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ICT IN WATER GOVERNANCE AND STAKEHOLDERS ENHANCEMENT IN PALESTINE

Master's Thesis

Supervisor: Ingrid Pappel
PHD

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INFORMATSIOONI JA KOMMUNIKATSIOONI TEHNOLOOGIAD VEEMAJANDUSE JUHTIMISES NING VEEMAJANDUSE OSANIKE VAHELISE KOOSTÖÖ PARENDAMINE PALESTIINAS

Master Thesis

Juhendaja: Ingrid Pappel
PHD

Tallinn 2016

Author's declaration of originality

I hereby certify that I am the sole author of this thesis. All the used materials, references to the literature and the work of others have been referred to. This thesis has not been presented for examination anywhere else.

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Abstract

Today, information and communication technology (**ICT**) have become pivotal in everyday life. Though there are many initiatives designed to empower and enhance the **water sustainability**, efficiency and accessibility via **ICT** to address the water crisis, there is still a need for standardization and proper **ICT** governance. Providing **ICT** tools ensures achieving an effective management of water sector, so the Smart water management and **water governance** are a keys policy issue on the global stage.

Due to the fragmented water sections in the municipalities of Palestine, the researcher's objective is to analyze the **ICT** instruments in **water sector** through studying different experiences in other countries in order to achieve a better and effective service provision and suggest a plan to unify all water sections in one water utility through using ICT tools.

The research illustrates the work mechanism of **ICT** tools in water sector and how it's providing precise data through an integrated information system which is assisting in managing the service provision process and helping the decision makers.

This study shows a result about citizens' satisfaction of the current water provision service, this data has been collected by a quantitative survey, and it also expresses the degree of acceptance about utilizing **ICT** in the water sector.

The outcomes of the study support creating a water environment which meets the needs and requirements of citizens and service provider in addition, the interaction enhancement between the all **stakeholders.**

Abstrakt

Informatsiooni ja kommunikatsiooni tehnoloogiad (IKT) on tänapäeva igapäevaelu pöördeliselt muutnud. Olgugi, et on palju algatusi, mis kasutavad IKT-d veemajanduse jätkusuutlikkuse võimestamiseks ja parendamiseks, veemajanduse efektiivsuse suurendamiseks veekriiside lahendamisel, on ikka veel vajadus standardiseerimise ja korraliku IKT juhtimise järele. Nende teenuste pakkumine tagab eelnimetatud tehnoloogiate õiget rakendamise ning hoiab ära elektroonilistest jäätmetest tingitud keskkonnakahjud. Seetõttu on arukas veemajanduse korraldus ja juhtimine globaalses mõttes võtmetähtsusega küsimused. Palestiina munitsipaalüksustes töötavad veemajadust puudutavad osakonnad fragmenteeritult. Siinkirjutaja eesmärk on seetõttu rakendada IKT vahendeid Palestiina veemajanduse sektoris, et tagada parem ja efektiivsem vee teenus ning pakkuda välja plaan IKT vahendite abil ühendada kõik Palestiina veemajanduse osakonnad ühtseks süsteemiks. Käesoleva uurimistöö eesmärk on luua veemajanduse süsteem, mis vastab kodanike ja teenusepakkujate vajandustele ning ühtlasi parendab veemajaduse osanike vahelist suhtlust ja koostööd.

Dedication

First and foremost, I'd like to dedicate this work to my parents and my brother Mohammed, and my country Palestine and Estonia

I also would like to thank my supervisor Ingrid Pappel for helping me and giving good recommendations to implement this search, and many thanks to the Estonian ministry of foreign affairs for supporting my study period by scholarship

Thanks for everyone who helped me…

List of abbreviations and terms

ICT	Information and Communication Technology
PWA	Palestinian Water Authority
CMWU	Coastal Municipalities Water Utility
SWM	Smart Water Management

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1 Introduction

1.1 Introduction

The conceptualized of water from one side by the physical flow of water and from the other side by the rules, political and socio-economic aspects and social practices. So "water is "a symbol of identity, power and citizenship" [6]; and drinking water as a fundamental right for humanity, this means that water resources, rules and water sections should be organized, taking into consideration that water sector management is not only affected by the scientific or natural-technical factors, but in fact it's highly affected by society and its social relations of culture and power.

Information and communication technology **(ICT)** has high capacity to improve the current water resource management of many countries. Satellite remote sensing, semantic sensor web, cloud computing, and geographical information system (GIS) these are few examples of technologies which currently available and can be used innovatively, to obtain real-time water using information in order to forecast and track as well as identify the new sources of good service and fresh water. Reliable and precise information that is easy accessible is extremely crucial for proper decision-making within a water sections and resources, So a unified and centralized water utility to manage these sections is needed to provide a good accessibility to the service and to integrate the water platform.

Pressing the water management issues are experiences by most of countries around the world, so the international cooperation in addition to the knowledge transfer can help countries which and allow them to identify new or better ways for dealing with these issues; Moreover, countries can learn from different experiences of other countries[1]

[1] How to facilitate transfer of water management knowledge by "Joanne Vinke-de Kruijf"

On the international level it became obvious that the allocation of good water at most areas in this world is a less problem of physical water scarcity than the problem of economical water scarcity. So “Mismanagement and poor governance lay at the heart of the world’s water crisis” [6].

1.2 Research objectives:

The main objective and purpose of this research is utilizing ICT in the water provision service and to propose a plan for unifying the water sections inside the Palestinian municipalities in one structured utility which could contain all water sections and its administrations to achieve an effective water provision service in addition to enhancing the interaction between all stakeholders (**PWA, CMWU, Municipalities, NGO’s, Ministry of agriculture, and citizens**).

1.3 Research motivation:

As one of significant cyber physical systems which should be achieved, the water sector and its importance to implement an environment which contains efficient service provision by utilizing ICT among this environment.

The current situation in Palestine shows that each municipality there has water section according to the geographic area, and there is no efficient management for all of these sections, in addition to some differences in the quantity, quality and tariff of water, so that needs to improve this environment through some projects to provide good service taking into considerations engaging process for citizens as a beneficiary of this service, they need to be connected easily with the service provider by using a system which could meet their needs and satisfaction.

The general trend nowadays in **PWA** is planning to unify these sections in one structure to facilitate the administration process of water sections, but it’s still missing involving the public or citizens through this process, especially while what are being achieved

right now of unifying the fragmented water networks in the different areas to be combined in one main line in order to provide all areas in these municipalities by the same water which has the same quality and tariff.

Through my previous experience of working in water sector in Palestine, I found out that these factors which I mentioned are enough reason to motivate me for implementation this project and utilizing **ICT** in water projects there in addition to my current experience in e-governance and how to use it empower the public services, especially while the technical projects to improve the water infrastructure in Palestine right now are being achieved according to a new computerized system by using some techniques such as **SKADA** ,thus utilizing **ICT** during these projects will create an integrated water sector which meets all stakeholder's requirements and needs, moreover the expected outcomes of this research would complement these infrastructure projects with the new technologies which makes the managing approach of this sector much easier, later on applying the new system could be easily achieved, so this is another motivation of this research.

Recently, and through my searching on web I found out that there is a general trend at the last 7 years around the world for using the **ICT** in water sector in many countries in EU, Africa and Asia as well; so it's on motivation for this research.

1.4 Research problem and questions:

As I mentioned briefly in the introduction about the water situation in Palestine, knowing that the fragmented sections in the municipalities, thus the consequences of this situation don't help the water sector to be unified in one water utility which could be responsible about managing these sections all together as one entity and this makes the administration process easier and allows the purposes of this research to be implemented, especially with the infrastructure projects right now in Palestine which are being achieved nowadays to improve the water situation and provide Gaza by one main line through a central desalination plant for the sea water; so this can finds out some questions which are required for the aims and purposes of this research.

1.5 Thesis Structure:

Chapter one: Introduction

Chapter two: Literature View

Chapter three: Research Methodology

Chapter four: Data presentation and analysis

Chapter five: Requirements

Chapter six: Solutions

Chapter seven: Conclusion and recommendations

2 Literature review

2.1 State of the art:

2.1.1 General overview about water sector institutional setup in Palestine:

The Current Water Sector Institutional Setup has an institutional structure which is divided in three levels according to a consultant's report in 2014 which aimed to evaluate the current structure and propose some solutions to upgrade the water system; and these three levels are the following:[1]

1. Policy level, represented by the National water council
2. Regulatory level represented by the Palestinian Water Authority
3. Service provision level represented by the regional water utilities and users associations.

2.1.1.1 A- National Water council (NWC):

Mandate of National Water Council in Palestine:

- Sanction the general water policy.
- Ratify plans and programs aimed at organizing the usage of water.
- Ratify the tariff policy.
- Approving the annual budget of the Authority and presenting it to the Council of ministers to confirm it.

