3366	0.4234	−0.4507	−0.2628	1.0000	0.1281	−0.3857	−0.4814
Education	0.3935	0.4627	−0.0929	0.4376	0.3963	0.1281	1.0000	0.4353	0.5881
Customer	0.8707	−0.0468	−0.1537	0.9918	0.6989	−0.3857	0.4353	1.0000	0.8783
Fineperviolent	0.7466	−0.1781	−0.0713	0.9080	0.5296	−0.4814	0.5881	0.8783	1.0000

The results show that there is a causal relationship between the value of fines imposed on each case of theft from the electricity grid, and the number of pre-paid meters on the one hand, and the loss of electricity on the other hand at the level of α=0.05, Where Prob. (Fineperviolent) <0.05, Prob. (Prepaid) <0.05.

Therefore, we reject the null hypothesis, which that the wages, number of subscribers, number of prepaid meters, and the value of fines, have no causal relationship with the loss of electricity.

Table 3 shows that there is no causal relationship between education, unemployment, and the price of electricity with the loss of electricity, where Prob.=0.3842, 0.6747, and 0.6836 respectively, greater than α=0.1.

4.3. Regression Results

To achieve the objectives of the study, the OLS method was performed. And then, the OLS hypotheses were tested to confirm that the study results are best linear and unbiased estimator (BLUE). By using EViews. 10 Table 5 shows the results of the regression analysis.

Table 5 shows that the study model is statistically significant at α=0.1, where Prob. (F-statistic)=0.0849. It turns out that R^2=96% and Adjusted R^2=87%, meaning that the model interprets about 96% of the change in the dependent variable.

Before presenting regression results, the researcher tested OLS assumptions, to ensure that the results of the study become BLUE. Therefore, tests were performed for multicollinearity, autocorrelation, and heteroscedasticity. Table 6 shows the results of the multicollinearity test.

Multicollinearity testing was performed, to detect and measure the correlation between independent study variables. Table 6 shows that variance inflation factors <10 for all model variables, so there will be no multicollinearity problem in the model.

Heteroscedasticity test to ensure that the model has a constant variance, and when the model without constant variance, it will be linear unbiased, but not best linear. Table 7 shows the results of the heteroscedasticity test.

Table 7 shows that Obs×R^2=0.6427 <0.05, i.e. we do not reject the null hypothesis, which views that the model has constant variance. Thus there is no heteroscedasticity problem in the model.

The next OLS test is an autocorrelation test using the Breusch-Godfrey Serial Correlation LM test, which reveals a correlation between error terms. Table 8 shows the results of the autocorrelation test.

Table 8 shows that Obs×R^2=0.3465 >0.05, i.e. we do not reject the null hypothesis, that indicates no autocorrelation problem.

In order to explain the results of the regression analysis from Table 5, when fines for theft from the electricity grid are increased by 1%, the loss of electricity will decrease by 0.13%. This is because the fines constitute a deterrent to the aggressors on the electricity grid, but this relationship is not statistically significant, where Prob.=0.1121>α=0.05.

The second independent variable (wages), shows that when wages increase by 1%, the loss of electricity will be reduced by 0.14%. This is because the subscriber becomes more able to pay electricity bills when wages increase, thus reducing the desire to theft from the electricity grid, but the results show that this relationship is not statistically significant, where Prob.=0.5254 > α=0.05.

Another result, when the number of subscribers increases by 1% per year, the loss of electricity will be reduced by 0.3%. This is contrary to the literature review, this can be explained by the fact that new subscribers are more disciplined and installed with a modern infrastructure, so the loss will decrease as subscribers increase.

