Journal of Water Resources and Ocean Science
2017; 6(2): 35-45
http://www.sciencepublishinggroup.com/j/wros
doi: 10.11648/j.wros.20170602.12
ISSN: 2328-7969 (Print); ISSN: 2328-7993 (Online)

The Determinants of Non-Revenue Water & Financial Viability for the Palestinian Water Service Providers

Abdullah Murrar[1, 2], Abdelrahman Tamim[3, 4], Subhi Samhan[5]

[1]Faculty of Graduate Studies, Strategic Planning & Fundraising, Arab American University Jenin, Jenin, Palestine

[2]Tariff & Licensing Directorate, Water Sector Regulatory Council, Ramallah, Palestine

[3]Faculty of Graduate Studies, Arab American University Jenin, Jenin, Palestine

[4]General Directorate, Palestinian Hydrology Group for Water and Environmental Resources Development, Jerusalem, Palestine

[5]Research and Development Directorate, Palestinian Water Authority, Ramallah, Palestine

Email address:

abdullah.murrar@gmail.com (A. Murrar), a.tamimi@phg.org (A. Tamim), subhisamhan@yahoo.com (S. Samhan)

To cite this article:

Abdullah Murrar, Abdelrahman Tamim, Subhi Samhan. The Determinants of Non-Revenue Water & Financial Viability for the Palestinian Water Service Providers. *Journal of Water Resources and Ocean Science*. Vol. 6, No. 2, 2017, pp. 35-45. doi: 10.11648/j.wros.20170602.12

Received: April 13, 2017; **Accepted**: April 21, 2017; **Published**: May 23, 2017

Abstract: Imagine that your water service provider gives your family at the end of the year $70 as a result of non-revenue water. Indeed, it is the value of Palestinian non-revenue water for year 2015; where, it was equivalent to a deposit $13 for each individual person. Due to its importance, this paper empirically evaluates the determinants of non-revenue water for the providers that deliver water services to 72% of Palestinian population. Two multiple regressions have been conducted; the first one measuring the non-revenue water. The findings of this measurement show that staff productivity, daily consumption, average price, energy cost, service providers' size and structure, have significant impact on the non-revenue water; wherein, the water production variable impact is not significant. However, those predictors have been included into another regression to explain the financial viability of the Palestinian Water Service Providers. The results indicate that staff productivity, daily consumption, average price, energy cost, and water production have significant effect on the financial viability. Only service providers' size and structure, have insignificant effect. In Palestine, the Palestinian Water Authority (PWA) is the policy maker. The results of this research implicate that PWA may put targets for Palestinian Service Providers at national level; such as non-revenue water, staff productivity, profitability, and water production. Therefore, this will lead to increase the performance of the water providers in non-revenue water and overall enhance their financial viability.

Keywords: Financial Viability, Non-Revenue Water, Palestinian Water Service Providers, PWA, WSRC

1. Introduction

On daily basis, water service providers lose considerable quantity of water. Technical difficulties related are to water leakages during pumping, storage, transmission in main pipes or in distribution networks are common causes of this loss. Other factors that could magnify water losses are thefts or illegal connections and metering inaccuracies. On the other hand, water service providers may not count, or bill, the quantity consumed by particular entities; such as government and public utilities. Therefore, the total of non-revenue water can be viewed as the aggregate of leakages, illegal connections, metering inaccuracies, and unbilled consumption [2].

The implications of non-revenue water are miscellaneous. Decreasing the expected water sales for the service providers, and increasing the water production quantities to cover the lost volume can be considered as examples. Likewise, in physical leakages, the risk of contamination occurrence and networks damage will also be increased. When the quantities of non-revenue water are at high levels, they threaten the ability of the water service providers to deliver enough quantities to their customers. The implications might go beyond micro units to water intermittent supply, social inequality and significant public health risk [11].

From a financial point of view, the quantities of non-revenue negatively affect water service providers on three scales. Firstly, they reduce the operating revenue (i.e. the

water sales invoices will not be issued as a result of unbilled or unmetered consumption). Secondly, increase the cost of production, operations and maintenance (i.e. salaries, electricity, and chemical cost). Thirdly, increase investment provisions and budget allocation for capital expenditures; additional amount have to be spent on investment in facilities. Those investments are mainly to meet the increasing demand and environmental effect, beside the disbursement on water production and distribution cost. [9]. Consequently, non-revenue water has major impact on water utilities bottom line i.e. the profit.

Given the fact that generating profits is a key aspect of maintaining water service providers' financial viability and sustainability, the non-revenue water would be a good indicator for management performance; high percentage indicates poor management. While some studies measure the financial viability in terms of returns on assets. Dave, Wadhwa, Aggarwal, & Seetharaman, [7], others and this research measure it by profit [29].

Due to their high important on service continuity and efficiency of water providers, this paper investigates the variables affect non-revenue water and financial viability for Palestinian water service providers. With the ultimate goal of exploring those variables, identifying the practical implications for better management of water utilities are main purposes of this study. Before that, next section in this paper shortly reviews previous studies that are in the same field. Then it presents model specification and methodology that are adapted. The descriptive and inferential analyses are developed in a specific section. Thereafter, the policy implications section has been carefully considered to provide practical recommendations for better performance of water sector.

2. Literature Review

The current study draws upon the related literature to extract the key variables affect non-revenue water, and then to explore the relationships among these variables and financial viability of utility firms. Although there is a long strand of literatures around non-revenue water especially in the developing countries, little researches take the determinates of non-revenue water in conjunction with financial viability of water service providers. It was imperative therefore to review related studies from other paradigms, besides what have been written in both subjects.

Non-revenue water can be shortly regarded as differences between supplied quantities i.e. produced or purchased or both and put in the distribution system from one side, and billed quantities to the end customers from the other side. [19] Many factors lead to increase non-revenue water. González-Gómez, García-Rubio & Guardiola, [14] investigated the reasons of high non-revenue water. They found that lack of incentive for utilities management to decrease the non-revenue, corruption among utilities management, carelessness of political level and also lack of awareness campaigns for customers are main reasons for high non-revenue water.

