American Journal of Environmental and Resource Economics
2017; 2(4): 162-174
http://www.sciencepublishinggroup.com/j/ajere
doi: 10.11648/j.ajere.20170204.13

The Efficiency and Institutional Performance of the Palestinian Water Service Providers

Abdullah Murrar[1, 2, *], Ahmad Sadaqa[3], Khalid Rabayah[3], Subhi Samhan[4], Abdelrahman Tamimi[3, 5], Walid Sabbah[3], Ihab Barghothi[3]

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

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

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

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

[5]General Directorate, Palestinian Hydrology Group, Jerusalem, Palestine

Email address:

abdullah.murrar@gmail.com (A. Murrar)

[*]Corresponding author

To cite this article:

Abdullah Murrar, Ahmad Sadaqa, Khalid Rabayah, Subhi Samhan, Abdelrahman Tamimi, Walid Sabbah, Ihab Barghothi. The Efficiency and Institutional Performance of the Palestinian Water Service Providers. *American Journal of Environmental and Resource Economics*. Vol. 2, No. 4, 2017, pp. 162-174. doi: 10.11648/j.ajere.20170204.13

Received: August 20, 2017; **Accepted**: September 1, 2017; **Published**: September 23, 2017

Abstract: The Palestinian Water Law 2014 calls for the amalgamation of the current water service providers into large regional utilities that are financially independent and have separate legal entities. This research, evaluates whether there are significant differences in the performance of the Palestinian water service providers based on their institutional structure and ownership. Thereafter, calculating the efficiency scores, in which the water providers may maximize the output for given level of input consumption. The multivariate analysis shows significant differences in non-revenue water, average price, and water consumption based on the structure. The water utilities perform better than municipalities when examining working ratio, gross profit, and collection efficiency. Wherein the Joint Service Councils have high sales price than utilities and municipalities; therefore, they are more profitable, more efficient in non-revenue water, and better in staff productivity. The results show more efficiency can be achieved during aggregation current water service providers into regional utilities. Amalgamating the providers into only four main water regional utilities – one in the north, middle, south, and Gaza will deliver less than current efficiency; and will double the cost or diminish half of overall output. Therefore, changing the current large and medium providers into regional utilities, and merging the current small providers into medium or large regional utilities will have more efficiency and capacity for improvement. Implications of these findings case by case through conducting further studies will add value for better merging efficiency and reforming process.

Keywords: Efficiency, Palestinian Water Law 2014, Performance, Regional Utilities, Structure

1. Introduction

In general, the efficiency is the ability to allocate resources efficiently to maximize the output and minimize the waste and cost. In the water sector, finding a way to measure the efficiency of water service providers has been one of the main concerns of many researchers, non-profit organizations, and government entities around the world. Similar to electricity, and energy sectors, this sector has received very special attention, not only because water is vital for every human being, but also because of its operation, management, and structure as a natural monopoly.

In principle, the water service providers among the world are mainly private or public. The option to choose one of type of ownerships is one of major interest of government and regulators bodies. Some researchers find the privatization of core sectors can generate more efficiency, higher quality of services, and expanding the services into new

geographical areas. On the other hand, others argue that efficiency may be achieved in the public entities also, and it is not exclusive to the private sector. Therefore, a debate between the two points of views has been elaborated.

Among those different views regard water structure, the public private partnership has been introduced for more efficiency and monitoring purposes. The concept is defined to be a contractual arrangement between the government side and private sector entity where both sides engage into an agreement by which the private sector provide the services to the public sector with the objective of increasing the efficiency of the services. The government could be central or local; and the private companies may be limited responsibility or shareholder's corporations. Through this agreement, the skills and assets of both sectors public and private are pooled efficiently to deliver the water services for consumption of the general public. In addition to the sharing of resources, each party shares in the risks and returns potential in the delivery of the water services.

For better choosing the efficient structure, investigation the existence of economies of scale, scope, and customer density in the water service providers have to be developed in a comprehensive framework that can facilitate managerial and political decision making. Economies of scale exist when a production unit increases its output results from a less than proportional increase in input. In this situation, the average input consumption declines whilst output rises. Economies of scope arises when a unit average cost to produce two or more products or services is lower than when they are produced by different entities. In the water sector, the average unit cost of water and wastewater services may cost more if they are delivered by two separate entities water and wastewater. Economies of density occurs when the change in costs for increases in the number of customers for a constant network length; or change in costs for increases in the total quantity of water produced for a constant number of customers and network length. This may be incentive for people to concentrate and agglomerate for cost saving purpose.

The ultimate goal of this paper hence is to find which institutional structure of the Palestinian water service providers is more efficient. Before that, next section in this paper shortly reviews previous studies that are in the same field. Then, background about the development of Palestinian Water Sector, reforming process, and type of structures and ownerships have been provided. However, the methodology and research design have been included in a separate section. After that, descriptive and inferential analyses are developed for that objective. Thereafter, the policy implications section has been carefully developed to provide practical implications for better performance of the Palestinian water sector and reforming.

2. Palestinian Water Service Providers

According to the data bank of Palestinian Water Authority, there are more than 280 water and wastewater service providers in the forms of water and wastewater utilities, undertakings, authorities, water departments within municipalities, village and joint service councils. Since the utilities, undertaking, and water authorities are of the same structure but different names; in this paper the water service providers can be divided into broad three types in terms of institutional structure and ownership. Firstly: Regional Utilities, according to the performance monitoring report of Water Sector Regulatory Council; the Coastal Municipal Water Utility CMWU is providing water services to Rafah Municipality [34]. However, in the West Bank, there are two utilities that may be considered to be regional, the first one is Jerusalem Water Undertaking. JWU is the largest service provider in the Palestinian areas based on the number of connections and network length. Next to the JWU is the Water Supply and Sewerage Authority in Bethlehem. WSSA is providing its services to Beit Sahour, Beit Jala, and Bethlehem in addition to other localities.

Secondly: Joint Services Councils. The Ministry of Local Government (MoLG) has established one legal entity to deliver different services to the small villages in the hope of achieving improved quality of services, economies of scale, and efficiency in cost during delivering those services. The small villages need services beyond water and wastewater that include development, solid waste collection, disposal, and treatment. According to MoLG report, there are about 47 joint service councils that providing different services in Palestine [22]. In this paper, the interest will concentrate only on five councils that are providing the water services: Northwest Jenin Joint Service Council, Maythaloun Joint Service Council, Tubas Joint water service council, Joint Services Council for Planning and Development Southeast of Nablus, and Joint Service Council Northwest Jerusalem.

Thirdly: Water departments within the municipalities. A quick scan of the services providers reveals that most of them are in this structure and ownership. In Gaza Strip, there are 25 water service providers; 24 of them are departments within the municipalities. However, in the West Bank, large Palestinian municipalities such as Jenin, Tulkarem, Qalqilia, Nablus, Jericho, Hebron, and others; the water services are provided by the municipalities. Some of medium and small size of Palestinian localities are also provided by the water department in the municipalities as Yatta, Dura, Salfeet, Kufr Rai, Qabatia, and others [35].