2.1.1.2 B- Palestinian Water Authority:

PWA is a regulatory body for water resource management and development, so PWA has the following primary objectives:

- Execute the National Water Policy

[1] The institutional setup of water sector in Palestine-2014; Source: PWA

- Ensure efficient management of the available water resources in Palestine;
- Explore additional water resources to ensure that there is a better balance between supply and demand.

According to the **World Bank**'s study in October, 2014 that in developing countries, the public sector, businesses and citizens are working all together in order to harness the transformative power for ICT which allowing services to be more efficient, promoting and empowering the economic development and strengthen the social networks. We can find according to a survey that more than 75 % of people around the world right now have accessibility to cell phones, with number of global mobile-cellular subscriptions which are quickly approaching 7 billion to use. In addition to some new industries and services are rapidly emerging [1].

The United Nations Education, Science and Cultural Organization **(UNESCO),** on the other hand has been a leader in building the scientific knowledge base to help countries to manage their water resources sustainably. Through the International Hydrological Program **(UN-wide World Water Development Report)**, the **UNESCO-IHE** Institute for Water Education, as well as affiliations with countless research centers and water-related Chairs on water around the world, UNESCO is strengthening global water security, and the intention is to provide a complete overview of ICT as a strategic instrument in **SWM**. It is also envisioned to act as a catalyst for further discussion and future successful implementation of smart water management initiatives worldwide [7].

ICT has transformed how people could communicate together. So ICT is quickly changing relations, facilitating the standers, controlling the interventions, and allowing practitioners in the local levels for using means and evidences in order to help decision making process for the equitable and sustainable extension of water, sanitation and hygiene **(WASH)** services [2].

Distances are becoming shorter and ICT now being is used to ease the measurement process and monitoring of the interventions with data from government, operators and customers. So using these new rich sources of data promises to guide decision makers for the equitable **(WASH)** services [12].

but there are several challenges are exist for using the integrated potential of ICT firstly about whether there a sufficient knowledge for applying new technologies effectively, secondly about what has been achieved and how, thirdly about Who can access to the information and are the incentives in a place which allows using the information to improve services, and finally about what are the associated costs [2].

Many workshops and events have been held during the fall of 2013 which aim to bring experts and implementers together in order to answer these questions in addition share lessons that learned in this growing field [12].

ICT has the ability to assist improving and developing rural water provision and treats the systemic problems which faced by the sector itself, but so far these potentials are exist but remained largely untapped and not used in some developing countries. Despite the accessibility to rural drinking water provision has improved, besides more than two billion people are gaining good accessibility to improved drinking water resources in between 1990 and 2010 but with existing of difficulty running for these water providers. Exchanging data and information could make difference between rural water supply which is still broken and unused for long years and water service with little interruption. So ICT could lead the innovations in other service sectors for example the health sector but it's still almost poorly resourced in the rural areas and in the water sector particularly [3].

The evolution of ICT nowadays is changing the previous paradigms that can make it major evolution for the water municipalities which could lead to new opportunities for managing the sectors and service provision as well, and that could be beneficial for all involved parties within this service process avoiding damaging the environment sustainability targets [4].

The large scale of ICT can provide information for the stockholders timely, that's allowing them to manage the core issues on the service delivery level and the performance of service provider, and also it provides the accessibility to data management tools inside the water municipalities which leads to

improve the quality and efficiency of monitoring the information by speeding up the process of data collection and analysis with reducing the required distances of data transferring in addition to shortening time between the failure of water services and corrective procedure, but still the barrier of ICT is decreasing the costs of internet access, computers, phones and software is falling largely [3].

it's obvious that if we want to develop an effective unified system for the water section by using ICT is not that simple task to achieve, where it implies both of improving the information system and maintaining that these information could lead to the required action, moreover using ICT in this process would not offset all additional costs which needed to implement the monitoring process at the first level, but in any case the main design and choosing the proper information system could affect who can own these data and how the status of using information already [3].

Opportunities in **ICT** have many trends; one of these trends is the influence of monitoring over the developing countries which related to many questions, who has access to the information? How much it's easy to use ICT in many service provider sectors? And how this new information system is governed? [3].

Through determining access levels to the information, we can classify the accessibility depending on for which purposes theses data are needed, and about facilitating using ICT in water sector this question related to one of the main questions in this research which relevant to the way of raising awareness for public to ease using the new system, the third part related to e-governance, and from this sense it shows that we have two elements of e-governance, G to G, and G to C.

This research would be depended on some different experiences according to EU standards and Africa as well in addition to present some previous studies, then showing how we can propose a new process in Palestine regarding on that.

The main elements which researcher is trying to make them included in this new system are some relevant processes in water field such as (reading meters, new subscriptions,

citizens complains, billing system, paying system and revenues), so all of these process should be working by the new system electronically.

2.2 Literatures:

There are many literatures and materials have similar objectives for this research; some of them have been taken from different experiences and some are articles from **PWA** and **CMWU** knowing that these articles are not published on web; so these articles can bring out some required purposes for this research.

2.2.1 Support and establish the interface between PWA and service providers:

This as a final report in 2010, it expresses an study of a consultant company about the assessment of the Palestinian water situation and some targets and procedures which should be implemented, so this shows that these parts would help in the unifying process of the water sections in Palestine and these and later on engaging the ICT.

A- Procedures for legal Streamlining:

This part aims resolve the current legal conflicts and contradictions, in addition to issuing the bylaw for establishing regional utilities in Palestine and this can be done through conducting several workshops and meetings with the relevant stakeholders to finalize the draft of bylaw, moreover they have to establish a number of regional water utilities and this could be done with taking into considerations that applications should be including all details about the members, financial, technical and legal documents of the proposed service provide then Review the applications and forward them to the National Water Council(**NWC**) for approval; and continue dealing with municipalities as a service provider in order to fulfill the obligations in order to monitor quality assurance procedures and their performance indicates.

B- Procedures for Implementing the Quality Assurance System:

Implementation a quality assurance system can be achieved through training PWA staff and service providers and testing the new proposed procedures with selected projects managed by services providers (one in Gaza and the other one in West Bank) and modifies them accordingly if needed.

This report shows that the consultant had reviewed the institutional and legal framework of the **PWA** and the existing service providers. It also examined the organizational structure and its adequacy for **PWA** functions and powers. The report also is looking at **CMWU**'s legal status and one of the service providers in the Palestine, their organizational structure, work systems and procedures to carry out their roles and functions. Moreover the review focused on the implementation of the water law 3/2002 and on PWA directions as well to manage the water sector as regulator and guardian of water resources in Palestine.

The consultant had examine the interface between the **PWA** as regulating governmental authority and the water service providers of which **CMWU** is an example of established service providers. In addition, the report examines the performance monitoring and control mechanisms of **PWA** to streamline the interface between **PWA** and water service providers it is recommended to.[1]

The outcomes of this report are missing the main purpose of my research which is engaging very important part of stakeholders it's the citizens as the final beneficial of the water service and have a right to have good service, so in this research I would complete this ring by engaging citizens through using ICT.

- **Using ICT for monitoring rural water services:**

This Search in 2013 is taking Burkina Faso and Ghana as a case studies, and it provides a conceptual framework for examining how is using the ICT to manage the water sector and establish the water governance to make the ability to sustainable rural water services through meeting the needed information of the stakeholders in this sector, and this framework indeed links information system for monitoring with

[1] Support and Establish Management Interface Between PWA and Service Provider, (2010)

the target of achieving the sustainable water services at the same scale, and the cases for both countries were used in order to illustrate how this technology can improve the water information flow and manage it to help the decision makers [3].

This search could bring out the main basis for data using to improve the water service provision and make it efficient, these bases could be achieved through;

- Providing useful monitoring reports which can be generated if the right indicators are collected, then the reporting format are standard
- Information improves service provision when this information is targeted to those charged with taking action and they have their responsibilities and roles clearly, and costs of maintenance are covered.
- The information system will be sustainable when the current costs for data analysis and management are budgeted.

So this search is covering three basic pillars of water management, the technical, and managerial and finance basis aiming to create an integrated platform for the sustainable water service in the society.

2.2.2 Partnering for Solutions (ICT in Smart Water Management):

The world as we see nowadays, and looking back 30 years ago, is not like what we have today; neither will it be the same 30 years from now. Such a dramatic difference in such a short period of time is basically attributed to the development of ICT. Modern ICT has provided today's society with a vast- array of innovative communication capabilities which have transformed the world into a global village. ICT has been influential in the world's collective economic; the social and cultural development. Utilizing this technology in the water sector creates a more intelligent means in order to manage and protect the planet's water resources [7].

For successful integration and implementation of smart water management within countries, stakeholders' involvement and interaction are necessary and it should not be conducted in a parallel form but rather as an iterative process which is woven strategically throughout the environment to strengthen the end result. In addition; Inclusive processes, increasing awareness and understanding of issues and challenges

are generating more data which is helping in determining the priorities, increase support for remediation programs, and generally enhancing the likelihood of success [7].

This search is seeking for reaching to a smart environment through using ICT, and aims some of the objectives in this research, which it could help to create the water environment with its elements of good service provision and the accessibility to this service.