Mathur & Vijay, [21] found that customers give little or no attention towards conservation of water since its inexpensive and therefore this encourages people to waste. In order to decrease non-revenue quantities, water providers have to increase the revenue collection to cover operating and maintenance cost. Gongera Enock, [8] studied the strategies of unaccounted water for Nakuru water company in Kenya. The researcher found that establishing appropriate strategies for unaccounted water leads to increase revenue for water service providers, and delivers more services to more customers.

Gjinali & Giantris, [13] were interested in studying Greater Balkans, such as Albania, Kosovo, Montenegro, Bosnia-Herzegovina, Macedonia, and Moldova since they have NRW values ranging between 40% and 70%. The researchers concluded that administrative issues have direct impact on the energy cost and continuing of water services. The staff skills, productivity, automated meters reading have high potential to reduce non-revenue percentage, therefore, administrative issues are main concerns in those counties. Abdullah Murrar, [25] studied the determinants of non-revenue water in Balkan countries. The researcher finds that increasing in metering level ratio and labor; lead to decrease the non-revenue water percentage. On the opposite side, more consumption per person, production per connection, number of population, network connection density, operating cost per cubic meter sold and number of connections, all those variables raise the non-revenue water percentage. The researcher calls for coordination, amalgamations and multiple efforts to handle this high percentage.

Caroline van den Berg [19] analyzed the non-revenue water for water utilities in 68 countries for five years. The findings of research indicated that some factors are out of control of water utilities management, such as population density, length of the network and the type of network distribution. Those variables are resulted from pattern of population, and the water utilities can do nothing to fully control those issues. Bisztray, Kis, Muraközy & Ungvári, [5] found that non-revenue water is a significant determinant of the unit cost of water service, where, 10 percent decrease in non-revenue water saves 3 percent in each unit cost of water. The astonishing result was found in the most significant variable which was the water consumption per capita. If a water utility serves with 10 percent higher per capita, its unit costs will be decreased by about 8 percent. Therefore, negative relationship is found between the cost and consumption, from one side, and same relationship i.e. inverse is also appeared between non-revenue water and cost per unit from the other side.

Some water utilities don't consider the non-revenue water in unit cost during the pricing process, Grima. A. P, [15] studied water rate modification, indicating that pricing urban water services in Ontario, Canada was up to a decade ago somewhat not cost-related and are underpriced especially in terms of new connections.

In Spain, a study indicates that, current water prices do not

encourage the control of water losses in supply networks [32]. The study shows inverse correlation between investment and non-revenue water. One can conclude, the more the price, the more the investment, which might lead depreciation in non-revenue water.

The size and structure of service providers may have impact on the percentage of non-revenue water. A study in Zimbabwe shows that service providers, especially in large scales and in developed countries have better performance due to benchmarking, monitoring financial performance, operational indicators, emerging new equipment and advanced technology for leak detection. However, those capabilities are limited in developing countries and small utilities [20].

The non-revenue water has direct impact on financial position of the water utilities. Onsomu, Bichanga, Munene & Obonyo, [29] studied the relationship between non-revenue water and financial viability of Gusii Water and Sanitation Company Limited as case study. The findings propose non-revenue water has direct effect on revenue adequacy. However, the researcher finds that cost in service delivery is influenced by non-revenue water, energy and staff costs. One may conclude; since non-revenue water affect cost and revenue then, by default, will have significant impact on the financial viability of the water providers. The study finds that increasing one percent in non-revenue water reduces the Gusii Company financial viability by 19 percent.

Data gathered from South Africa representing over 75% of the total volume of water supply shows that the estimated non-revenue water for the whole country was 36.8% [22]. The study presents non-revenue water as a percentage of total water cost, which was generally 36%. Expressed in further details, total non-revenue water was about 46% of total cost for rural or small providers; where it was 35% for urban service providers cost. Therefore, the size of water providers, the cost, and the non-revenue water have effect on financial viability. The larger the size, the less the non-revenue water; the more the financial viability can be achieved. Other interesting finding of the study is, low level of customers' payment causing increases in non-revenue water level. Since there is little incentive to save water when no intention to pay for it.

The financial viability may be affected by staff productivity. As a general rule, the more the staff number serves 1,000 connections, the less the productivity of this staff. Mugabi, Kayaga & Njiru [23] recommend to follow participatory methodology in development, where, all level of seniority staff and gender have to be involved to increase capacities. This causes more in productivity, less cost inefficiencies and financial viability. McKenzie, Siqalaba & Wegelin, [22] find that an increase in the number of staff per 1,000 water connections reduces the service providers' profitability by 7.4 percent. Kim & Ployhart, [18] examined why and weather staffing and training influence firm-level financial performance, profit and growth for 359 firms with over 12 years of Longitudinal data. The results indicated that effective and trained staff always outperform competitors for those companies; therefore, the more the productivity of staff, the more the profitability of the service provider and the more the financial viability, other things being constant.

3. The Research Study Method

A review of related studies clearly elucidated that there are many variables and strategies can be adapted by water service providers to reduce non-revenue water and to enhance the financial viability. This research will test by conducting multiple regressions the relationship and significant impact of staff productivity, daily consumption, average water price, energy cost, service provider size, service provider structure, and production percent from water supplies on non-revenue water and on financial viability of Palestinian water service providers.

Field visit to different sizes of Palestinian water service providers to perform interviews with the decision makers, was the first process in this method. According to the Water Sector Regulator Council, the service providers are classified into three broad categories, the first one is small, where, they serve less than 2,000 connections. Medium scale where, providers serve from 2,000 to 8,000 connections. However, the third category which is the largest scale of distribution due to their services more than 8,000 active connections [34].

The overall purpose of the interview hence, is to have full understanding of the water providers' procedures, and programs to reduce non-revenue water, and think strategically to enhance their financial viability. The exerted variables as per literature reviews also verified with those managers. In addition to interviews, secondary data have been collected from published performance indicator reports of Palestinian water service providers. The Performance Reports were published by *Palestinian Water Authority* (*PWA);* and currently are published by *Water Sector Regulatory Council (WSRC);* with full support as financial and technical advisors team by *Deutsche Gesellschaft fuer Internationale Zusammenarbeit (GIZ) Water Program*. According to the Water Sector Regulatory Council, the published data in 2015 report covers about 72% of total Palestinian population [35]. Expressed in other terms, the sample size in this research has included all service providers that deliver water services to 72% of the Palestinian population. However, to avoid not representative sample i.e. may be too small, a cross sectional data has been considered; where, this research includes all data in performance reports from year 2010 and up to year 2015 for all service providers [6].