The regional utilities are semi-independent and report to their board of directors. The joint service councils are reporting to the ministry of local government directly; and the water department within the municipalities report to the mayor of the municipality, which at the end report to ministry of local government. The selected joint service councils in this paper are providing water services only, where, the regional utilities generally provide water and wastewater services; however, the municipalities are providing many services to the people, such as permitting and licensing, managing water and wastewater services, electricity, solid waste, infrastructures, and so forth.

The three Palestinian water utilities deliver water services to more than half millions of people i.e. about 18% of the

sample population. However, the municipalities deliver their services to more than 75% of total population; and the rest is served by the joint service councils. The following table summarizes the Palestinian water service providers according to their structure based on performance report of data for year 2015. [35]

Table 1. *Palestinian Water Providers Summary.*

Items and Description	Number of Entities	Number of Connections	Served Population	Network Length Km	Employees Number
Water Utilities	3	91,358	628,377	2,110	394
Water Councils	5	28,685	209,894	1,198	102
Municipalities	55	298,529	2,565,174	5,493	1,307
Total	63	418,572	3,403,445	8,801	1,803

3. Palestinian Water Reform

In 2009, the Palestinian Council of Ministers endorsed the Action Plan for Reform towards the definition and implementation of a comprehensive program of institutional and legislative restructuring in the Palestinian water sector. The overall framework of this reform process envisions a new distribution of responsibilities and authorities and split policy from the regulatory functions. In 2014, a new Water Law was passed. The institutional framework of the water sector in Palestine has been defined by this Water Law 2014. The major player in the sector is Palestinian Water Authority PWA i.e. ministerial role to ensure better handling of the planning and developing policies of the water sector. It is responsible for setting water sector policy, strategy, master planning, sector development, restructuring, water resources licensing, management, and monitoring. However, for Water Sector Regulatory Council WSRC, it has the function of monitoring the performance of water services providers, approving water prices, water tariff to ensure that service is provided according to the standards; and with the aim of ensuring water and wastewater services quality and efficiency to customers in Palestine at affordable prices. To do this job, the licensing of water service providers has been assigned to the WSRC. The third party of water sector, is water service providers that include municipalities, regional utilities, joint water councils, and the national water company (i.e. the bulk provider); those are in charge of water and wastewater services delivery [30].

According to the Water Law 2014, the PWA is the entity in charge in establishment, in coordination and cooperation with the relevant competent authorities' the regional water utilities for the provision of water and wastewater services. The law points out that those utilities are legal entities and financially independent. They also enjoy the full legal capacity to carry out their activities and responsibilities. The overall objective of the regional water utilities is the provision of water and wastewater services each within its specified administrative and geographical scope [30].

So far, the Palestinian water law calls for merging current water providers into regional utilities; changing the structure and ownership from municipalities to be fully legal and financial independent utilities. The purpose of this merging is based on expectation that amalgamation will achieve more efficiency, high quality of water services, expanding the services into new areas, investment allocation, and increase collection efficiency of debt. The expected number of utilities will be at the end four utilities; therefore, consolidation the 280 water providers during period of time i.e. many years will be based on gradually method.

4. Related Literature

Many literatures have tackled the efficiency of water service providers. Some studies indicate water utilities may perform better than municipalities due to economies of scale, scope, and density. Others may argue that small and private water providers are more efficient, manageable, smart, and future. It is imperative, therefore, to review related studies which to that end lead to exert the effect of structure on different performance areas and to measure the efficiency of Palestinian water providers.

The Italian water sector has experienced a comprehensive reform of water service providers. The purpose of this reform process was to encourage the merge of the current water providers into larger entities. Therefore, decrease their number from large to small, under control, achieving economies of scale, and economies of scope. Abrate et al. [3] studied the efficiency of Italian water sector for potential gains from merging water service providers. The authors implemented a parametric framework using a corrected ordinary least squares estimation of a frontier cost function. The researchers assumed a single input i.e. cost which to produce given quantity of output. The optimal cost or the minimum that required to produce the output. By pooling the cost and summating the output, the researchers can find the potential advantage from this merger. The authors concluded that the potential gains or losses from this merger are dependent on the characteristics of the merging firms and on the merged entity. Therefore, case-by-case approach is recommended before move into merging [3].

Andrea et al. [5] studied the efficiency of water and wastewater utilities in Denmark. The authors measured performance of the 101 water utilities consists of 606 data items by adapting methodology of Data Envelopment Analysis and regression analysis. Three input items are used: production, distribution, and customer handling cost; and one output variable which is the volume of water sold. The authors measured the wastewater service also by adapted the inputs to be transport, treatment, and customer handling costs; where the output was volume of water in the sewer catchment area. The result of this research indicated that significant differences in efficiency across firms involved in wastewater treatment but not in water services. The service

providers that served more than 100 inhabitants per km of sewers achieved the best global efficiency. The efficiency decreases when the scale of operations expands; expressed in other term, the expanding into new areas served by wastewater utilities or merging with other companies does not lead to save the cost [5].

In Spain, a study over 70 water utilities which served up to 50,000 households. 33 of those utilities are privately managed through public private partnership; and the rest 37 are public management. To measure the efficiency, the researchers considered three input variables; which are the length of water network, staff cost, and operating cost. The output variables are water delivered to the customers, and number of served population. The researchers find that the private water utilities management is more efficient in the use of labour input. However, the public utilities have some legal, political, and institutional restrictions. The results of the study show that private management appears to be less efficient at managing operational costs compared with the public management; since they work in complex environment that leads to higher costs [21].

In India, a study for evaluation the public and private water utilities has been conducted over 27 cities. The researchers used of data envelopment analysis model which simply measures of technical efficiency that explains how much more a water utility can produce from a given amount of resources. They included two input variables; which are the revenue, expenditures, and the production capacity. However, the output variable was the water served as per capita, times the number of the served population in the city. The results of this study indicated that, the utilities that are managed by municipal corporations and parastatals with a certain amount of functional autonomy, perform better in comparison to the group municipal corporations and government. This implies that functional autonomy in management leads to better performance of the water utilities than those are not autonomy [12], [25], [29].

The structure and ownership may have direct influence on the efficiency. However, other variables may also have impact on the efficiency such as the geographic location, and the size of the water service providers. Pazzi, Ausina, Duygun & Zambell, [26] measure the efficiency of Italian water utilities from 2008 to 2011. The 272 observations are related to 68 water utilities which represented 45% of Italian population in that period. The researchers considered the moderators such as size, and geographical in investigating whether ownership structure has a significant effect on the cost efficiency. The data envelopment analysis was used in this study with cluster analysis. The input variables for this study were cost of materials, cost of services, cost of using third party resources, and wages. The output variable was the revenue generated as a result of those input variables. The results show that the privately owned utilities that controlled by a public entity reach the highest level of efficiency. However, the researchers concluded that mixed owned utilities become higher efficiency when combine the size, structure, and location [26].