2.2.3 ICT and stakeholders participation for improved urban water management in the cities of the future:

Urbanization and technology means which enhance the knowledge and intensive economies have put cities at the core of our societies and economy increasingly at large, cities population are expected to be increased in addition to have growing share in resources consumption and emissions [8].
According to the United Nations, cities dweller is expected to double by 2050, with most of this urban growth expected to be occurred in developing countries. And urgent actions are needed to combat water stress, to remedy the vulnerability of infrastructures, in addition to modify water use patterns in agricultural, industrial and domestic processes [8].
It is estimated that distribution systems are losing in average around 20% of the transported water in Europe with large variability between; So ICT tools for early leakage detection and smart metering may lead to substantial reduction in the water resource losses. Moreover water utilities, service provider, city, regional authorities those manage urban water networks, and administer of wastewater treatment and water competence centres; now they see the needs to enhance the collaboration and exchange innovative promising practices jointly with the industry, researches establishment and laboratories, in order to ensure an efficient water resources management for the upcoming decades that risk to be dramatically affected by the climate change and water scarcity[8].

This paper brings out that the best powerful tool to minimize network leaks through an optimal and precise water network pressure management is realized through smart ICT

solutions with flow and pressure sensors in the network which proving providing an online visibility and network intelligence, and the other thing is remote control of valves based on automatic pressure optimization algorithms. Moreover, ICT can enable both of active learning and social proof processes through transmitting information active learning and achieving social proof by reinforcing broader social patterns through social media, thus the stakeholders' involvement can be achieved.

2.2.4 ICT to improve the water governance:

This paper aims engaging the populations as a part of the government processes; it's taking some case studies in different countries such as Senegal, Mali, Benin and Niger.

It shows that there are more than 3,000 private schemes; all of them are providing water to 10 million people. Moreover, ICT has been used as a tool to achieve the best monitoring of these schemes; also it shows that three layers of services have been developed from data collected by using mobile phones, leading to the water operators and improving their operations in addition enabling regulators to monitor the performance of water schemes. Thus; Information which was not available before it's available now to be used by decision makers; then if you give value of the tool to the operators, this will help to ensure that data is updated [2].

2.2.5 The use of ICT in the Water Sector:

(Management Information Systems to support regulators and resource management)
In this Paper, it shows how using ICT to support regulators, so water supply service is essential for human life; Ensuring that good quality water is distributed equitably, reliably and efficiently is the objective of the regulator. A task that often proves difficult, because the basis of a sound WSS management is usually missing main objects such as; reliable information about the quantities, qualities and how this system is managed. ICT based on water service system can add real value. It provides regulators, decision makers, policy makers and service providers with the basic data to

improve water services and with needed instruments to measure nationwide coverage [9].

Benchmarking, for example, allows the comparison of water service provider competitors and helps identifying good and bad performers. Software solutions can promote accountability and transparency in the water sector [9].

It shows the ICT impacts as well, so resources of information management leads to a better understanding of the complex natural environment, on which our lives depend, and how it evolves under the influence of society. ICT provides data accessibility for rational decision making with respect to environmental issues both in politics and corporate management [9].

The outcomes of this paper bring out that:

- ICT can serve as a facilitating medium with no sufficient condition to achieve the goal of sustainable development when it's implemented carefully.
- Implementation of ICT never completely finishes and there are a continuous training and preventive maintenance of the software and hardware.
- Ownership and sustainability of new technological systems, can be achieved only when (predominantly is free and open sources are available).

2.2.6 ICT for water efficiency:

This paper shows different sectors and businesses which are relevant to the water sector, so according to the defined water domains in this paper, the water uses are representing the largest field where ICT solutions can be implemented and developed. The various uses could be classified and defined as the following different natural resources and activities (Agriculture, Aquaculture, Industry, Recreation, Energy, Transportation and Urban) [10].

The water uses are associated to these business processes and linked to the economic and social values. In most of the conditions, there are five major activities are taking place within each water uses and it appears as invariants. These key activities are (Investigating -surveying, observing - monitoring, designing, building and decommissioning, operating. Thus each activity can be defined [10].

The outcomes of this paper are representing the major challenges for the 21th century such as the climate evolution combined with the growing of populations, these could generate new stresses on a limited resource that has to be carefully protected and managed, not to mentions that the fast development of ICT solutions today allows to enter a new area which can be characterized by the idea to move from data scarcity to a continuous data flow.

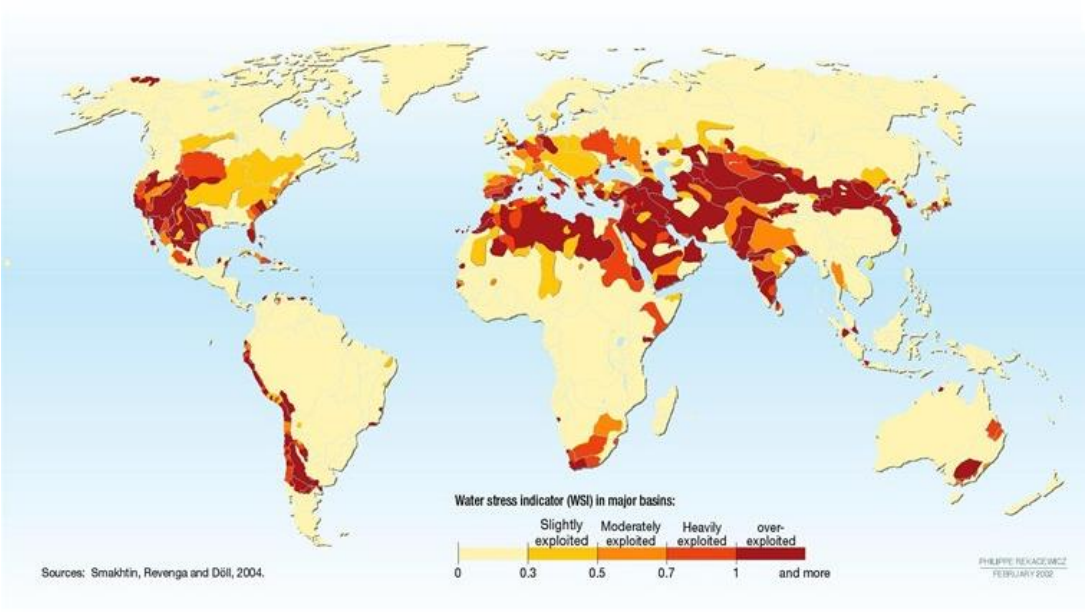

Figure -1: The Global water's stress indicator (WSI) in the major basins at the last ten years [14].

Source: http://www.grida.no/graphicslib/detail/water-scarcity-index_14f3#

- **ICT and Water, Sanitation, Hygiene (WASH) sector fall 2013:**
- **(A synthesis of conference presentations for mobile technology in the water, sanitation, and hygiene sector) :**

This conference report shows together the common themes and challenges which have been identified during the Stockholm's World Water Week conference, the University of North Carolina Water and Health 2013 conference, and the International Water Association Development Congress; the organizers of each workshop have summarized the key messages of their event and provided a snapshot view about ICT in the WASH sector [12].

The final outcomes of this paper shows some elements of ICT use such as; ICT for services and in this condition ICT should be seen as a long term service to the final users with a technical support provision when necessary and there is need to be constant improvements for these technologies in order to maintain that data is collected and used as well.

And it shows the scale of ICT for monitoring and evaluating purposes; so it needs to shift the thinking from what is the cost of monitoring to look at the added value, in addition; when it comes for using data to steer projects which makes them more effective and efficient.

The final element is ICT for all; ICT adoption is growing up in some areas, however if it will hit a plateau for using this technology in monitoring and should look further down the road for other ways in order to integrate the instruments into our programs. And what would be needed to get there is increased knowledge of sharing experiences around the use of ICT, Particularly on the best practice for adoption and evidence of its benefits. Thus we must harness the experiences among sectors as well, not just for WASH system projects, and should look at how we can apply these new ideas to our own programs to enhance equitable services [12].

3 Research Methodology:

3.1 Introduction:

This part is discussing and introducing and the research framework and the methodology which adopted for this study; the research was conducted through a survey questionnaire, knowing that survey is effective way to obtain information from large pool of citizens and it gives more specific results, accurate and faster, It's further providing focused insight to the research questions, and the objectives within the theoretical framework of the study.

3.2 Framework of the study:

The theoretical framework of this study guides the research to determine what things which should be studied and makes the direction of the research within boundaries. The imitative theoretical framework of this study was discussed in the literature view section in this research though revising and studying theoretical approaches for ICT in water governance and the use of tools in water sector.

Thus, the researcher has developed the conceptual framework with the purpose to explore part of the problems which are recognized in the literature review as referred in the research objectives.

3.3 Research strategy and approach:

Through the relevant literature review, the survey was conducted aiming to identify the level of using the technology and e-services by citizens and how they are satisfied about the e-services which they used before and the proposed e-service in this search, taking into considerations ages and qualifications.