4. The Research Design

Referring to Figure. 1, the framework was inspired and adapted from Murrar [24, 26], and Onsomu, Bichanga, Munene & Obonyo models [29]. Wherein this research, the examination evaluates the impact of the seven independent variables on the non-revenue for the first panel, on the other panel, it shows the effect of those variables on the financial viability.

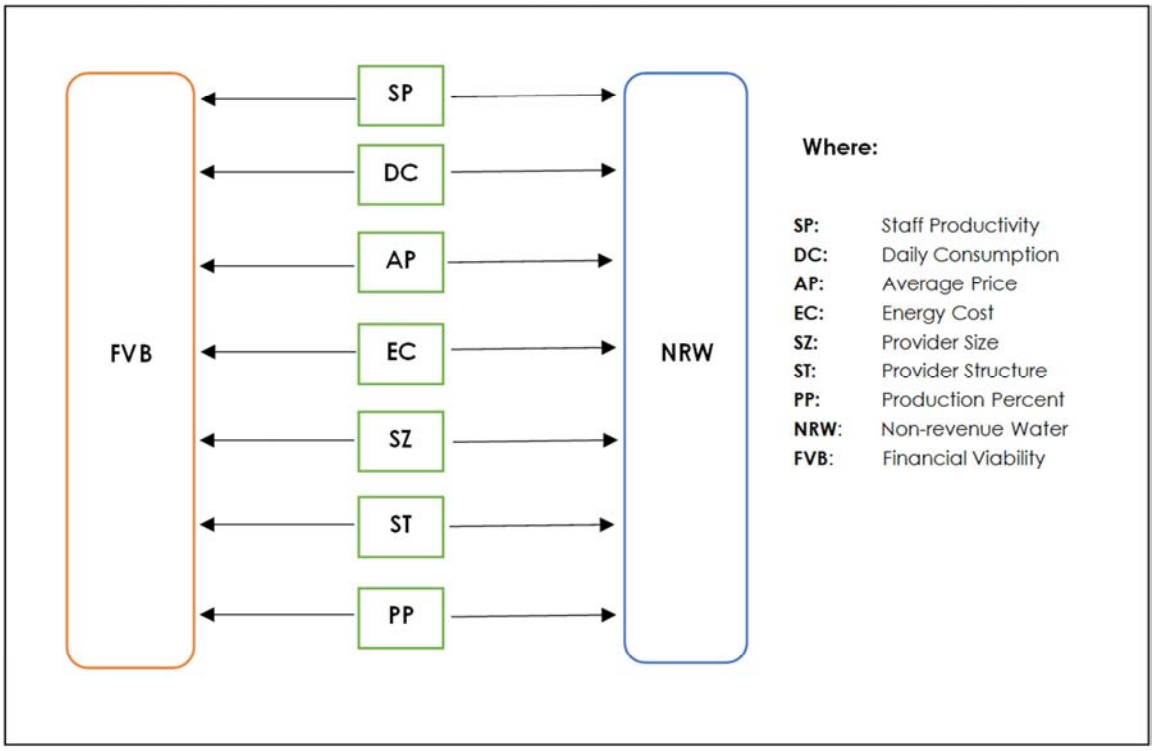

Figure 1. *Research Model.*

Based on the above diagram, the financial viability and non-revenue water can be as per the following: -

$$NRW = \alpha + \beta_{1sp} + \beta_{2dc} + \beta_{3ap} + \beta_{4ec} + \beta_{5sz+} \beta_{6st+} \beta_{7pp+} \ldots\varepsilon\ldots\ldots (1)$$

$$FVB = \alpha + \beta_{1sp} + \beta_{2dc} + \beta_{3ap} + \beta_{4ec} + \beta_{5sz+} \beta_{6st+} \beta_{7pp+} \ldots\varepsilon\ldots\ldots\ldots (2)$$

where: -

α = Constant.

$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7$ = Coefficients of the model variables.

SP= Staff Productivity predictor.

DC= Daily Consumption predictor.

AP= Average Price predictor.

EC= Energy Cost predictor.

SZ= Provider Size predictor.

ST= Provider Structure predictor.

PP= Production Percent predictor.

NRW: =Non-revenue Water respondent.

FVB= Financial Viability respondent.

5. Research Analysis & Discussion

The collected data from published performance reports have been analyzed and tested using Statistical Package for Social Science (SPSS). Both descriptive and inferential analyses have been carried out.

5.1. Factor & Multicollinearity Analysis

Factor analysis is carried out to determine if the collected data can be grouped according to items in each of the assumed dimension, and to detect structure in the relationship between variables. According to Table 1, *Kaiser-Meyer-Olkin Measure of Sampling Adequacy*, shows the value as 0.585. Generally, more than 0.5 is considered to be acceptable. The table presents *Bartlett's Test of Sphericity* statistically significant value i.e. less than.01. Further, the values communalities generally after extraction should probably be above 0.5. Table 2, generates *KMO Communalities* values as all above required values [10]. Table 3 extracts three variables that those explain 68% of variance. Therefore, the results of factor analysis are statistically significant, high communalities, and acceptable values KMO.

When independent variables are correlated, there is the possibility of multicollinearity i.e. high correlations. This term has impact on the regression and it increases estimate of parameter variance. *Tolerance Levels and (TLV) Variance Inflation Factor (VIF)* both are used in the multicollinearity. In order to determine the existence of multicollinearity for a particular variable; and referring to O'BRIEN [28], tolerance level should be more than or equal to.01 and VIF value is 10, 20, 40 or higher. In this paper, all predictor variables are examined to determine the existence of multicollinearity. According to Table 4 all those variables have tolerance more than 0.1; further, all of the (VIFs) are less than 10. This implies that no existence of multicollinearity in the model and all predictor variables have been included in the model.