Peda et al. [27] studied the influence of ownership and size for 43 water utilities serve 68% of Estonian population on efficiency. The researchers found, the larger the size of water providers, the more the efficiency achieved. The research results show that the structure ownership doesn't affect the efficiency of the Estonian water service providers.

Measuring the efficiency of water utilities is mainly used the data envelopment analysis. The main advantage of this model is sorting water utilities on the basis of their efficiency without requiring any assumption on the distribution of the data [6], [7], [28]. However, some researchers adapt weights based measure to the input and output as per the impotence of those variables [19]. Others consider financial and non-financial criteria such as customer satisfaction, advanced services, employee skills to compare the performance of different institutions [18]. In all cases, assessing privatization or public own water utilities requires a more sophisticated and cautious treatment of the influence of ownership in determining utility performance in different aspects [17].

Generally, measuring the performance of water service providers is based on the efficiency of water distribution system. This is mainly affected by the structure and the ownership. The impact of the efficiency can be noted in the performance indicators of water utilities. In a case study of the city of Harare in Zimbabwe, the city has 53% non-revenue water efficiency after applying non-revenue water assessment indicators [20]. Therefore, it requires investigation and continuous monitoring for better performance and efficiency.

5. Research Methodology

A review of related studies clearly indicates many performance areas are affected by the structure of the service providers. A study shows that ownership structure, diversification, size, and geographical location have direct effect on the performance of water utilities in Italy by different degree of significance [11]. This research will consider two tests: the first test is conducting multivariate analysis, which shows the relationship and significant impact of service provider's structure on non-revenue water, staff productivity, collection efficiency, average consumption, average price, operating and maintenance cost, working ratio, and gross profit. Expressed in other term, this test will specify whether significant differences in the performance based on the three types of structures of Palestinian water service providers.

The performance areas are selected to achieve financial sustainability of service providers. Four elements have been considered: firstly, profit/loss generated by service provider. For this factor, operating and maintenance cost, and average price are considered. On the other hand, gross profit margin and working ratio have been included to support this factor. Generally, less cost and high price, produce more in gross and net profit margin. Secondly, consumption issue, the average consumption may indicate as ability of Palestinian service provider whether municipality, regional utility, or

council to deliver quality of service and continuous supply. Generally, in Palestine, there is shortage problem in water supply. In some areas such as in Yatta and Dura, the per capita is less than 30 liters per day due to unavailability of water [24]. A study shows that domestic water consumption depends on adequacy of water supply up to customer satisfaction [4]. Thirdly, the collection efficiency dimension. This aspect is correlated with the profit generating since, this profit shall be collected and changed into cash inflow to enable service provider to pay due invoices and operating expenses. The lower the collection efficiency, the less the water utility is liquid. For this reason, collection efficiency has been reflected as a key performance area. The last dimension in this performance is service providers' efficiency in non-revenue water reduction and employees' productivity. The less the non-revenue water percentage, the more the management efficiency, and then the more financial sustainability.

Secondary data has been collected from published performance indicator reports of Palestinian water services providers. The Performance Reports were published by Palestinian Water Authority (PWA); and currently are published by Water Sector Regulator Council (WSRC).

According to Water Sector Regulator Council, published data in its report for 2015 covers about 75% of total Palestinian population [35]. In this research, the collected cross sectional data covers from year 2010 up to year 2015, with 143 observations. The stated sample of this research contains all Palestinian water utilities, which are 3; and from joint service councils, the selected almost all which are 5 councils. The rest of this sample is collection of data for water departments in the municipalities which are 55 municipalities; this is sum up to 63 Palestinian water service providers. Those observations are analyzed and tested using Statistical Package for Social Science (SPSS). Both descriptive and inferential analyses have been carried out. The purpose of this inferential test is to know whether or not significant differences appeared in those performance dimensions based on the structure of water providers.

The second test will evaluate the effect of this structure on the efficiency by implementing the Data Envelopment Analysis (DEA). This methodology is widely applied in measurement the efficiency and performance. A paper presented a comprehensive review of 196 studies showed that the Data Envelopment Analysis is the most used methods in this evaluation and assessment [9].

To make this test practical and beneficial, this data has been divided into four categories. First category contains the water service providers according to their institutional structure. Within this category, there are three classes, the water utilities, joint service councils, and water department in the municipalities. Second category classifies that water providers according to their size. According to the Water Sector Regulator Council, (WSRC) service providers are divided into three broad categories based on the number of connections they serve. The small, where, they serve less than 2,000 connections. Medium category serves from 2,000 to 8,000 connections; and the large scale provides services to more than 8,000 active connections. Third category divides the water providers based on their density. Within this category, the water service providers have three groups. High density, which refers to the providers in Gaza strip and the water providers in main Palestinian cities. The medium density, where the water providers serve both main cities and some villages i.e. Jerusalem Water Undertaking, and others. The low density, in which, the water providers deliver services in small villages, where, the number of connections are limited and network is expanded. The last category contains long run water providers deliver services based on main aggregate areas. Such scenario is similar to the current electricity sector, wherein five electricity companies provide the electricity services to major areas. North water service provider will deliver water services to Jenin, Tulkarem, Qalqilia, Salfeet, Tubas and Nablus. The Middle water service provider will contain Ramallah, Jerusalem, Jericho; the South service water provider mainly will deliver to Hebron and Bethlehem. For Gaza areas, all will be served by one water service provider.

Table 2. *Main features of each cluster.*

Firms Features	Short Abbrev	Served Population	Water Sold Quantity (m^3)	Network Length (Km)	Operating Cost (NIS)	FirmsCount
Water Utilities	UTL	344,477	10,670,849	981	44,285,986	18
Water Councils	JSC	54,175	917,361	220	4,542,890	18
Municipalities	Mun	54,207	1,809,733	132	5,729,868	107
Large Size	LSZ	203,208	6,462,379	527	24,576,118	51
Medium Size	MSZ	33,793	1,003,041	119	3,080,859	59
Small Size	SSZ	18,744	408,137	57	1,723,121	33
High Density	HDN	111,068	3,628,172	250	9,642,823	79
Medium Density	MDN	122,350	3,874,043	455	25,961,450	24
Low Density	LDN	31,630	565,665	128	2,678,947	40
North Provider	NWP	58,222	1,783,835	196	7,414,012	57
Middle Provider	MWP	120,927	4,512,668	471	26,770,857	19
South Provider	SWP	76,183	1,649,055	193	10,360,602	20
Gaza Provider	GWP	124,171	3,868,698	252	7,522,525	47

To detect economies of scale, and density in the Palestinian water sector, Data Envelopment Analysis has been implemented. As a non-parametric technique, DEA is used to determine a frontier and measure the efficiency ratio

for each specified unit. To do that, two sets of inputs and two of outputs have been considered in this research. For input, network length and total operating cost; and for the output, the served population and water sold quantity have been included [5].

To solve linear programming model, DEAP software for efficiency analysis has been used and to specify the return to scale i.e. constant or variable, as well as the orientation toward input or output and the number of stages needed to solve the problem. According to the literatures, most studies in this field used input-oriented models [8]. In this research the efficiency scores for both input-oriented and output oriented of each unit have been estimated [14].