The survey utilized a well-designed questionnaire approach. Which is based on the fact that questionnaire methodology is the simplest way to collect data from a big number of

respondents, a well-structured questionnaire which is used effectively allows gathering information about the initiative thoughts of the citizens about applying the new service and allows having a good vision of the future as well, besides it has some demographic questions which can show how the performance and satisfaction about the current e-services among different classes of citizens.

Survey is categorized as a quantitative research because, quantitative methods are deemed more specific and results are oriented in addition it involves collections of numerical data in order to explain and predict the interest artefacts.

The research questionnaire was prepared by Google document on line which allows people in Palestine to fill it up taking into considerations that some people don't read and understand English, thus it was in both English and Arabic.

The questionnaire has scoped different areas in Palestine and it the number of survey samples was 150 copy, 58 of them have filled it.

3.4 Questionnaire Design:

The design of this research consists of:

- Questionnaire design
- Determination of sample size
- Main Questionnaire administration
- Data Analysis tools

Questionnaire design:

Based on the research objectives, the structure of the questionnaire was prepared and self-administered to the various respondents; almost all of questionnaires have ended -questions to ensure the consistency of respondent feedback.

For the study purposes, the questions have been grouped under five main sections:

1- Age and qualification
2- The current water service provision and its timetable and how satisfaction.
3- Availability of internet access.
4- The use of e-services and how satisfaction about it.
5- How acceptable it would be to utilize ICT in water sector.

The first section is to show ages and qualifications, knowing that researcher wants to know the relationship between the qualifications and using the e-services.
The second sections is to give a clear image about water provision service by testing water quality (Pressure, quantity and continuity) in addition to the timetable for supply water to houses, it also tests if the municipalities are engaging the citizens in the infrastructure projects in their areas.

The third section is testing how the scale of the internet access points at houses, knowing that it's important tool to use internet at houses for e-service at houses, because so far they don't have 3G or mobile data in Gaza due to the political issues.
The fourth section is testing how much people have used the current e-services before and how their satisfaction about that.

The fifth section is testing how the acceptance about achieving e-water service in Palestine which can allow them in customers complains and other issues such as alerts and feedback about service provision satisfaction.

Determination of sample size:

As the researcher has mentioned briefly that the size of survey was 150, and 58 have filled them up totally and 2 samples have been deleted due to unreasonable answers and are not fully filled.

Main Questionnaire administration:

The administration of this questionnaire has begun in in the mid of April and completed in the first of May, 2016. A period of four weeks was allowed for the administration of the questionnaire; and it was sent by some assistance to different classes of citizens and the following table shows the details of the questionnaires which have been sent and returned.

	Amount of sent	Fully filled	Deleted
samples	**150**	**58**	**2**
Percent%	**100%**	**39%**	**1.5%**

Data analysis tools:

Researcher used the google tools to analyse the results of the survey, and it shows charts and tables, because the research's survey already was designed by google Doc. technology.

4 Data presentation and analysis:

As the researcher mentioned that this survey was published online by using Google document, and then all answers have been checked to find how it's reasonable and logic answers.
Google gives ratios, percentages and pie charts for each question, so it's using the frequency analysis and researcher used these pie charts to design tables.

The results show that 74.1% of answers were from ages between 20-30 years, and 72.4% have a bachelor degree, and the assumption in this study is to figure out the relationship between the qualification and the acceptance to use e-service.
The following table shows the qualifications:

Qualification	**High school**	**Diploma**	**Bachelor degree**	**Master degree**	**Other**
Percentage	12.1%	8.6%	72.4%	3.4%	3.4%

The result shows that 17.5% of people don't have a constant timetable for water provision and this indicator is positive for the study, and it also shows that 63.8% have not visited the municipalities before and 78.9% have not visited the municipality's web page.

The study displays that 94.8% of customers are not engaged in the criteria selections of water projects and infrastructure developments in the areas.
The main ratios in this study show that 31.6% of customers are strongly disagree about the current water provision service, while 36.2% of them are disagree about the municipality's response for customers complains, and 47.5% are not satisfied about the water quality.

The major question in this study was about testing the acceptance of utilizing ICT in water sector which can enhance the interaction between customers and service provider, and the results show that between 33, 9% and 35.6% are strongly agree about that.

The following table shows the indications about using ICT in water sector:

Satisfaction level	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Percentage	**6.8%**	**5.1%**	**18.6%**	**35.6%**	**33.9%**

Summary:

Indeed, the result was negative about the current water provision service and positive about using ICT to improve the service provision, and this chapter has comprehensively described the entire research methodology in this study. Following this, the design of survey tool in addition to the sampling frame, sample size, and techniques for eliciting the relevant data and how the data will be analysed were described.

5 Requirements:

Currently, PWA is establishing the biggest project in Gaza strip for desalination the sea water and by 2019 this project should be totally implemented according to the contract with donors and other stakeholders.

This water plant with a capacity of 55 million m3 per a year will provide all of the municipalities in Gaza strip; moreover it provides about 1.9 million of Gaza's population and it maintains water quality only, but still the fragmented water sections will make the water governance system very weak because of the difference of water Tariff between each municipality, which will misguide the decision makers and again will find the same problem which is exist right now.

So the proposal here is to utilize **ICT** instruments through this service provision which can maintain a high and effective and efficient service provision by unifying the quality, quantity and tariff as well.
The only solution for that is combining all of water departments in **CMWU** to be a service provider under the administration of PWA.
Using these tools of ICT would provide CMWU precise numbers for all steps within the service provision process, and would help the customers to complain by electronic system.

5.1 ICT instruments which should be available in water sector:

ICT and water experts started to explore new ICT applications and testing their impacts on the water sector, so Hydro-informatics system now can investigate the details of physical hydrodynamic process and the complexity of geometry for continental and marine environments.

Thus, to involve the ICT in water sector firstly they should rehabilitate the water infrastructure through an electronic data base and then provide the water networks by new types of sensors and Light Detection and Ranging (LIDAR), which can modify the quality and the quantity of the data and transfer this digital data to information that can help the decision makers.

Hydro-informatics approaches (data driven and physically based) nowadays can be associated and combined together; The European Union has defined their priority of targets for the next two decades, to include the application of ICT in order to achieve the sustainable growth [16].

Sustainable growth requires a specific management of all natural resources, which can be implemented through the efficient application of ICT [16].

ICT instruments are crucial demanded for improving water management, and these tools were increasingly used in water supply and irrigation management [17].

The applications of advanced technology in water resources management provide a remarkably efficient of water service provision, especially in the countries which exposed to severe water scarcity [17].

There is an increasing strain on the natural resources pressure for most of developing countries, which has worried many regions about implementing environmental sustainability.

Utilizing ICT as a potential instrument is essential way for completing growth of the agricultural sector; Moreover ICT tools provide a proper solution to collect the remote data; a process which will be somehow difficult, expensive and time consuming. Currently, ICT tools are implemented to exchange, process, activates and manage data and knowledge [18].

Moreover, ICT tools have quiet big capacity to:

- Maintain texts, audio, photographs, drawings, descriptions and videos.

- Collect and save digital format of information in addition to produce precise copies of this information at a lower cost.
- Transfer information and enough knowledge quickly through a quit wide range of communication networks.
- Improve the standardized procedures for a huge quantity of information speedily.
- Attain larger activity for producing, communicating, sharing and evaluating a useful knowledge and information.
- Design from raw data (well-structured information) and inter personal discussion and communication [18]; [19].

The following electronic instruments would illustrate a possible ICT which may decrease some of the challenges by providing some means to make better measurement process, control, model, or predict water resources supply and demand.

5.1.1 Meters and sensors:

Meters and sensor currently are being applied intensively which aims regulating the different activities of water distribution systems such as; flow and hydraulic pressure, water and energy consumptions, water quality and head losses, Moreover the major goals of water utilities in this tool are to transmit water from one place to another place without any losses, avoiding any expected damages which could be caused by leaking water and finally saving water [21].

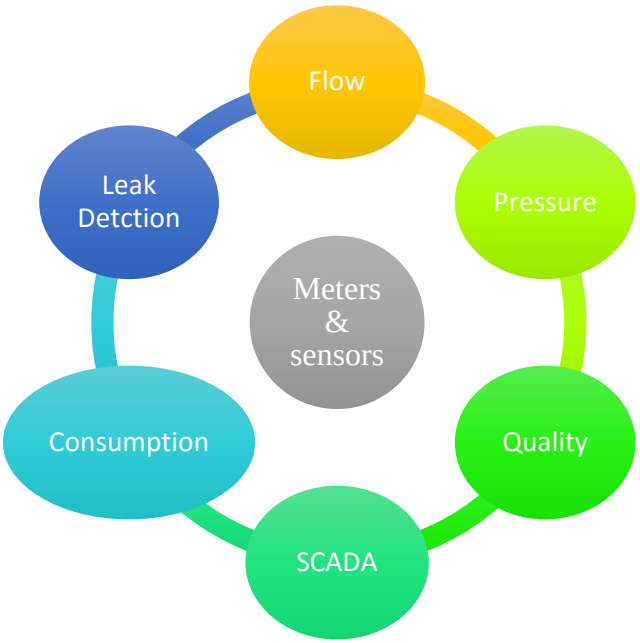

Figure-2: different types of meters and sensors which have been developed for effective and sustainable water resource management [21].