5.2. Descriptive Statistic Analysis

Table 5 displays the basic values about the variables. The non-revenue water is 32%, where, the minimum value is only 4% and the highest value is 59%. A study for World Bank

shows non-revenue water in developed countries is 15%, in Eurasia 30% and in developing countries 35%. The result of developing countries is matched with IBNET database which is 35% as reported by 900 utilities in 44 developing countries [19]. In Palestinian water sector, some water service providers have old network compared with other providers. The largest Palestinian water service provider is Jerusalem Water Undertaking; this utility provides water services for about 62,000 connections. It was established in 1949, so the network service age is near to 70 years [17]. In this paper, the researcher conducted field visit to Ellar Municipality. It is a small provider that delivers water services to 1,430 connections. The water network was built before few years to serve total number of population in the town which is near to 7,000 residents. The non-revenue water is less than 7%. This water provider implements many processes to keep minimum non-revenue water percentage such as: all meters are fixed outside the customer's houses. This benefits the water collector since he or she can read the meter without entering resident house. It can prevent the illegal connections, since the meter can be shown from the main street. The water department in Ellar municipality issues the invoices to all authorizes as public utilities and the metering level is maximum.

In this research, the number of staff that are serving 1,000 water connections are 4.8 employees, where, the overstaffing is 13.7. Generally, the more the staffing, the less the productivity; where when the number is less than 3 or 4 employees, it may affect the service delivery. In Mexico it was 5.2 employees [1].

The average consumption for all types is 92 liters per capita per day. Of course this quantity will be less if it considers only the domestic level. Some Palestinian areas especially in Hebron which faces water shortage; the average consumption per capita per day is 25 liters i.e. is too low [16]. On the other hand, in some areas like Qalqilia & Jericho, the water is available. But the *Palestinian Water Authority PWA* can't transmit the water to Hebron and other areas that have shortages without Israeli approval.

For utilities that depend mainly over the production from their own wells rather than purchases, the energy cost always more, because it costs more electricity and energy to pump water. Table 5 shows large differences in energy, i.e. minimum.01 and maximum is 8.71, where, the average is 0.67 NIS. In Gaza, and during the Israeli attack, there was shortage in fuel and its cost was very high. In other water providers, the cost of energy is minor, since there is no need for pumping.

Generally, the average price is 3.67 NIS i.e. about one dollar per cubic meter. The table comes with the fact that the price is insufficient to generate profit or even covers operating and maintenance cost; the average losses are near to 30%. This loss percentage affects the financial sustainability and viability of the Palestinian water providers to secure their financial resources effectively [12].

Table 5 records the size and structure of the Palestinian water providers that shared in performance report 2015 and are serving 72% of Palestinian population. According to WSRC [35], 18% are large water providers i.e. serving more than 8,000 connections; whereby 47% are in the medium scale; and the rest are small providers i.e. serving less than 2,000 connections. On the other hand, near to 87% of Palestinian water providers are in forms of municipalities.

In this research and on macro level, the non-revenue water has financial value, it is calculated based on average price for the commercial losses and on the cost for the physical losses. The total value of non-revenue water for 72% of Palestinians' service providers in year 2015 is $ 43,778,000 with assumption that physical leakage is 6% as per sample taken from the water balance of some service providers. If this amount is divided by the number of Palestinian; then, at the end of the year, water utility will give to each person $12.7 i.e. $70 for each Palestinian family!

Another aspect of financial viability is the invoice collection from customers. In Palestinian water providers the average customers' payment is only 65% from annual sales of water. If the water utility issues sales invoice by $100, then it receipts $65 and the remaining amount will be accumulated as debt for the next year. Some water providers have large percentage of collection i.e. they implement prepaid meters, and other have low percentage. In some areas only 30% collection i.e. areas are facing water unviability and very poor services. Currently, large amount of debt is accumulated on water providers and this, for sure, affects their financial sustainability.

5.3. Multiple Regression Analysis

A histogram of standardized residuals Figure 3 shows a normally distributed residual error. However, the figure also plots approximately linear, as a result of observed cumulative probabilities of occurrence against expected cumulative probabilities. Table 6 presents correlation between the variables in the model; and Table 7 shows the results of two regressions. The first regression has been developed to measure the non-revenue water; seven predictors have been included. Excluding the water production variable, all other independent variables have significant impact on non-revenue water, where, staff productivity ($r = 0.38$, $p = 0.011$), daily consumption, ($r = -0.085$, $p = 0.00$), average water price ($r = -0.247$, $p = 0.041$), energy cost ($r = 0.395$, $p= 0.011$), water production ($r = 0.433$, $p = 0.084$), service providers' structure ($r = 0.278$, $p= 0.000$) and service providers' size ($r = -0.291$, $p = 0.002$). Based on those results, there is significant impact of staff productivity, daily consumption, average water price, energy cost, service providers' structure and service providers' size, on the non-revenue water of Palestinian water service providers.

Further, another regression has been conducted to measure the financial viability; the same predictors for non-revenue water have been included in this measurement. Five from seven determinants have significant effect on financial viability. Only the structure and size of Palestinian water service providers have no significant impact over the financial viability. Further details are, staff productivity ($r= -0.091$, $p=0.014$), daily consumption ($r=0.130$, $p=0.013$),

average water price (r=0.297, p=0.000), energy cost (r=-0.518, p=0.000), production percentage (r=0.013, p =0.000), service providers' (r= 0.304, p= 0.127), structure and service providers' size (r=0.143, p= 0.197).

The correlation table also proposes that there was significant relationship between the non-revenue water and the financial viability of the Palestinian service providers. Negative and high correlation has been founded; (r= -.204, p=.015) implying that the more the non-revenue percentage, the less the financial viability for Palestinian service provider's, other things being constant.