6. Research Model

Referring to Figure 1, the framework is adapted to reflect multivariate analysis. The examination evaluates the groups of performance based on the three structure types of Palestinian water service providers. The performance areas are collected from water providers and published on annual basis, they are non-revenue water, staff productivity, collection efficiency, average consumption, average price, operating and maintenance cost, working ratio, and gross profit. This relationship may be positive or negative; the following diagram sketches this relation.

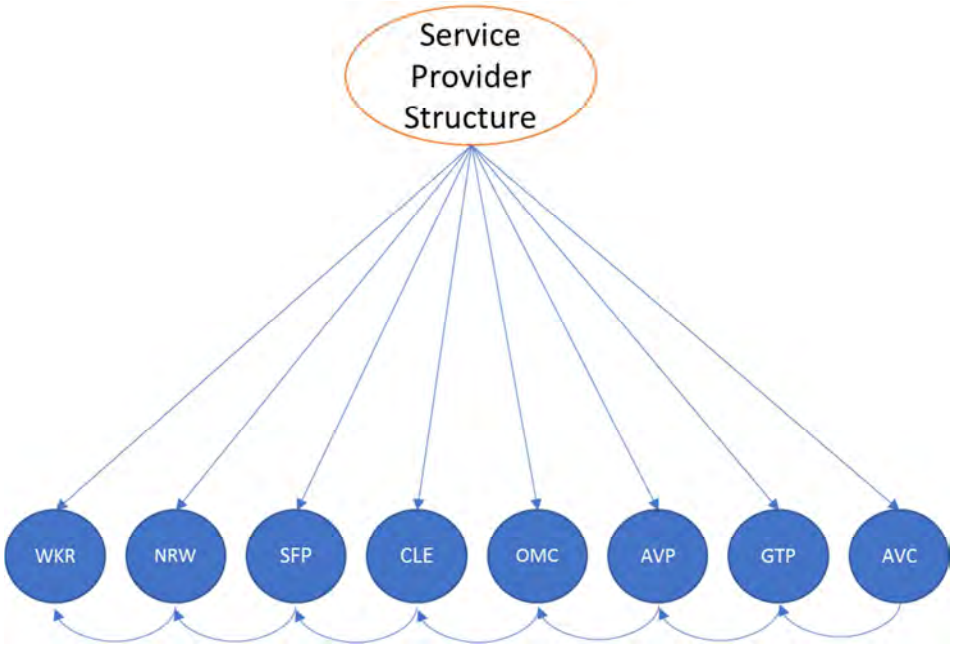

Figure 1. *Research Model.*

Where: -
WKR: Working Ratio.
NRW: Non-Revenue Water.
SFP: Staff Productivity.
CEL: Collection Efficiency.
OMC: Operating and Maintenance Cost.
AVP: Average Price.
GTP: Gross Profit.
AVC: Average Consumption.
STR: Service Provider Structure.

Since only one predicator and many dependent variables, multivariate analysis of MANOVA is used. The goal of conducting MANOVA thus is to maximally discriminate between distinct groups of performance areas and the indicators [10], [15] and [33].

Once there are significant differences in performance areas based on the structure of the Palestinian water service providers. Another test has been conducted to measure the efficiency scores for those providers. According to Coelli, [31] the input-oriented DEA model based on the variable returns to scale (VRS) is stated as follows:

$$\min_{\theta,\lambda} \theta,$$

Subject to

$$-y_i + Y\lambda \geq 1,\ \theta x_i + X\lambda \geq 0,\ N1\lambda = 1,\ \lambda \geq 0 \qquad (1)$$

According to Coelli, et al., [32] the output-oriented DEA model based on the VRS is stated as follows:

$$\min_{\varphi,\lambda} \varphi,$$

Subject to

$$-\varphi y_i + Y\lambda \geq 1, x_i + X\lambda \geq 0, x_i + X\lambda \geq 0, N1\lambda = 1, \lambda \geq 0 \quad (2)$$

7. Research Analysis and Discussion

Table 4 summarizes the collected panel data from Palestinian water service providers' performance reports. The table shows 143 observations for near to 65 service providers with coverage period from year 2010 and up to year 2015. However, Table 6 proposes multiple and significant comparisons between those structures. The approximate multivariate for Wilk's Lambda analysis as in Table 5 shows that overall model is significant where P = 0.000 [13]. This means that there is a statistically significant difference in performance of Palestinian water service providers based on their structure. Where $F = 3.941$, $P < 0.0005$, and Wilk's $\Lambda = 0.653$.

7.1. Profitability Analysis

Two ratios in this paper measure water providers' profitability. The working ratio; equals the total amount of operating and maintenance cost incurred by service provider over operating revenue generated during the year. The purpose of this ratio hence is to measure the ability of the water provider to cover operating and maintenance cost from recognized revenue, and whether will be remaining amount to cover capital investment for expanding into new areas. The default amount of this ratio may be 1, wherein total revenue equals total operating expenses. Less than 1 means revenue covers operating expenses. Table 4 shows that joint councils are more profitable than the other structures. The working ratio is 0.8850, 1.0700 and 1.2940 for JSC, utilities, and municipalities respectively. On the other hand, the gross profit ratio shows that the JSCs generate profit by 4%, where, the utilities incurred losses by 17%, however, the municipalities incurred more losses by 39% on average. This means that 92% of the Palestinian water service providers have losses in their financial statement at the end of the year (58 as municipalities and utilities /63 as of all water providers in this paper = 92%). Expressed in other way, there is 94% of the Palestinian water connections work under losses and only 6% from total water connections deliver water at profit. Again, those water providers in this paper cover 75% from total Palestinian population.

As a general rule, the working ratio and gross profit are affected by revenue and cost of water providers. The more in revenue and less in recognized cost, the more in operating and net profit achieved. The sales price of cubic meter plays major factor in revenue calculation [23]. Table 4 shows that on average the JSCs deliver water service at price 5.5 NIS, where the municipalities can charge people only by 3.2 NIS in average, however, the utilities price their services at 4.7 NIS. For the cost of water cubic meter, the same cost for both JSC and utilities i.e. 5.16 NIS, where, it cost less for the municipalities by 3.88 NIS.

In Palestine, the water supply for service providers comes from two sources: water production and bulk purchases. It has been noted that water providers incurred less cost once they depend on production rather than purchases. The descriptive statistic table shows, the more the price, the more the revenue generated, and therefore, the more in profit margin. To summarize, when moving from dependent to autonomy structure of water providers i.e. from municipalities to utilities and to JSCs; the water price raises, the gross profit margin increases and achieves more efficiency in working ratio. The results are similar to the cases of India water providers. A study over groups of Indian water utilities finds that the group of utilities are managed by municipal corporations and parastatals, with a certain amount of functional autonomy, perform better in comparison to the group municipal corporations and government [12].