Source: The role of ICT in water resource management (2014) [21].

Localizing and detecting leakages are helping in easily and effectively managing of water loss. Leakages are detected mainly by controlling and measuring the hydraulic pressures and water's flow within the piping network. Sensors are used as basic tools for monitoring the pressure and flow of water, which provides an advanced management by digital data [21].

The following main elements of Meters and sensors are showing the water provision working mechanism:

- **Pressure Management Sensor:**

The pressure sensor is an efficient method and cost effective to decrease real water losses and it's an operational cost in water provision networks; So many different types of pressure sensors have been applied for the measurement of water in networks in order to detect the levels of water storage [20].

- **Flow sensors:**

Flow sensors are helping to regulate the volume of water flow within the production and distribution system. Usually these sensors employ the principles of electromagnetics, which are considered an assessment method for calculating the rates of water flow and environmental conditions as well [21].

- **Energy consumption sensors:**

These sensors are providing a reasonable use of electrical energy within production and water provision service system, knowing that this tool basically applied for optimal power management of pumps mechanism within the water woks [21].

- **Supervisory Control and Data Acquisition (SCADA):**

SCADA technology has been evolved at the last 30 years as a method for controlling and monitoring the large process, and the general trend for PWA now during implementing the large scale project to desalinate the sea water is to use this technology which is giving precise numbers for decision makers and makes the service provision more efficient and effective.

Generally, SCADA system performs the main functions like data acquisition through the sensors, acquired data transmission between number of remote sites, data presentation within the central host computer and finally data controlling at the operator terminal or workstations [20].

SCADA system consists of some sub-systems [22].

- Remote terminal units and programmable logic controls; those interface and helps sensors within its processes.

- A communication infrastructure which is connecting remote units with central host computer.
- A supervisory computer which is gathering and acquiring data within the process then sending commands to SCADA's master station.
- A communication system which is supporting the use of operator workstations.

- **Water quality sensors:**

These kinds of sensors are helping to address and detect the problems which related to the water quality before affecting consumers within the water distribution in the networks. This application also provides verified information which leads to informed decisions that related to the observed water quality change [23].

- **Water Consumption Meter:**

This technology measures and records the amount of water which is used over time by different methods. It's not only measuring the consumption, but also it improves management and helps to detects leakages [20]; [24].

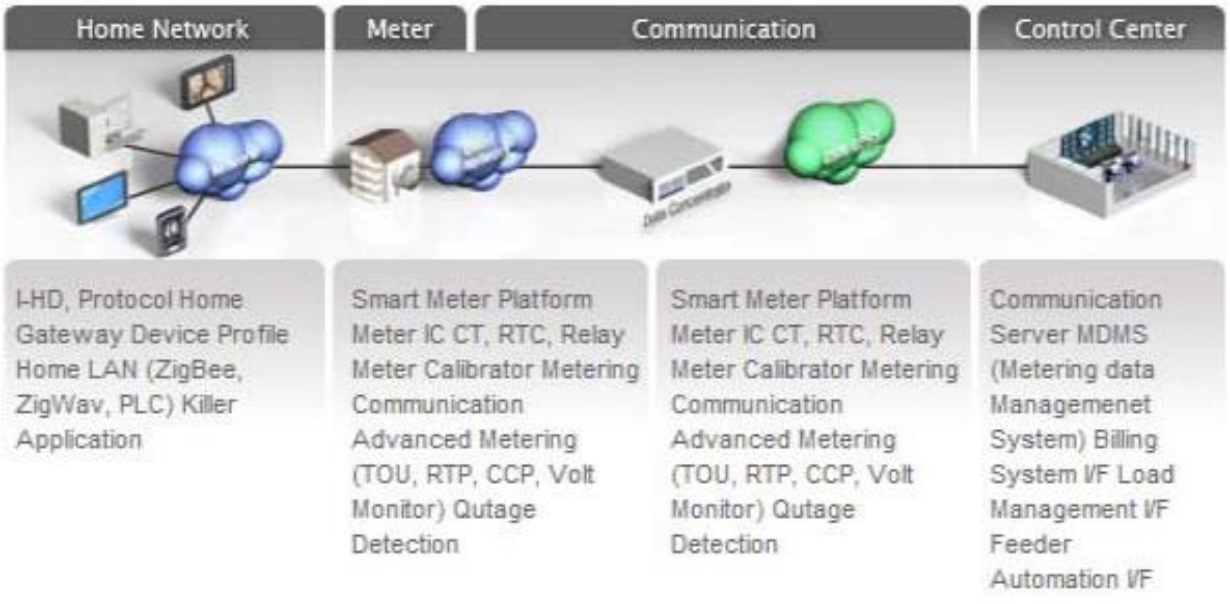

Figure-3: The Components of intelligent remote data collection for smart metering [15].
Source: http://www.moxa.com/solutions/AMI/index.htm

5.2 Communication infrastructure:

The traditional water provision and management system basically is depending on protocols, adopted registered structures and industrial control systems, so it is not easy to follow the trends of emerging communication quickly. And currently; water utility networks provide a good opportunity to adopt the existing infrastructure into flexible monitoring system based on IP which has some features such as alarm gathering, energy reduction, leakage detection and prevention, demand prediction, water quality monitoring, and billing system [21].

SCADA system advantageous is being highly distributed and applied to control the distributed resources geographically where a centralized data acquisition and control are important to the system activities and operations. Knowing that method is the most common which is currently applied in distribution systems such as; water distribution and wastewater collection system. And this control unit performs a centralized monitoring system, and control communication network for long distance; including monitoring the status of data processing and controlling the alarms, in addition this method is a combination of radio and direct-wired connection systems [25].

The Global System for Mobile Communication **GSM** in addition to General Packet Radio Services **GPRS**; these both are the common wireless technologies which have been applied to the cellular networks in order to be used as water metering infrastructure, That's because these technologies are widely available and supported by many telecommunication operators and vendors. Knowing that **GPRS** allows GSM users to apply wireless data services as a packet-data tool. [26].

5.3 Information system:

An information system plays a very important role for managing companies and industry facilities by providing the required information and data to achieve an effective management in different projects activities. In the water sector, ant it's recognized as important attributes for efficient and effective water works [21].

Information system has many sub-elements which should be combined all together to create an integrated information system and these elements are represented as the following:

- ### Geographic Information System (GIS):

GIS technology integrates hardware, software, and required data to arrange, analyze, and display all of geographically referenced information. And this technology allows the users to view, visualize, interpret, and understand data in different circumstances which can clarify trends, patterns and relationships charts, maps and reports form [21].

This technology helps by answering questions and solving problems easily by looking to the generated data. so it helps in the customers complains aspect through finding the exact location for issue easily by the geographic coordinates, which can make the response of solving the water networks more efficient, effective and fast by CMWU field teams.

The GIS technology includes a sequence of applications and maps which are structured on a common information model and designed to work across several disciplines in order to help water professionals, in addition to manage wide range of workflows and operations and support daily utilities[27].