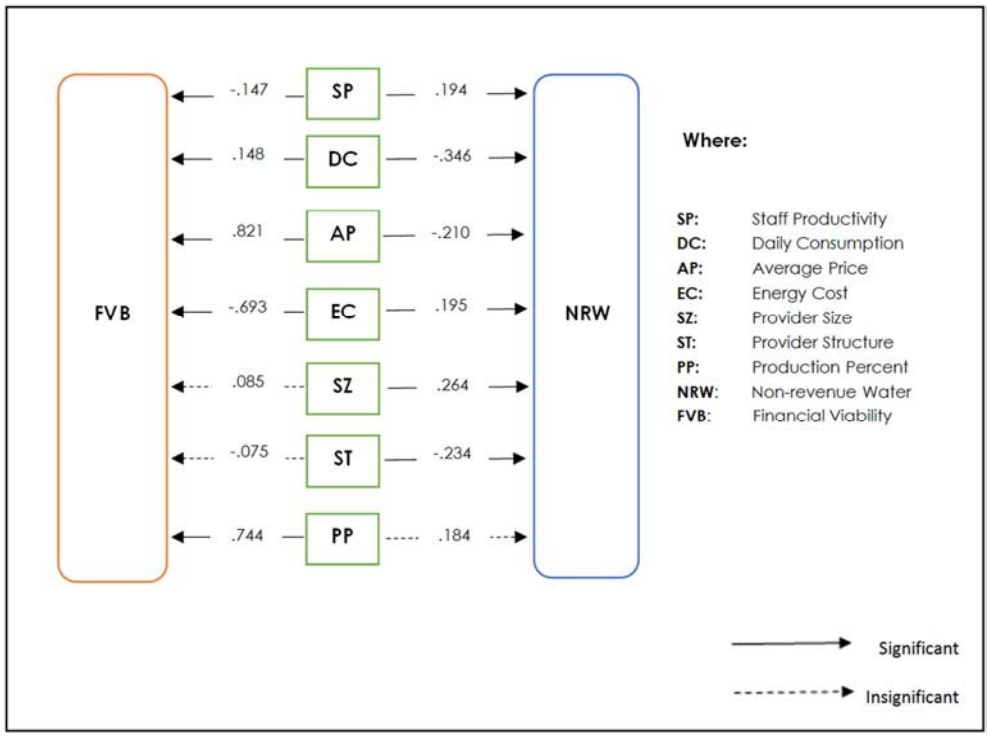

Figure 2. *Regression Results.*

The overall regressions results can be summarized in Figure 2. The non-revenue water for the Palestinian service providers is determined by many variables. This research sketches negative relationship between staff productivity and non-revenue water. The more the staff productivity, the less the non-revenue water is. Explained in another term, if the number of staff increases relative to the 1,000 connections, then, there will be less productivity; this case produces more non-revenue water percentage. On the other hand, the staff productivity has positive effect on the financial variability, i.e. the more the staff productivity, the more the financial viability for the water service providers. The issue of overstaffing is mainly as a result of poor management, inefficiency, high staff cost and long hierarchy in decision making. Therefore, to decrease the non-revenue water and achieve financial sustainability, the management of water providers is expected to solve the issue of overstaffing [29]. The findings of this research shows that decreasing one unit in number of staff that is serving 1,000 connections, will lead to a decrease of.19 percent unit of non-revenue water; and.14 percent units in financial viability, other things being equal.

The research displays negative relationship between consumption, price from one side and non-revenue water from the other side. The more the daily consumption, the less the non-revenue water is. This finding is matched with Mexican cities, where, the water losses decrease due to increases in consumption [1]. In Palestine, some water providers have non-revenue water projects, especially from international donors, so changing unmetered to be metered. Therefore, the consumption will be increased, since new water quantity becomes in counting and metering process. Other Palestinian water providers may pay heavy efforts to decrease illegal connections. This action leads to an increase in the metered consumption and a decrease in the non-revenue water [25].

From financial point of view, high price of cubic meter means covering cost and possibly allocating part of surplus for non-revenue water reduction projects. In this setting, this paper confirms positive relationship between price and consumption from one side, and the financial viability from the other side. The low in price and less in quantity sold, results less in revenue generated by water utility, which to that end leads to less in financial viability. In high non-revenue, low water prices, those conditions are favorable for financial unsustainability [27]. The results of this research show high effect of price and consumption. The increasing price and consumption by one unit, results in decreasing the non-revenue water by.346 and.21 units respectively.

In this paper, the water providers which produce rather than purchase have incurred more non-revenue water, and more energy cost. This means that, there will be considerable quantity of water losses during the production and

transmission process. However, the energy cost is always increased since there is pumping and transmission during the production process; but generally the overall cost of cubic meter is less for the water providers that produce water rather than purchase. Table 6 shows that negative relationship between the utilities that depend mainly on production and the average price. The more the production percentage, the less the price; since the water production in Palestine costs less than purchases. The price variable has the highest positive coefficient in the financial viability. This explains high price, leading to generate more revenue, and then more in financial viability and profitability.

The findings indicate that the structure of service provider has direct impact on the performance. The utilities and joint service councils i.e. autonomies, perform better than municipalities in non-revenue water. In Palestine, the water utilities and joint service councils have more flexibility in decision making and for attracting the projects. However, the water department in the municipalities have to report and gain approval of the mayor and management of the municipality before taking decisions especially the strategic level such as, water prices, projects, collection, implementation procedures, staff recruitment, implementing new technology and others. Many researcher concludes that municipal corporations and parastatals i.e. autonomies water providers perform better in comparison with the government entities [24].

Another variable affects on the non-revenue water is the size, the research shows that the larger the size of water provider, the more the non-revenue water. This doesn't match with some studies which stats that large water providers are more efficient and outperform the small utilities [30]. In Palestine, the large water providers may have more percentage of non-revenue water, since their water networks are old, many of them have old meters, and generally they are departments in municipalities. It is 29% in medium and small water providers, where, its 37% in large scale.

Table 6 presents correlation between non-revenue water and financial viability of the water providers. Negative, strong, and significant relationships have been found, meaning that water utilities shall decrease the non-revenue to consider the financial viability and sustainability [4, 31].

6. Conclusion & Policy Implications

Studies performed on non-revenue water are many in last few decades. Their importance lies in fact that the non-revenue water affects the revenue part of water utilities and the cost of sold water. The net result of non-revenue water is profit devaluation. When cost of water sold isn't covered within revenue generated by the service providers; then, the result will be financial unsustainability and unviability.

The main purpose of this study is to evaluate the independent parameters of non-revenue water and financial viability for the Palestinian water service providers. In addition, this study aims to come up with understanding of how the water stakeholders could perform effectively to reduce the non-revenue water, and ultimately, maintaining the financial viability. Further, this study attempts to benefit the policy makers regarding key issues to be considered in the coming revisions of policies and guidelines.