7.2. Non-Revenue Water Analysis

Descriptive statistic table indicates that non-revenue water percent is less in JSC structure of service providers than in utilities and municipalities. The non-revenue water is near to 22% in JSCs, 34.5% in utilities and 33.5% in municipalities. The multiple comparison table proposes significant differences in non-revenue water between municipalities and JSCs where, P =.000; the same results are noted in utilities and JSCs P =.002. However, no significant differences are found between the utilities and municipalities since P =.946 i.e. value more than.005.

In Palestinian water sector, utilities structure of service providers always has old network compared with JSC structure. The largest Palestinian water service provider is Jerusalem Water Undertaking JWU, this utility provides water services for near to 62,000 connections, as of more than 370,000 residents. JWU was established in year 1949, so the network was placed in service before 70 years; where, the Joint Services Council Southeast Nablus was established before couple of years [16]. The non- revenue water for Jerusalem Water Undertaking is 28%, however for Joint Services Council Southeast Nablus it is 11% [35].

7.3. Collection Efficiency Analysis

The ability of water service provider to collect water bills from its customers is an indicator for financial sustainability. This paper indicates that JSCs can collect 71% from their annual water bills; the utilities providers collect 69%, where, municipalities collect only 60%. From statistical point of view, there are no significant differences between the three structures based on collection efficiency of outstanding debt as noted in the multiple comparison table (P=.365,.243,.979).

In Palestinian water sector, some of strategies are always implemented in JSCs service providers lead increase the collection efficiency such as installing prepaid meters instead of postpaid meters. A study over water invoices and collections strategies that implemented in Palestinian water service providers shows many strategies lead to increase collection efficiency as of installation prepaid meters, implementation advanced technology such as mobile software, quality of water services provided, quality of other services provided, and customers' satisfaction. All those

predictors motivate the customers to pay their water bills [24]. In the case of JSCs structure, only water services are provided to the customers. However, for utilities and municipalities, there are many services such as wastewater, licensing of building, electricity, and so forth. This implies that if the customer is not satisfied from building licenses or electricity service, he or she will not pay the water invoices, since one entity provides those services. This applicable in utilities and municipalities, but not found in JSCs.

7.4. Average Consumption Analysis

The core function of water service providers is to deliver the best quality of water services to the customers at affordable prices. If there is no available water to deliver, then, the customer will not consume the required quantities. The descriptive statistic table shows that the average consumption per capita per day in JSCs are only 49 liters. However, in utilities and municipalities the total consumption for all connection types are near to 84 and 100 liters per day respectively.

Many reasons for this variation between JSCs and the others. It has been noted that the JSCs deliver water services to villages, i.e. no JSCs are founded in the main cities. There are no industrial, commercial, and touristic connections in the villages where the JSCs serve; most of those connections in those small villages are households. However, the municipalities and utilities mainly deliver their water services in major cities and dense areas; wherein the manufacturing zones and different types of connections that consume considerable quantity of water. Some people in the Palestinian small villages where JSCs deliver water have their own wells and they are partially dependent on their water wells. In the major cities, this issue is not noted and people are rarely own private wells.

Generally, some municipalities and utilities depend partially or fully on water produced from their own wells, Tulkarem, Qalqilia and Jericho, wherein large consumption quantities, fully produce water from their own wells. However, JSCs, purchase the water from the bulk provider; this implies that the consumer in municipality and utility pay less price of cubic meter compared with the JSCs consumer who pays 45% more in price than municipalities. This because that JSCs purchase the water rather than produce i.e. they don't have own wells like some municipalities and utilities [1].

7.5. Staff Productivity Analysis

The staff productivity ratio generally indicates the number of employees serving 1,000 water connections. If the number of staff increases relative to the 1,000 connections, then, it will be less productivity. Table 4 shows that municipalities require an average of 4.9 employees to serve 1,000 connections, where, the utilities require 5.3 employees to do the same job. However, the JSC structure can serve the 1,000 connections with only 4 employees. It seems that JSC structures is more productive in terms of staff than municipality and utility structures, since it can serve the same number of connections by 75% and 82% of municipality and utility providers respectively. The reason for high number of employees in municipalities and utilities providers relative to JSCs is poor management in hiring, and some staff may be also recruited to serve water department in municipality, but may serve other departments as safeguard staff, drivers and admin officers [2].

7.6. DEA Efficiency Analysis

So far, many performance areas have significant differences based on the water provider structure. The DEA efficiency score can be summarized to show how much water service provider can maximize output without addition of input. The technical efficiency is estimated by using the approach of maximizing the output subject to constant input and measured based on the VRS (input oriented and output-oriented). Efficiency scores for both input-oriented and output oriented of each cluster are estimated as per the following table.

Table 3. *Efficiency Scores of each cluster of Palestinian Water Service Providers.*

Method	**Input Oriented**				**Output Oriented**			
Firm Features	**CRSTE**	**VRSTE**	**SCALE**	**RS**	**CRSTE**	**VRSTE**	**SCALE**	**RS**
Water Utilities	0.471	1.000	0.471	drs	0.471	1.000	0.471	drs
Water Councils	0.722	0.808	0.894	irs	0.722	0.774	0.934	irs
Municipalities	0.614	0.711	0.864	irs	0.614	0.647	0.950	irs
Large Size	0.511	0.876	0.583	drs	0.511	0.920	0.556	drs
Medium Size	0.665	0.883	0.753	irs	0.665	0.823	0.807	irs
Small Size	0.659	1.000	0.659	irs	0.659	1.000	0.659	irs
High Density	0.732	0.738	0.991	irs	0.732	0.851	0.859	drs
Medium Density	0.290	0.290	0.998	drs	0.290	0.532	0.545	drs
Low Density	0.715	0.908	0.788	irs	0.715	0.876	0.817	irs
North Utility	0.476	0.543	0.876	irs	0.476	0.476	0.999	irs
Middle Utility	0.328	0.411	0.797	drs	0.328	0.607	0.540	drs
South Utility	0.445	0.471	0.945	irs	0.445	0.540	0.826	drs
Gaza Utility	1.000	1.000	1.000	---	1.000	1.000	1.000	---
Mean	0.587	0.742	0.817		0.587	0.773	0.766	

CRSTE = technical efficiency from CRS DEA, VRSTE = technical efficiency from VRS DEA, SCALE = scale efficiency = CRSTE/VRSTE, irs = increasing return to scale; drs = decreasing return to scale; RS = return to scale.

The average scores for water providers are high, where, CRSTE 0.587; VRSTE 0.742; and SCAL 0.817. The results imply that, on average, Palestinian water service providers can reduce the inputs by 41% (100%–58.7%) without any reduction in output. The results show near to 14 out of 63 water providers are set on the efficient line.

The results of this test indicate that the highest efficiency appeared during the merging Gaza water service providers into one water utility. Under this case the lowest cost with maximum output can be generated. The constant economies of scale in Gaza utility will work at optimal scale; a one percent changes in input leads to one percent change in output. The analysis of data figures out the small size and water utilities structure, both are set at efficiency frontier line based on variable return to scale. This indicates that changing current water providers into regional and legal independent utilities, will lead to decrease the cost. The municipalities and JSCs have a deficiency by 30% and 20% respectively comparing with water utilities.