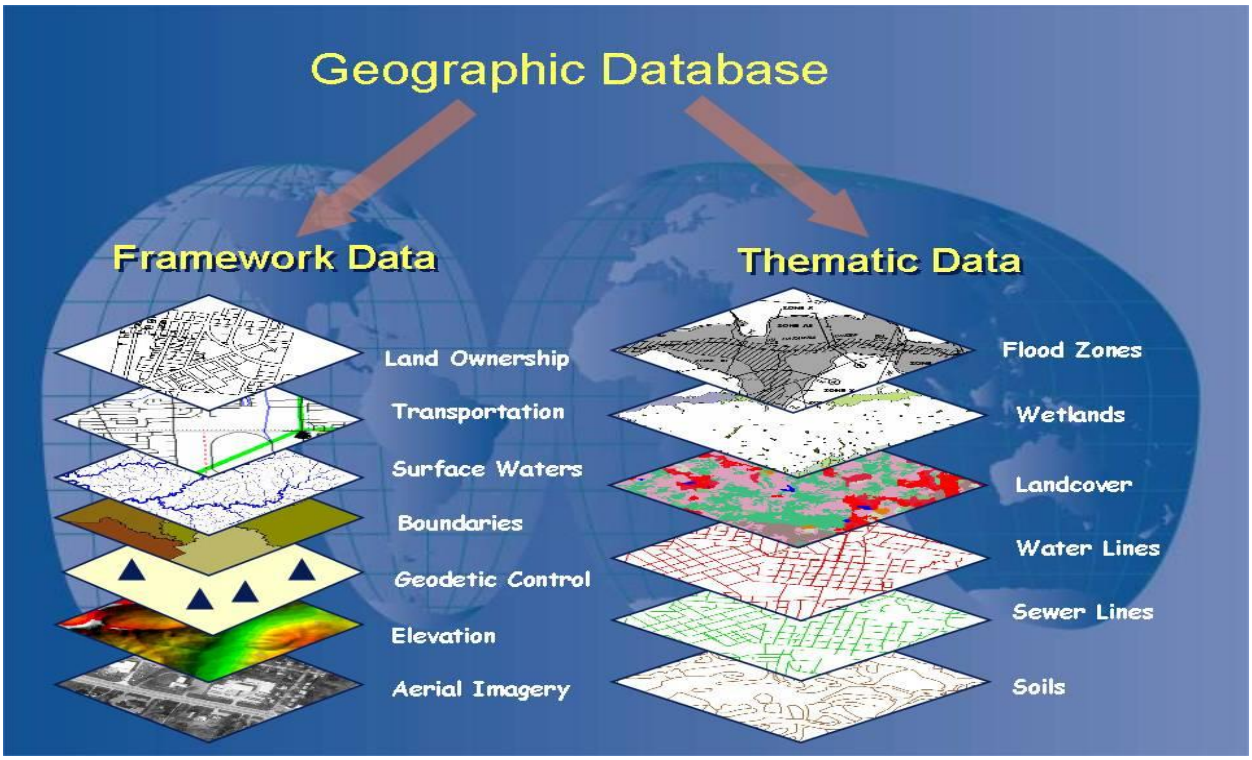

Figure-4: Different visualizations of the future areas

Source: http://www.onslowcountync.gov/assets/18981.jpg?langType=1033

Thus; this technology shows that the engineering solution for designing a municipal water network and management activities is GIS as a geo-spatial, an integrated GIS and designed environment together with an intelligent network model; these can allow the municipalities and water utilities to address all operations of a typical water supply network. And this system generates water networks information from scanned maps and graphics, and then uses GIS technology for thematic mapping and other instruments to publish data on the web [28].

CIVICA GIS – Community Map is example to show the web based on GIS community map which supplies GIS, management solution gazetteer, and related back office software applications. And CIVICA -GIS method can help the users to reduce related risks and operational costs and, which are available on web, mobile phones and other devises. Service companies are improving their assurance of information and

management systems on millions of underground assets, such as water pipes and sewage networks by using a web-GIS tool which gathers suggested correction from contractors and employees. It can also capture field data and delivers needed information on real time to help decision makers for easy management through easy access to the observed data [29].

- **Enterprise Resource Planning System (ERP):**

The mechanism of this system is integrating the internal and external management information through the entire of organization, in addition to embracing finance, manufacturing, service provision and customer relationship management. [34].

The ERP system aims to facilitate information's flow between all business functions within any organization and it manages the connection with the external stakeholders.
The potential of this system in smart water management is tremendous. So its packages help can many companies to reduce operational cost, increase productivity and improve customer service [34].

- **AQUAkNOW information system:**

This system is an active web-based platform aims to share knowledge which is related to water issues. And it's a combination of collaborative workstation with data management system committed to provide a technical knowledge and scientific results for achieving sustainable water resources development. This platform is intended for experts and practitioners of different institutions those are involved in the water sector and it creates a space for gathering and providing productive instruments to manage scientific and technical information. It also enables to share data, information and documents such as, news, events, ideas, and experiences to find help and work with other members those engaged in the water sector [30].

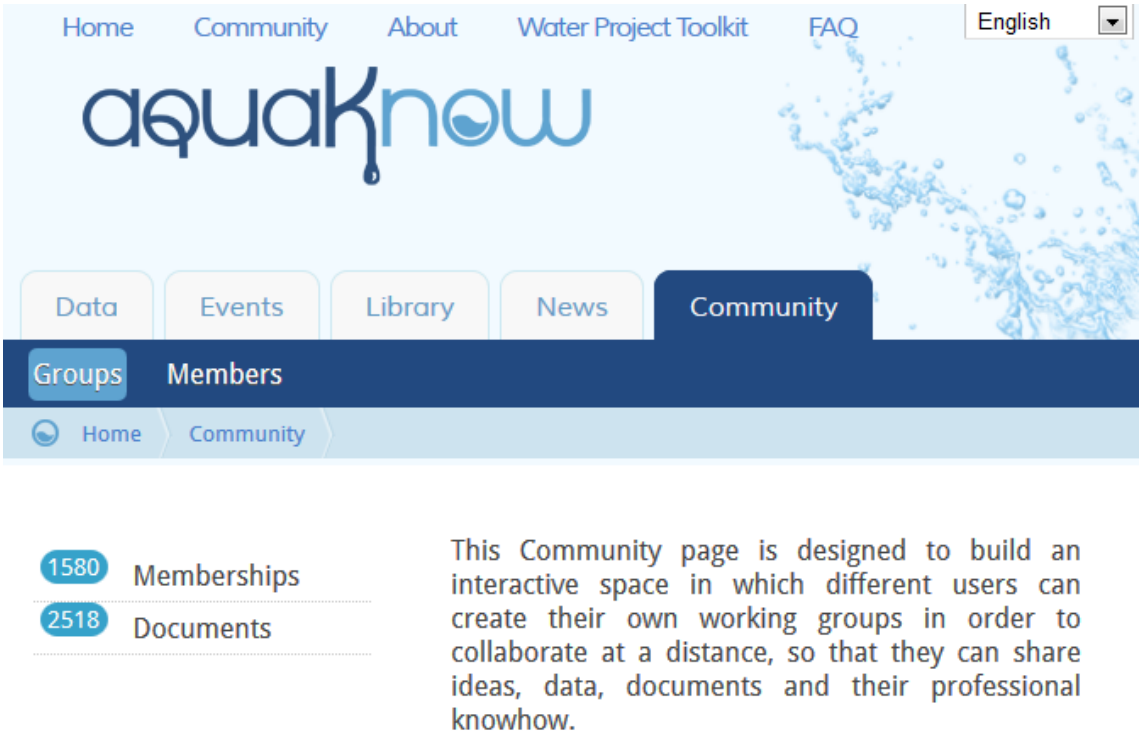

Figure-5: AquaKnow community web page

Source: http://www.aquaknow.net/en/community/groups

- **EUWI communication and information system:**

European Union Water Initiative EUWI for communication and information system, It's a web-based system that contains a comprehensive information about water initiative activities [31].

The mechanism work that the communication and information system enables an efficient connection through web-based instruments and services with all members of (EUWI), scaling from the international organizations and to non-governmental organizations [31].

The main objective of EUWI is disseminating knowledge and information about water through effective networks in addition to affirming transparency toward public and exchanging data within its members [31].

1- Hydraulic models:

This system helps the water professionals, metrological agencies, governmental authorities, and water sector for achieving an effective management system and it can help them to make the proper decision about the available water resources [32].

This technology establishes an optimization of water distribution network and simulation system based on that, knowing that it was a trend of research purposes during last decades.

This simulation models component incorporates the water decision support system with the network of sensors in addition to the forecasting models to achieve a practical management for water provision system [32].

The approach of this new simulation has been developed with optimization linkage based on the innovative using of global and traditional simulation with optimized algorithms.
Different countries in EU are providing simulation and optimization products to help the water network managers aiming to design costs and decline the water loss and make effective strategies [32].

There is one example about Hydraulic models, it is SIWA technology which is a computer-based system and used hydraulic behaviour in water provision service and also helps to optimize any other related process [32].

2- Decision Support system:

This system helps decision makers for managing the water provision service and makes technical solutions easier, so through the out coming data it helps in controlling energy

consumption in water pumping, water quality; the section of water provision network has an important task which significantly simplifies management of highly complicated structures in water provision networks, moreover; this method helps to find leakage detection easily and increases the water quality and service provision [20].

3- Water provision and Irrigation Design and Management:

ICT instruments and mechanization in water provision service and water facilities were adopted since the early fifties, knowing that the advanced and modern water provision plants in the developed countries right now are fully automatic, So through utilizing these instruments of ICT, it can be achieved the main pillars of high quality of water provision service such as, regulating the pump operations and managing the withdrawal of water from the different resources and reservoirs [21].

Improvement process for water use in agriculture meets the sharp challenge of freshwater which is like facing the humankind of the coming 50 years [21].

Different **ICT** instruments have been applied in agricultural developments actions and activities which these tools are helping to improve the hydraulic design and networks of irrigation system [33].

There are many and different types of elementary software applications that have been developed to measure the water head losses rate during flow water in pipes, moreover; the modern advanced software applications simulate the water flow when they have a complicated loop of water networks and it also facilitates the optimization of pressure flow in the irrigation system [33].

The design of networks requires a comprehensive software development by using GIS technology to facilitate the computerized design of the irrigation networks system that can create better water resource management [21].

From mechanical meters to smart metering:

Reading water meters remains one of the core processes for water service provider in charge of water supply, and this technology requests a large level of the water municipalities and good management of the devices, so in this system; data are collected regularly and directly in the field [10].