On the one hand, this study extracts elements that affect non-revenue water from literature reviews, and, it evaluates those predictors with the financial viability of the Palestinian water providers. To that end, two regressions have been conducted. The results show that staff productivity, daily consumption, average price, energy cost, service providers' size and structure all have significant impact on the non-revenue water; wherein, daily consumption and average price have negative effect. Expressed differently, the more the price and the consumption, the less the non-revenue water.

Another result is the structure of the service provider; where; it has been concluded that autonomy forms especially Joint Services Councils have less in non-revenue water compared with municipalities or department in local municipalities. The study indicates that water production variable is insignificant with the non-revenue water. This means that non-revenue always appears as a result of distribution networks and meter inaccuracies for all water providers whether they purchase or produce.

Those predictors have been included in another regression to explain and measure the financial viability of the Palestinian water service providers. The results propose that staff productivity, daily consumption, average price, energy cost, and water production have significant effect on the financial viability. Only service providers' size and structure, have insignificant impact.

The results of this research propose that Palestinian Water Authority (PWA) as policy maker may put some targets for Palestinian service providers at national level. Therefore, those targets may lead to increase service provider's performance in non-revenue water and overall enhance their financial viability.

The reduction of non-revenue water has not only remarkable positive impact on the performance of the service providers, but also on the quality of provided services in particulate under uncertain socioeconomic and fragmented institutional framework as Palestine.

Appendix

Table 1. *KMO and Bartlett's Test.*

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.585**
Bartlett's Test of Sphericity	Approx. Chi- Square	332.382
	df	28
	Sig.	.000

Table 2. *KMO Communalities.*

	Initial	Extraction
Staff Productivity	1.000	.558
Consumption	1.000	.716
Average Price	1.000	.767
Energy Cost	1.000	.702
Production	1.000	.743
Size	1.000	.822
Structure	1.000	.487
Non-revenue Water	1.000	.647

Extraction Method: Principal Component Analysis.

Table 3. *Total Variance Explained.*

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative%	Total	% of Variance	Cumulative%	Total	% of Variance	Cumulative%
1	2.721	34.011	34.011	2.721	34.011	34.011	2.256	28.195	28.195
2	1.670	20.870	54.881	1.670	20.870	54.881	1.941	24.260	52.455
3	1.050	13.119	68.000	1.050	13.119	68.000	1.244	15.545	68.000
4	.823	10.293	78.293						
5	.693	8.656	86.949						
6	.524	6.550	93.500						
7	.323	4.033	97.533						
8	.197	2.467	100.000						

Table 4. *Multicollinearity Diagnostics Coefficients*[a].

	[a]Dependant Variable: NRW				[a]Dependant Variable: Profit			
	t	Sig.	Collinearity Statistics		t	Sig.	Collinearity Statistics	
			Tolerance	VIF			Tolerance	VIF
(Constant)	8.931	0.000			-9.05	0.000		
Staff Productivity	2.578	0.011	0.714	1.401	-2.482	0.014	0.714	1.401
Consumption	-4.629	0.000	0.726	1.377	2.512	0.013	0.726	1.377
Average Price	-2.058	0.041	0.389	2.57	10.208	0.000	0.389	2.57
Energy Cost	2.583	0.011	0.708	1.412	-11.629	0.000	0.708	1.412
Production	1.738	0.084	0.36	2.776	8.905	0.000	0.36	2.776
Size	3.74	0.000	0.816	1.226	1.536	0.127	0.816	1.226
Structure	-3.186	0.002	0.75	1.333	-1.296	0.197	0.75	1.333

Table 5. *Descriptive Statistics.*

	N	Minimum	Maximum	Mean	Std. Deviation
Non-revenue Water	143	4.00	59.00	32.1557	11.42957
Staff Productivity	143	.80	13.70	4.8210	2.61038
Consumption	143	25.70	314.00	91.9045	50.55069
Average Price	143	.810	8.130	3.67451	1.916633
Energy Cost	143	.01	8.71	.6706	.95027
Production	143	.00	100.00	51.0451	45.85724
Size	143	1.0	3.0	2.126	.7587
Structure	143	1.0	3.0	1.378	.7001
Profit	143	-7.63592233	.461254612	-.308292703	1.073054946

Table 6. *Variables Correlation.*

		NRW	SP	DC	AP	EC	PP	SZ	ST	FVB
NRW	Pearson	1	.380	-.085	-.247	.395	.433	.278	-.291	-.204
	Sig. (2-tailed)		.000	.312	.003	.000	.000	.001	.000	.015
	N	143	143	143	143	143	143	143	143	143
SP	Pearson	.380	1	.127	-.024	.370	.387	.236	-.079	-.091
	Sig. (2-tailed)	.000		.132	.774	.000	.000	.005	.347	.281
	N	143	143	143	143	143	143	143	143	143
AC	Pearson	-.085	.127	1	-.433	-.053	.394	.015	-.337	.130
	Sig. (2-tailed)	.312	.132		.000	.526	.000	.861	.000	.121
	N	143	143	143	143	143	143	143	143	143
AP	Pearson	-.247	-.024	-.433	1	-.041	-.638	.178	.439	.297
	Sig. (2-tailed)	.003	.774	.000		.623	.000	.034	.000	.000
	N	143	143	143	143	143	143	143	143	143

		NRW	SP	DC	AP	EC	PP	SZ	ST	FVB
EC	Pearson	.395	.370	-.053	-.041	1	.350	.000	-.154	-.518
	Sig. (2-tailed)	.000	.000	.526	.623		.000	.999	.065	.000
	N	143	143	143	143	143	143	143	143	143
PP	Pearson	.433	.387	.394	-.638	.350	1	.148	-.292	.013
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.078	.000	.876
	N	143	143	143	143	143	143	143	143	143
SZ	Pearson	.278	.236	.015	.178	.000	.148	1	.069	.304
	Sig. (2-tailed)	.001	.005	.861	.034	.999	.078		.413	.000
	N	143	143	143	143	143	143	143	143	143
ST	Pearson	-.291	-.079	-.337	.439	-.154	-.292	.069	1	.143
	Sig. (2-tailed)	.000	.347	.000	.000	.065	.000	.413		.089
	N	143	143	143	143	143	143	143	143	143
FVB	Pearson	-.204	-.091	.130	.297	-.518	.013	.304	.143	1
	Sig. (2-tailed)	.015	.281	.121	.000	.000	.876	.000	.089	
	N	143	143	143	143	143	143	143	143	143