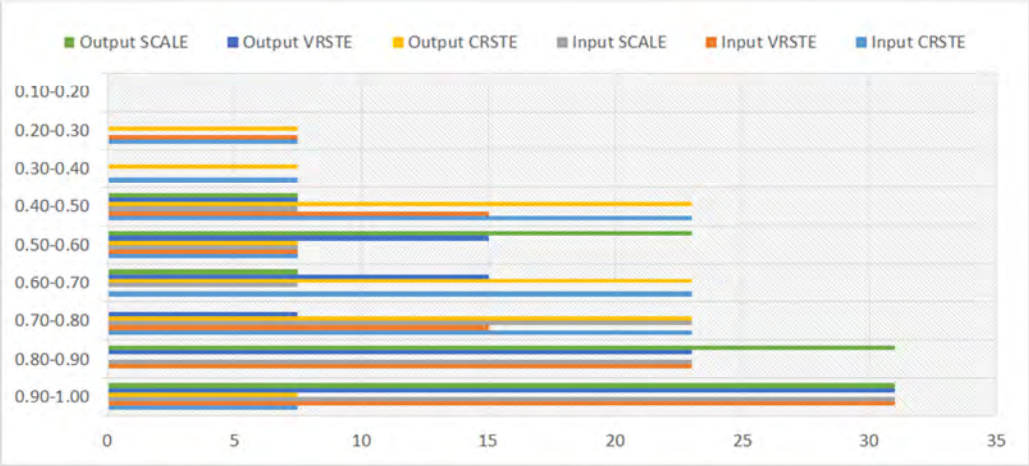

Figure 2. *Efficiency Distribution of Palestinian Water Service Providers.*

One of the scenario is to merge current providers into four main water regional utilities –north, middle, south in the West Bank and one in Gaza. The results of this test show less than the current efficiency can be achieved. Merging into limited regional utilities will double the cost or diminishing half of overall output. Other scenario may be the merging based on the density of population. In economies of density, higher population densities allow synergies in water service provision leading to lower unit costs. The test of this alternative delivers the highest deficiency in cost saving, merging Salfeet municipality and Bedia is one of the instance for this alternative.

The empirical results of this research give the decision maker i.e. Palestinian Water Authority a guideline for the different alternatives in term of cost, water quantity, and served population. This research can direct the decision maker how to reach the efficiency for the selected scenario. Therefore, changing the utilities into another options will not reduce the cost or increase the output. To increase the efficiency of the current municipalities and JSCs, it requires to adapt the procedures implementing by the small providers in terms of cost and other key indicators. However, to increase the efficiency of large and medium size of water providers, they should follow the practices of the regional utilities or Gaza option. The low density is to follow the small size providers so they can increase their output with current input they consume. The subject of limited number of regional utilities can enhance the efficiency once the middle regional utility adapts its practices based on the Gaza regional utility; such as total costing relative to quantity of produced cubic meters and number of served population. However, for the north and south water utilities, they can increase their output with current input by following the current water utilities or small provider's practices.

Three types of return to scales result from this DEA test. First: increase return to scale. This includes case of increasing economies of scale, such as water councils, municipalities, medium, small size, high, low density, north, and south utilities; those firms have no optimal size. In order to reduce their average cost, they have to increase their size. Practically, this could be done either by internal growth (i.e. producing more output) or by merging with another firm which is also facing increasing returns to scale. Second: decreasing returns to scale. This contains the diseconomies of scale, for instance, water utilities, large size of providers, medium density, and middle utility; those firms are already oversized, having exceeded their optimal size. In order to reduce their average cost, they have to decrease their size. Practically, this could be done either by internal decay (i.e. producing less output) or by splitting the firm into two separate water providers. Note that some of the production could be transferred to a firm facing increasing returns to scale as in the first type. The last type is constant return to scale which has been founded in Gaza utility where optimal produced water and served population to input cost.

8. Conclusion & Policy Implication

Measuring the effect of structure on the performance of Palestinian water service providers is necessary at this phase. The Palestinian Water Law, 2014 calls for merging current water providers into large, financially, and legally independent regional utilities. The purpose of this merging and legal framework is to achieve more efficiency, water availability, and more service quality at reasonable price. In Palestinian water sector, a few studies over this subject are prepared. This study evaluates the performance areas of Palestinian water service providers based on their current institutional structure from the first side; and calculates the efficiency for different features of water providers from other side. Thereafter, ranking the calculated alternatives based on efficiency for the purpose of guiding the decision makers. Cross sectional data for those service providers has been analyzed using Multivariate Analysis of Variance (MANOVA). This analysis measures whether there are significant differences in eight responsive variables based on water provider's structure. The eight performance areas are non-revenue water, staff productivity, collection efficiency, average consumption, average price, operating and maintenance cost, working ratio, and gross profit.

The results show that there are significant differences in different performance areas such as, non-revenue water, average price, and water consumption based on service provider's structure. In this setting, no significant difference has been found in working ratio, staff productivity, collection efficiency, operating and maintenance cost per unit, and gross profit based on those structures. The results show that utility service providers perform better than municipalities in working ratio, gross profit, and collection efficiency. On the other side, the JSCs service providers have high sales price than utilities and municipalities, therefore, they are more profitable, more efficient in non-revenue water, and more in staff productivity.

Since there are significant differences in performance based on the water provider's structure, there is a need to test the efficiency; in which the water providers can maximize the output for given level of input consumption, or minimize input for a given level of output. By calculating an efficiency score, it indicates if a water provider is efficient or has capacity for improvement; by how much; and if a water provider has to decrease or increase its scale or size in order to minimize the average cost.

The results of this test indicate more efficiency can be achieved during merging current water service providers into regional utilities. Gaza water providers into one water utility found to be set at optimal size; and the current water utilities are set on the efficient line based on variable return to scale. Amalgamation of current service providers into only four main water regional utilities – one in Gaza and three in the West Bank; north, middle and south, will deliver less than current efficiency and will double the cost or diminish half of overall output. Therefore, changing current large and medium water providers into regional utilities, and merging the current small providers into medium or large regional utilities will have more efficiency and capacity for improvement.

Decreasing returns to scale i.e. diseconomies of scale is another finding of this research. This case is found in water utilities, large size of providers, medium density, and middle utility. Those firms are already oversized and having exceeded their optimal size. In order to reduce their average cost, they have to decrease their size. On the opposite side, increase return to scale or economies of scale is noted in water councils, municipalities, medium, small size, high, low density, north, and south utilities; those firms have no optimal size. In order to reduce their average cost, they have to increase their size. Practically, this could be done either by internal growth i.e. producing more output, or by merging with other firms which are also facing increasing returns to scale.

Acknowledgements

This research paper has been made possible through the support from MEDRC Water Research at the Sultanate of Oman. We would like to express our deepest appreciation to MEDRC for publishing this paper. The deepest gratitude also to Palestinian Water Authority (PWA) for valuable, effective supervision, coordination of the scientific researches, and directing them toward finding creative solutions for current water problems.