Thus the process reports about water consumption and can detect some leakages within the water networks: [10].

- So the smart metering can record and achieve the following:
- Recording water consumption within using water networks instantly.
- Reading meters remotely on a scheduled or on-demand basis.
- Abnormal usage notification of to the customer or the water utility.
- Controlling the water consumption devices within the customers premise.
- Messaging and notifying the customers.
- Customized of segments targeting.

The options which should be considered for smart water metering: [10].

- Choice of communication to the water utility (service provider) and houses.
- Choice of data consumption measurement (pulse or interval metering).

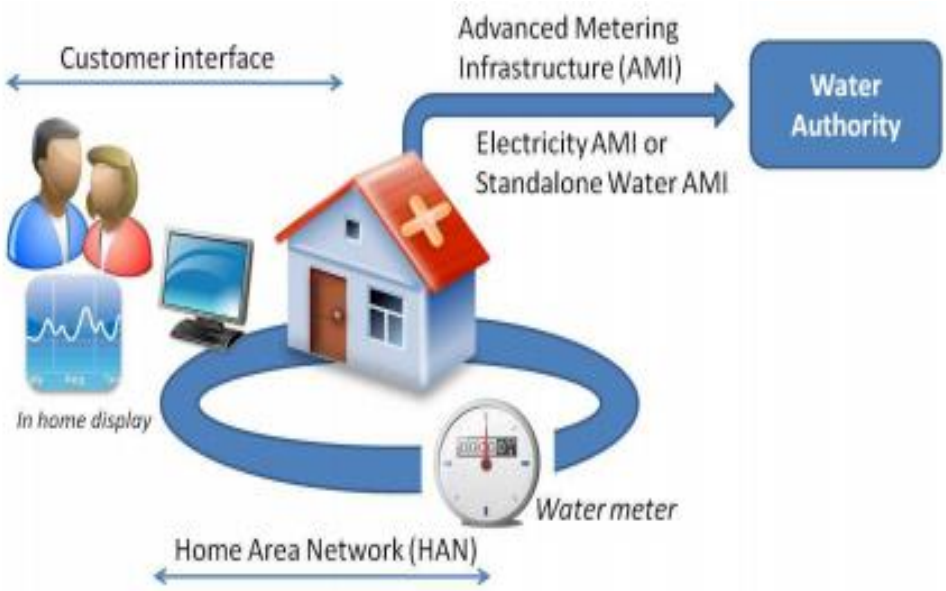

Figure-6: The smart water metering at logical architecture [10].

Source: http://cdn.intechopen.com/pdfs/22755/InTech-Ict_for_water_efficiency.pdf

5.4 Stakeholder platform in Smart Water Management:

Establishing a new environment would change in the structure of water sector, and it depends on how the new system is transmitting data between stakeholders, so the stakeholders in smart water management are classified the following: [7].

- **Service provider (water utility):**

As researcher mentioned that the unified system would be managed by CMWU as a service provider, and leakage of water is the major issue for service provider which is trying to prevent it or decrease the ratio of water leakage.
Many water utilities have identified the need for smart infrastructure and technological investments as well as smart instruments in order to measure the performance precisely.

So according to a study under title (Partnering for solutions: ICT in Smart Water Management) [7]. "It was estimated that over three-quarters of the required spending, globally, on water supply between 2005-2015 which should be for operating, maintaining and replacing the existing facilities" Depending on that; the intelligent technologically advanced management systems, that can improve the efficiency of water service provision, have become raised in the agenda for water utilities" [7].

ICT instruments in smart water management allows the water utilities to reduce costs, improve efficiency of service provision, while at the same time enhancing customer service, through making a better customer engagement. So that can be achieved by improving and well-designed of water industries infrastructure through ICT tools solutions such as smart meters as researcher mentioned before.

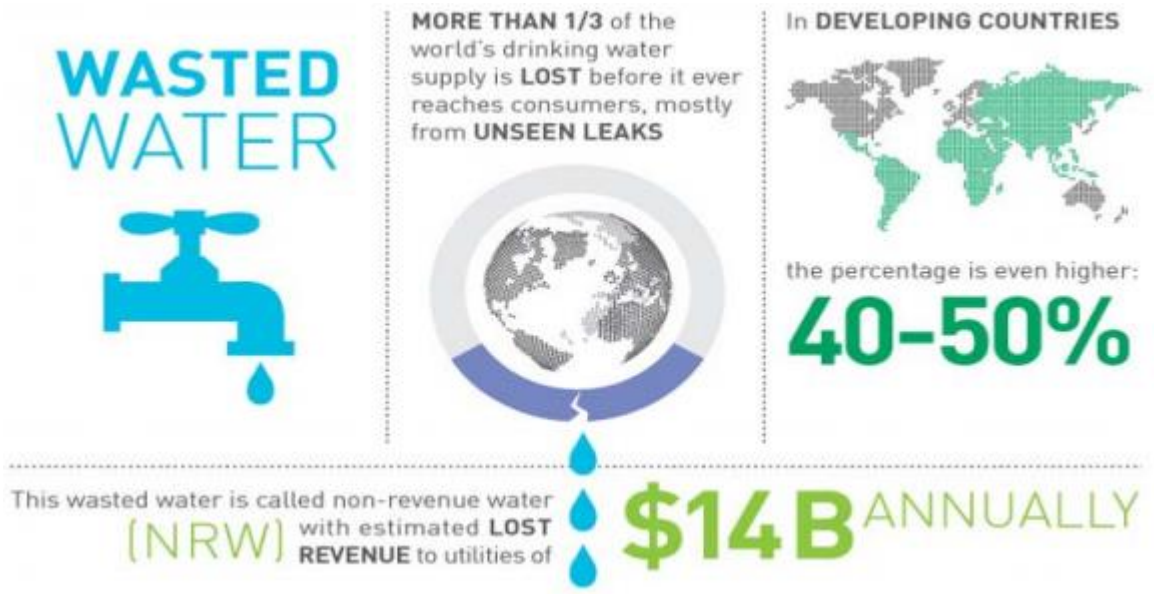

Figure-7: **The water leakage as a challenge in water utilities:** [7].

Source: https://www.itu.int/dms_pub/itu-t/oth/0b/11/T0B110000253301PDFE.pdf

-Government, Municipalities and NGO's:

The water governance is processes through which water resources are governed and managed, so the implementation and decision making are major processes in water governance. Governments, municipalities and NGO's are players in water governance and are significant stakeholders in, especially in Palestine as the projects are donated at the first level by the international organizations as a country which has a political situation so far [7].

So without rules and laws which govern the smart water management, it would be not feasible to achieve it, therefore regulation support the development process of the environmental technology which tackles water quality and availability which are making government, municipalities and the international organization very important to the overall process [7].

These stakeholders are playing a very important role in overseeing and implementing smart water management systems, since they have the direct and indirect responsibility for water security of the country [7].

Stakeholders cycle actions:

- The effective stakeholders inter actions comes through the following:
- Stakeholder's identifications and analysis
- Stakeholder's consultation
- Information exchange and disclosure
- Negotiation and partnership
- Stakeholder's grievance management

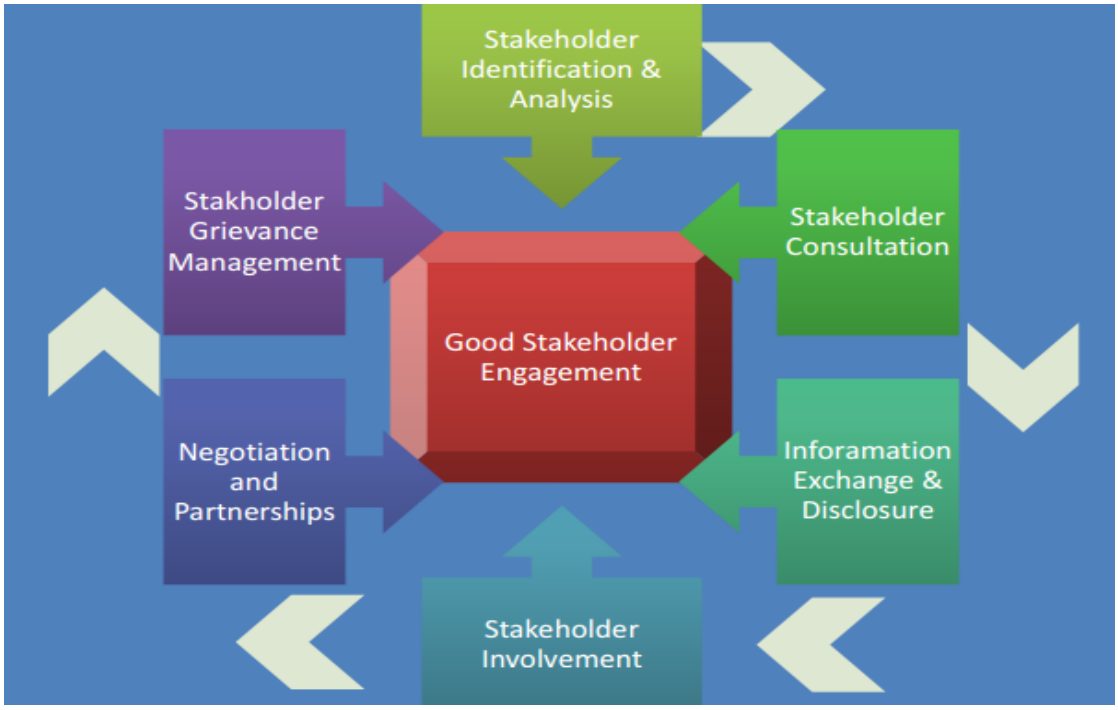

Figure-8: The good stakeholder's management:

Source: https://www.itu.int/dms_pub/itu-t/oth/0b/11/T0B110000253301PDFE.pdf

6 Solutions:

As the main objective of this research about proposal to unify the water sections in the municipalities, Coastal Municipalities Water Utility (CMWU) as a responsible of implementing the water infrastructure projects, it should contain all of these sections and establish a centralized data system, in addition to unify the water quality, quantity and tariff, because according to data analysis of the survey in this research which indicates that 68% are not satisfied about the current water provision service; it seems that water is being distributed in the water networks with different quantities and different prices per unit.