Table 7. *Result of Regression Analysis.*

Independent Variables	□	t	p-value	□	t	p-value
Constant		8.931	.000		-9.050	.000
Staff Productivity	.194	2.578	.011	-.147	-2.482	.014
Consumption	-.346	-4.629	.000	.148	2.512	.013
Average Price	-.210	-2.058	.041	.821	10.208	.000
Energy Cost	.195	2.583	.011	-.693	-11.629	.000
Production	.184	1.738	.084	.744	8.905	.000
Size	.264	3.740	.000	.085	1.536	.127
Structure	-.234	-3.186	.002	-.075	-1.296	.197
Dependent Variable:	*Non-Revenue Water*			*Financial Viability*		
P<.05	*F* =		15.989	*F* =		37.444

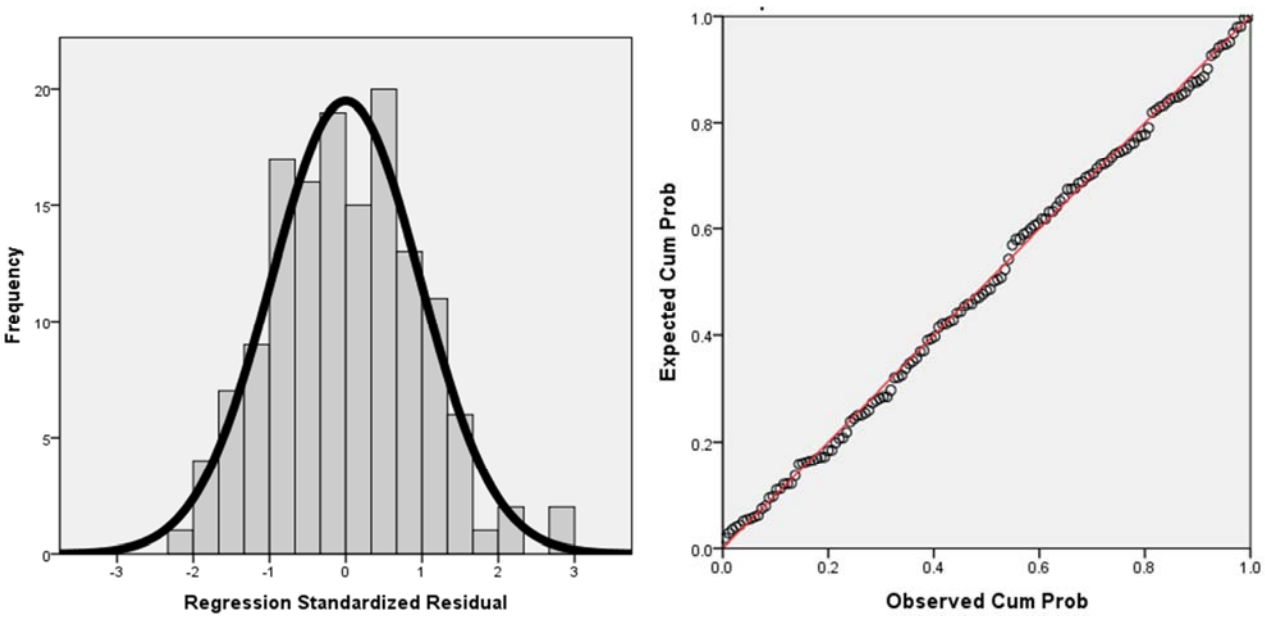

Figure 3. *Scatterplot of the Standardized Residual.*

References

[1] Adams, A., Lutz Ley. A, (2012). An Empirical Study of Factors Affecting Water Loss in Mexican Cities. Journal of Water Sustainability, Volume 2, Issue 3, September 2012, 167–178.

[2] Alegre H., Hirner W., Baptista J. M. and Parena R. (2000) Performance Indicators for Water Supply Services. IWA Manual of Best Practice. ISBN 900222272.

[3] Berg. Caroline van den (2014). The Drivers of Non-Revenue Water How Effective Are Non-Revenue Water Reduction Programs? Water Global Practice Group. World Bank. Policy Research Working Paper 6997.

[4] BISWAS. A, TORTAJADA. C. (2010). Water Supply of Phnom Penh: An Example of Good Governance. Water Resources Development, Vol. 26, No. 2, 157–172, June 2010.

[5] Bisztray M., Kis A., Muraközy B. & Ungvári G. (2009). Statistical Analysis of the Performance Data of Central and Eastern European Water Utilities. Regional Center for Energy Policy Research Corvinus University of Budapest. World Bank IBNET Program. January 2009.

[6] Dattalo, Patrick (2010). Ethical Dilemmas in Sampling. Journal of Social Work Values and Ethics, Volume 7, Number 1 (2010). Copyright 2010, White Hat Communications.

[7] Dave P., Wadhwa V., Aggarwal A., & Seetharaman A. (2013). The Impact of Research and Development on the Financial Viability of Information Technology (IT) Companies Listed on the S&P 500 Index. Journal of Sustainable Development; Vol. 6, No. 11; 2013 ISSN 1913-9063 E-ISSN 1913-9071.

[8] Enock George (2015). Assessment of Unaccounted for Water Strategies in Service Delivery: Case of Nakuru Water and Sanitation Services Company, Kenya. European Journal of Business and Management. www.iiste.org ISSN 2222-1905 (Paper) ISSN 2222-2839 (Online) Vol.7, No.5, 2015.

[9] Fanner P., Sturm R., Thornton J., and Liemberger R. (2007) Leakage Management Technologies. Awwa Research Foundation, American water Works Association, IWA Publishing. 2007 Awwa RF.

[10] Field, A. P., (2005). Discovering statistics using SPSS. Research methods II factor analysis in SPSS. Second edition.