Appendix

Table 4. *Descriptive Statistics.*

	Structure	Mean	Std. Deviation	N
Working Ratio	MUN	1.2940	1.07446	107
	UTL	1.0700	.20508	18
	JSC	.8850	.20232	18
	Total	1.2143	.94493	143
Non-Revenue Water	MUN	33.5128	11.54768	107
	UTL	34.3889	6.53021	18
	JSC	21.8556	9.37376	18
	Total	32.1557	11.42957	143
Staff Productivity	MUN	4.8764	2.85553	107
	UTL	5.3044	1.57490	18
	JSC	4.0078	1.62088	18
	Total	4.8210	2.61038	143

	Structure	Mean	Std. Deviation	N
Collection Efficiency	MUN	60.4467	26.24641	107
	UTL	69.3600	24.20664	18
	JSC	71.0333	23.87608	18
	Total	62.9013	25.90054	143
O&M Cost	MUN	3.8766	2.44727	107
	UTL	5.1694	2.29996	18
	JSC	5.1667	1.09983	18
	Total	4.2017	2.35907	143
Average Price	MUN	3.19874	1.742875	107
	UTL	4.68778	2.362371	18
	JSC	5.48944	.404453	18
	Total	3.67451	1.916633	143
Gross Profit	MUN	-.3908945	1.2229	107
	UTL	-.1724808	.183957	18
	JSC	.0469174	.250586	18
	Total	-.3082927	1.073054	143
Consumption	MUN	100.4768	54.57882	107
	UTL	84.0406	11.50169	18
	JSC	48.8111	12.01308	18
	Total	91.9045	50.55069	143

Table 5. *Multivariate Tests*[a].

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.986	1206.191[b]	8.000	133.000	.000
	Wilks' Lambda	.014	1206.191[b]	8.000	133.000	.000
	Hotelling's Trace	72.553	1206.191[b]	8.000	133.000	.000
	Roy's Largest Root	72.553	1206.191[b]	8.000	133.000	.000
STR	Pillai's Trace	.365	3.742	16.000	268.000	.000
	Wilks' Lambda	.653	3.941[b]	16.000	266.000	.000
	Hotelling's Trace	.502	4.139	16.000	264.000	.000
	Roy's Largest Root	.436	7.307[c]	8.000	134.000	.000

Table 6. *Multiple Comparison.*

Dependent Variable	(I) STR	(J) STR	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Working Ratio	MUN	UTL	.2240	.23955	.619	-.3434	.7915
		JSC	.4090	.23955	.206	-.1584	.9765
	UTL	MUN	-.2240	.23955	.619	-.7915	.3434
		JSC	.1850	.31343	.826	-.5575	.9275
	JSC	MUN	-.4090	.23955	.206	-.9765	.1584
		UTL	-.1850	.31343	.826	-.9275	.5575
Non-Revenue Water	MUN	UTL	-.8761	2.75341	.946	-7.3986	5.6465
		JSC	11.6572*	2.75341	.000	5.1347	18.1798
	UTL	MUN	.8761	2.75341	.946	-5.6465	7.3986
		JSC	12.5333*	3.60265	.002	3.9990	21.0677
	JSC	MUN	-11.6572*	2.75341	.000	-18.1798	-5.1347
		UTL	-12.5333*	3.60265	.002	-21.0677	-3.9990
Staff Productivity	MUN	UTL	-.4280	.66403	.796	-2.0010	1.1450
		JSC	.8687	.66403	.393	-.7044	2.4417
	UTL	MUN	.4280	.66403	.796	-1.1450	2.0010
		JSC	1.2967	.86884	.298	-.7615	3.3549
	JSC	MUN	-.8687	.66403	.393	-2.4417	.7044
		UTL	-1.2967	.86884	.298	-3.3549	.7615
Collection Efficiency	MUN	UTL	-8.9133	6.55450	.365	-24.4403	6.6137
		JSC	-10.5866	6.55450	.243	-26.1136	4.9404
	UTL	MUN	8.9133	6.55450	.365	-6.6137	24.4403
		JSC	-1.6733	8.57614	.979	-21.9894	18.6427

Dependent Variable	(I) STR	(J) STR	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
O&M Cost	JSC	MUN	10.5866	6.55450	.243	-4.9404	26.1136
		UTL	1.6733	8.57614	.979	-18.6427	21.9894
	MUN	UTL	-1.2928	.58781	.075	-2.6853	.0997
		JSC	-1.2900	.58781	.076	-2.6825	.1024
	UTL	MUN	1.2928	.58781	.075	-.0997	2.6853
		JSC	.0028	.76911	1.000	-1.8192	1.8247
	JSC	MUN	1.2900	.58781	.076	-.1024	2.6825
		UTL	-.0028	.76911	1.000	-1.8247	1.8192
Average Price	MUN	UTL	-1.48904*	.441064	.003	-2.53388	-.44420
		JSC	-2.29071*	.441064	.000	-3.33555	-1.24587
	UTL	MUN	1.48904*	.441064	.003	.44420	2.53388
		JSC	-.80167	.577104	.349	-2.16877	.56544
	JSC	MUN	2.29071*	.441064	.000	1.24587	3.33555
		UTL	.80167	.577104	.349	-.56544	2.16877
Gross Profit	MUN	UTL	-.2184136	.272493	.703	-.863925	.4270977
		JSC	-.4378120	.272493	.246	-1.08332	.2076993
	UTL	MUN	.21841367	.272493	.703	-.427097	.8639250
		JSC	-.21939834	.356540	.812	-1.06400	.6252108
	JSC	MUN	.43781201	.272493	.246	-.207699	1.083323
		UTL	.21939834	.356540	.812	-.625210	1.064007
Consumption	MUN	UTL	16.4363	12.18849	.371	-12.4371	45.3096
		JSC	51.6657*	12.18849	.000	22.7924	80.5391
	UTL	MUN	-16.4363	12.18849	.371	-45.3096	12.4371
		JSC	35.2294	15.94784	.073	-2.5494	73.0083
	JSC	MUN	-51.6657*	12.18849	.000	-80.5391	-22.7924
		UTL	-35.2294	15.94784	.073	-73.0083	2.5494

References

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

[2] Abdullah Murrar, Abdelrahman Tamim, Subhi Samhan. (2017). 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

[3] Abrate et al., (2016). Efficiency in the Consolidation of the Italian Water Sector. Water Resour Manage. Springer Science+Business Media Dordrecht 2016. DOI: 10.1007/s11269-016-1376-9

[4] Andey, S. P. & Kelkar, P. S. (2009). Influence of Intermittent and Continuous Modes of Water Supply on Domestic Water Consumption. Water Resour Manage. Volume 23, Issue 12, pp 2555–2566. 23: 2555. doi: 10.1007/s11269-008-9396-8

[5] Andrea et al., (2015). The Effects of Operational and Environmental Variables on Efficiency of Danish Water and Wastewater Utilities. Water 2015, ISSN 2073-4441 www.mdpi.com/journal/water.7, 3263-3282; doi: 10.3390/w7073263

[6] Balaguer-Coll, M. T., Prior, D., and Tortosa-Ausina, E. (2013). Output Complexity, Environmental Conditions, and the Efficiency of Municipalities. Journal of Productivity Analysis, 39(3): 303–324.