Table 5: Regression results

Dependent variable: Log (loss)				
Method: Least squares				
Sample (adjusted): 2011-2018				
Included observations: 8 after adjustment				
Variable	**Coefficient**	**Std. Error**	**t-statistic**	**Prob.**
C	7.8622	0.7026	11.1889	0.0079
$Loss_t - Loss_{t-1}$	0.0023	0.0009	2.4035	0.1381
Log (fineperviolent)	−0.1340	0.0490	−2.7302	0.1121
Log (wage)	−0.1420	0.1862	−0.7625	0.5254
Log ($customer_t - custumer_{t-1}$)	−0.3072	0.0071	−3.8811	0.0604
Log ($prepaid_t - prepaid_{t-1}$)	0.0544	0.0867	0.6276	0.5944
R-square	0.9651	Mean dependent var		4.9928
Adjusted R-square	0.8779	S.D. dependent var		0.0641
S.E. of regression	0.0224	Akaike info criterion		−4.6449
Sum squared residual	0.0010	Schwarz criterion		−4.5854
Log likelihood	24.579	Hannan-Quinn criter		−5.0468
F-statistic	11.069	Durbin-Watson stat		2.2308
Prob. (F-statistic)	0.0849			

Table 6: Multicollinearity test

VIF	
Variable	**Centered VIF**
$Loss_t$-$Loss_{t-1}$	1.5908
Log (Fineperviolent)	4.3025
Log (Wage)	2.6499
Log ($Customer_t$−$Custumer_{t-1}$)	1.6008
Log ($Prepaid_t$−$Prepaid_{t-1}$)	1.1561

VIF: Variance inflation factors

Table 7: Heteroskedasticity test

Heteroskedasticity test: Breusch-Pagan-Godfrey		
Null hypothesis: Homoskedasticity		
F-statistic	0.2915 Prob. F (5,2)	0.8846
Obs×R^2	3.3726 Prob. Chi-square (5)	0.6427
Scaled explained SS	0.0771 Prob. Chi-Square (5)	0.9999

Table 8: Autocorrelation test

Breusch-godfrey serial correlation LM test		
Null hypothesis: No serial correlation at up to 1 lag		
F-statistic	0.1245 Prob. F (1,1)	0.7840
Obs×R^2	0.8862 Prob. Chi-Square (1)	0.3465

As for the effect of the annual increase in the number of pre-paid meters on the loss of electricity, the results show that the relationship is not statistically significant.

5. CONCLUSIONS

The study investigated the factors that affect the amount of electricity loss in Ramallah and Al-Bireh Governorate in Palestine. The study concluded that there is a causal relationship between the amount of electricity loss on the one hand, and the wages, the number of participants, the fines imposed on the theft of electricity, and Prepaid meters on the other hand. While the study showed that there is no causal relationship between the price of electricity, unemployment, education, and maintenance costs on the one hand, and the amount of loss on the other hand.

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The results showed that there is a negative relationship between the daily wage and the amount of electricity loss. This result is consistent with the results of (Gaur and Gupta, 2016), (Jamil and Ahmad, 2014), (Kwakwa, 2018), and (Mimmi and Ecer, 2010), Who stressed that the increase in wages has a negative impact on the loss of electricity. As wages increase, subscribers become more able to pay their electricity, without risking electricity theft and legal accountability.

The study also showed a negative relationship between the value of fines for each case of theft of electricity and the amount of loss in electricity. This finding is in line with the findings of (Jamil and Ahmad, 2014) and (Obafemi and Ifere, 2012), which confirm that one of the ways to reduce electricity losses is to impose high fines on aggressors on the electricity grid.

The results of the study indicate the negative impact of the number of participants on electricity losses, which is contrary to the results of the study (Gaur and Gupta, 2016), (Yurtseven, 2015), and the study (Kwakwa, 2018), who found that increasing the number of subscribers lead to an increase in electricity losses. This difference can be explained by the fact that new subscribers are using newer extensions and technologies than old subscriptions, thus reducing electricity losses as subscriber numbers increase.

The study came out with the need to conduct additional research solutions to the problem of loss of electricity and focus on the problem of loss of electricity in the Palestinian camps. According to the Jerusalem Electricity Company, the company's losses in the camps alone amounted to about 120 million shekels a year, due to the non-payment of electricity consumed in the camps. Knowing that this issue is a political one.

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