[11] Frauendorfer, R, Liemberger, R. (2010) The Issues and Challenges of Reducing Non-Revenue Water. Asian Development Bank. Publication Stock No RPT102319. ISBN 978-92-9092-193-6.

[12] Gakuu. K, Kirimi. K, (2014). ASSESSMENT OF FACTORS INFLUENCING FINANCIAL SUSTAINABILITY OF NON-GOVERNMENTAL ORGANISATIONS IN ISIOLO COUNTY, KENYA. International Journal of Economics, Commerce and Management. Vol. II, Issue 9, Sep 2014. United Kingdom. ISSN 2348 0386.

[13] GJINALI E., Giantris P. (2014). Non-Revenue Water and Some Simple Economics for Developing Counties. Online International Interdisciplinary Research Journal, {Bi-Monthly}, ISSN2249-9598, Volume-IV, Nov 2014 Special Issue.

[14] González-Gómez F., García-Rubio M. & Guardiola J. (2011). Why Is Non-Revenue Water So High in So Many Cities? International Journal of Water Resources Development Volume 27, 2011 - Issue 2.

[15] Grima. A. P. (2013). Empirical Basis for Municipal Water Rates Modification. Canadian Water Resource Journal / Revue canadienne des ressources hydriques. ISSN: 0701-1784 (Print) 1918-1817 (Online) Journal homepage: http://www.tandfonline.com/loi/tcwr20.

[16] Howard Guy (2003) Domestic Water Quantity, World Health Organization 2003. Service Level and Health WHO/SDE/WSH/03.02.

[17] Jerusalem Water Undertaking. (2016). Foundation of JWU. Historical Background. Published on May 23, 2016 http://www.jwu.org/jwu/?p=1698&lang=en read on 21.02.2017.

[18] Kim. Y, & Ployhart R. (2013). The Effects of Staffing and Training on Firm Productivity and Profit Growth Before, During, and After the Great Recession. Journal of Applied Psychology., Vol. 99, No. 3, 361–389 0021-9010/14/$12.00 DOI: 10.1037/a0035408. © 2013 American Psychological Association.

[19] Kingdom B., Liemberger R., & Marin P. (2006). The Challenge of Reducing Non-Revenue Water (NRW) in Developing Countries How the Private Sector Can Help: A Look at Performance-Based Service Contracting. The International Bank for Reconstruction and Development. PPIFA. PAPER NO.8 DECEMBER 2006.

[20] Makaya E., & Hensel O. (2012). Water Distribution Systems Efficiency Assessment Indicators – Concepts and Application. International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064. Volume 3 Issue 7, July 2014. Paper ID: 02014259.

[21] Mathur P., & Vijay A. (2013). Non-revenue Water Reduction-A Tool for Achiving 24x7 Water Supply. IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X, Volume 7, Issue 3 (Jul. - Aug. 2013), PP 25-28 www.iosrjournals.org May 2013, Volume 17, Issue 2, pp 237–259 17: 237. doi:10.1007/s10997-011-9173-6.

[22] McKenzie, R., Siqalaba, Z. N., & Wegelin (2012). The state of non-revenue water in South Africa, Water Research Commission Research Report. ISBN 978-1-4312-0263-8. WRC Report No. TT 522/12. Printed in the Republic of South Africa © WATER RESEARCH COMMISSION.

[23] Mugabi, J., Kayaga, S. & Njiru, C. (2007). Strategic planning for water utilities in developing countries, Utilities Policy, 15(1), 1-8.

[24] Murrar. A. (2017). EPRA International Journal of Economic and Business Review-Online ISSN 2347-9671 & Print ISSN 2349-0187. Vol: 5, Issue: 1, January 2017.

[25] Murrar. A. (2017). American Journal of Water Science and Engineering. The Determinants of Non-Revenue Water in Balkan Countries. Vol. 3, No. 2, 2017, pp. 18-27. doi: 10.11648/j.ajwse.20170302.11.

[26] Murrar. A. & Hamad. A (2013). RELATIONSHIP BETWEEN JOB SATISFACTION AND TURNOVER INTENTION: An Empirical Study on the IT Firms in Palestine. Interdisciplinary Journal of Research in Business. ISSN: 2046-7141 Vol. 2, Issue. 8, (pp.67- 83) | 2013.

[27] Mutikanga. H, Sharma. S, & Vairavamoorthy. K. (2011). Investigating water meter performance in developing countries: A case study of Kampala, Uganda. ISSN 0378-4738 (Print) = Water SA Vol. 37 No. October 2011 ISSN 1816-7950 (On-line) = Water SA Vol. 37 No. 4 October 2011.

[28] O'brien, R. M. (2007). Quality & Quantity October 2007, Volume 41, Issue 5, pp 673–690 41: 673. doi:10.1007/s11135-006-9018-6.

[29] Onsomu L., Bichanga W., Munene C. & Obonyo G. (2013). Factors Influencing the Financial Viability of a Water Service Provider in Kenya: The Case of Gusii Water and Sanitation Company Limited. International Journal of Arts and Commerce. Vol. 2 No. 9. October, 2013.

[30] Peda, P., Grossi, G. & Liik, M. J Manag Gov (2013). Do ownership and size affect the performance of water utilities? Evidence from Estonian municipalities. Journal of Management & Governance.

[31] Raj, Krishna. (2013). Where All the Water Has Gone? An Analysis of Unreliable Water Supply in Bangalore City. The Institute for Social and Economic Change, Bangalore. Working paper 307. ISBN 978-81-7791-163-3.

[32] Rubio M., Villaverde A., & Gómez F. (2015). Urban Water Tariffs in Spain: What Needs to Be Done? Water Journal 2015, 7, 1456-1479; doi: 10.3390/w7041456. ISSN 2073-4441.

[33] Wallac P. Laynn (1987) Water & Revenue Losses, Unaccounted for Water. American water Works Association. Research foundation TMISBN 0-89867-417-4.

[34] Water Sector Regulatory Council. (2014). Water Services Providers Performance Report 2014. WSRC hardcopy and softcopy publishing report. wsrc.ps.30.03.2017.

[35] Water Sector Regulatory Council. (2015). Water Services Providers Performance Report 2015. WSRC hardcopy and softcopy Arabic Version. publishing report. wsrc.ps.12.04.2017.