[7] Charnes, A., Cooper, W. W., and Rhodes, E. (1978). Measuring the efficiency of decision making units. European Journal of Operational Research, 2(6): 429–444

[8] De Witte, K.; Marques. (2010). Influential observations in frontier models, a robust non-oriented approach to the water sector. Ann. Oper. Res. 2010, 181, 377–392

[9] Fethi, M. D. and Pasiouras, F. (2010). Assessing Bank Efficiency and Performance with Operational Research and Artificial Intelligence Techniques: A Survey. European Journal of Operational Research, 204(2): 189–198. DOI: 10.1016/j.ejor.2009.08.003

[10] Grice J, Iwasaki. M. (2007). A TRULY MULTIVARIATE APPROACH TO MANOVA. Applied Multivariate Research, Volume 12, No. 3, 2007, 199-226. DOI: 10.22329/amr.v12i3.660

[11] Guerrini, Romano, & Campedelli. (2010). Factors affecting the performance of water utility companies. International Journal of Public Sector Management Vol. 24 No. 6, 2011 pp. 543-566 q Emerald Group Publishing Limited 0951-3558 DOI: 10.1108/09513551111163657

[12] Gupta, Kumar & Sarangi, (2012). Measuring the performance of water service providers in urban India: implications for managing water utilities. Water Policy 14 (2012) 391–408. IWA Publishing 2012. doi: 10.2166/wp.2011.109

[13] Haase, R. and Ellis, M. (1987) Multivariate Analysis of Variance. Journal of Cou nseling Psychology, 34, 404-413. https://doi.org/10.1037/0022-0167.34.4.404

[14] Hossian, Sobhan & Sultana, (2016). Application of DEA Methodology in Measuring Efficiency of Some Selected Commercial Banks in Bangladesh. JUJSS. ISSN 1022-4734. Vol. 33, 2016, pp. 57-64.

[15] Anil Ghash. (2007). Applied MANOVA and discriminant analysis. Journal of the American Statistical Association 102(479): 1075-1076 September 2007. DOI: 10.1198/jasa. 2007.s203

[16] Jerusalem Water Undertaking (2016) Foundation of JWU. Historical Background. Published on May 23, 2016. http://www.jwu.org/jwu/?p=1698&lang=en. June 30, 2017.

[17] Johan Willner and David Parker. (2007). The Performance of Public and Private Enterprise under Conditions of Active and Passive Ownership and Competition and Monopoly. Journal of Economics. Springer-Verlag 2007. Vol. 90 (2007), No 3, pp. 221–253. DOI 10.1007/s00712-006-0230-6

[18] Khaki, Najafi, Rashidi. (2012). Improving efficiency of decision making units through BSC-DEA technique. Management Science Letters 2 (2012) 245–252. 2012 Growing Science Ltd. All rights reserved. doi: 10.5267/j.msl.2011.08.016

[19] Lledó Castellet & María Molinos (2016). Efficiency assessment of wastewater treatment plants: A data envelopment analysis approach integrating technical, economic, and environmental issues. Journal of Environmental Management. Volume 167, 1 February 2016, Pages 160-166. doi: 10.1016/j.jenvman.2015.11.037

[20] Makaya & Hensel. (2014). 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] Marta et al., (2016). Ownership and Performance in Water Services Revisited: Does Private Management Really Outperform Public? Water Resour Manage. Springer Science+Business Media Dordrecht 2016. DOI 10.1007/s11269-016-1495-3

[22] MoLG. (2017). Joint Service Councils Archive. http://www.molg.pna.ps/Join_Council_arch.aspx.Ministry of Local Government. 27/06/2017

[23] Murrar, A. (2017) The Relationship between Size and Performance of Palestinian Water Service Providers. Journal of Water Resource and Protection, 9, 536-552. Doi: org/10.4236/jwarp.2017.95035

[24] Murrar. Abdullah. (2017). The water invoices and customers' payment motivational strategies: an empirical study on Palestinian water service providers. EPRA International Journal of Economic and Business Review-Online ISSN 2347-9671 & Print ISSN 2349-0187. Vol: 5, Issue: 1, January 2017.

[25] Obosi, J. O. (2017). Impact of Public-Private Partnership on Water Service Delivery in Kenya. Open Journal of Political Science, 7, 211-228. doi: 10.4236/ojps.2017.72017

[26] Pazzi, Ausina, Duygun & Zambell. (2016). The Cost Efficiency of Water Utilities: When Does Public Ownership Matter? Article in Local Government Studies. August 2016. DOI: 10.1080/03003930.2016.1207630

[27] Peda, P., Grossi, G. and Liik, M. (2013) Do Ownership and Size Affect the Performance of Water Utilities? Evidence from Estonian Municipalities. Journal of Management & Governance, 17, 237-259. Doi: 10.1007/s10997-011-9173-6

[28] Rao, D. P., O'Donnell, C. J., Battese, G. E., and Coelli, T. J. (2005). An Introduction to Efficiency and Productivity Analysis. Springer, New York. DOI: 10.1007/978-1-4615-5493-6

[29] Rubio, Go´mez & Guardiola. (2010). Performance and ownership in the governance of urban water. Municipal Engineer 163 Issue ME1. Proceedings of the Institution of Civil Engineers Municipal Engineer 163 March 2010 Issue ME1 Pages 51–58 doi: 10.1680/muen.2010.163.1.51

[30] State of Palestine (2014). Decree No. 14 for year 2014 relating to the Water Law. Palestinian Water Authority. Articles 45, 46 and 47.

[31] T. Coelli (1996): A Guide to DEAP Version 2.1: A Data Envelopment Analysis (Computer) Program, Australia: University of New England.

[32] T. J. Coelli, S. Rahman and C. Thirtle (2002): Technical, Allocative Cost and Scale Efficiency in Bangladesh Rice Cultivation: A Non-Parametric Approach, Journal of Agricultural Econometrics, 53 (3): 607-627. DOI: 10.1111/j.1477-9552.2002.tb00040.x

[33] Warne, Russell (2014). A Primer on Multivariate Analysis of Variance (MANOVA) for Behavioral Scientists. Practical Assessment, Research & Evaluation, 19(17). Practical Assessment, Research & Evaluation, Vol 19, No 17 http://pareonline.gross/getvn.asp?v=19&n=17

[34] Water Sector Regulatory Council. (2014). Water Services Providers Performance Report 2014. WSRC hardcopy and softcopy publishing report. wsrc. ps.20.06.2017.

[35] Water Sector Regulatory Council. (2015). Water Services Providers Performance Report 2015. WSRC hardcopy and softcopy Arabic Version. publishing report. wsrc. ps.30.06.2017.