It is obvious that Palestinian Water Authority (PWA) is being implemented nowadays a large project in Gaza strip to establish a central sea water desalination plant with a capacity of 55 million m^3 annually, and this plant will be beneficial for all citizens in Gaza by 2019, moreover this project comes as a strategic project to end up the current problem of water quality, knowing that this project will provide the municipalities by main carrier line.

The researcher considers that this large project is one initiative part of solutions, but the following ICT tools should be provided in this project, and these instruments were mentioned in the requirements chapter in details:

1- **Meters and sensors:**

The water service provider should supply water networks by integrated meters and sensors such as; pressure management sensors, flow sensors, water quality sensors, SKADA system, water consumption sensors.

2- **Communication infrastructure:**

And this can be achieved by using some technologies such as GIS and SKADA system.

3- Information system:

Information system is a major tool in the water provision process; it gives all the stakeholders the required information at the proper time, which helps to make decisions instantly, and it can be achieved by using GIS in addition to Enterprise resource planning system (ERP).

4- Hydraulic models:

This tool can create a simulation system which supports the sensors within its wok.

5- Decision support system:

Through the linkage between this tool and the information system, this technology gives precise information for decision makers.

6- Water provision and irrigation design and management:

This system can manage the relationship between the water sector and the ministry of agriculture, knowing that in Gaza there is a central plant for treating sewage water, which the treated water is providing the agriculture sector only, and through this technology the interaction enhancement between water sector and ministry of agriculture could be implemented.

This integrated **ICT** tools allow the service provider to create an e-service for citizens, It can give the customers precise numbers about water consumption by billing system, notifications, and it allows them in customers complains issue.

Through all the previous tools it would be created an integrated environment which would meet the citizens and service provider requirements, thus the main question of this research about creating the proper environment which could meet all stakeholders needs, and this can be solved by providing these instruments in water networks.

It can also solve and support the first sub-question in the research about how this environment makes the service provision more efficient, so through providing the water

networks with **ICT** tools in addition to apply an electronic billing system, it will give a precise numbers for the service provider and detect the leakages; thus the service provision would be more efficient and effective, knowing that according to the survey of this research, 70% are agree with utilizing ICT in water provision service.
The survey results show that 95% of citizens are not engaged in the criteria selections of water projects, and that reflects a negative indicator about the interaction between service provider and citizens, so the answer of the second sub-question in this research could be solved through achieving the following:

- Implementing an e-service for citizens to use it in water service, which can meet their needs for customers, complains and other needs.
- Engaging citizens in the criteria selections of the water infrastructure projects and that helps to create the confidentiality between citizens and stakeholders.
- Implementing the e-Billing service and using ICT tools helps to achieve this service easily.

Therefore; **ICT** in water sector will change the environment, and this change needs citizen's awareness about using the new system and the good use for water resources. The survey result shows that 62% of citizens have used the e-government services before, and 40% satisfied about it.

It illustrates the lack of awareness for using e-services and from that sense; **CMWU** should arrange public awareness campaigns with the current campaigns about the good use of water resources through Web, social media and TV, and that solving the third sub-question of this research.

7 Conclusion and Recommendations:

At upcoming years, **ICT** will affect whole of the water sector and its management, and as long as the water sector in this shape according to the survey's data, ICT should be utilized and water sections should be unified in one central utility because these fragmented sections are giving an estimated numbers and the major outcome of using this technology is "getting precise information which can help in decision making process.

The following are the recommendation:

- Applying the **ICT** instruments and especially the sensors in the water networks which helps to detect the leakage at the first level and that enhances the water networks efficiency and contributes to national economy.
- Set training sessions for the service provider teams and felid teams to be aware of running the new system.
- Raising public awareness for citizens about rationing the water use and the good use of water resources through awareness campaigns.
- Support the proposal for implementing the electronic billing system.
- The computerized system helps in increasing the revenues through providing effective service and detecting the water leakage in water networks.

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The Questionnaire:

This questionnaire is prepared for research purpose, so please fill up these questions carefully.

This search about using Information and communication technology (ICT) in the water provision service in Palestine:

No.	Questions					
1	Age:	20-30	31-40	41-50	over 51	
2	Qualification:	High school	Diploma	Bachelor degree	Master degree	
3	Timetable of water service distribution in your area	Everyday	Every second day	Every third day	Other	
4	Do you have internet access at home	Yes	No			
5	Have you ever visited Coastal Municipalities Water Utility (CMWU) or the municipality at your region	Yes	No			
6	Have you ever visited CMWU's web page or the region's municipality web page	Yes	No			
7	Do you think that citizens are engaged in the criteria selections of water projects in your area	Yes	No			

8	Have you tried the government's E-services before	Yes	No			
9	Satisfied about the government's E-services	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
10	Satisfied about the current water provision service	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
11	Satisfied about the response of CMWU or the municipality in your area for the customers complains	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
12	Satisfied about the water cost (Tariff) in your area	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
13	Satisfied about the water quality (Pressure, quantity and continuity) in your area	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
14	Agree about utilizing e-service and technology in water provision service to enhance the interaction with service provider	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree

The questionnaire as published in Arabic Language:

هذا الاستبيان لغرض البحث عن وضع خدمة المياه الحالي ، واهداف البحث لحل مشكلة تواصل المواطنين مع مزودي الخدمة من خلال استخدام التكنولوجيا(الخدمات الالكترونية)

الاستبيان باللغه الانجليزية ويوجد فوق كل سؤال ترجمة بالعربية، الرجاء الاجابة على كل سؤال حسب ترتيب الاجابات كما هو موضح:

الرقم	السؤال	الإجابات				
1	العمر: كما هو موضح حسب الفئات التالية	20-30	31-40	41-50	over 51	
2	المؤهل العلمي حسب الترتيب	ثانوية عامة	دبلوم	بكالوريوس	اخرى	
3	جدوال توزيع المياه في المنطقة	يومياً	كل يومين	كل ثلاثة ايام	أخرى	
4	هل لديك شبكة اتصال انترنت في المنزل	نعم	لا			
5	هل زرت من قبل مقر مصلحة المياه او البلدية لأي غرض	نعم	لا			
6	هل زرت من قبل الموقع الالكتروني الخاص بمصلحة المياه او بالبلدية	نعم	لا			
7	هل تعتقد ان المواطنين يتم اشراكهم في معايير اختيار المشاريع للبنية التحتية للمياه في المنطقة	نعم	لا			
8	هل استخدمت من قبل بعض من الخدمات الحكومية الالكترونية	نعم	لا			
9	هل انت راض عن الخدمات الالكترونية للحكومة	غير موافق تماما	غير موافق	طبيعي	موافق	موافق بشدة
10	هل انت راض عن خدمة تزويد المياه الحالية في المنطقة	غير موافق تماما	غير موافق	طبيعي	موافق	موافق بشدة

11	هل انت راض عن استجابة مصلحة المياه او البلدية لشكاوي المواطنين	غير موافق تماما	غير موافق	طبيعي	موافق	موافق بشدة
12	هل انت راض عن التعرفة للمياه(تكلفة الوحدة لكل كوب)	غير موافق تماما	غير موافق	طبيعي	موافق	موافق بشدة
13	هل انت راض عن جودة خدمة المياه في المنطقة (الضغط، الكمية ، استمرارية التزويد)	غير موافق تماما	غير موافق	طبيعي	موافق	موافق بشدة
14	هل انت موافق على تسخير واستخدام تكنولوجيا المعلومات والخدمات الاكترونية في قطاع المياه من اجل تحقيق سهولة التواصل مع مزود الخدمة وتعزيز التفاعل	غير موافق تماما	غير موافق	طبيعي	موافق	موافق بشدة