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Impact of Smart Technology on Sustainability Monitoring of Water Quality in Palestine

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Thesis Approval

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Declaration

I acknowledge that what is contained in the thesis is nothing but the product of my own effort, except for what has been referred to as not my effort. I also acknowledge that no part hereof was previously submitted for a degree or scientific title or to any other scientific or research institution.

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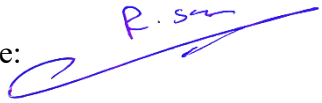
Signature: 

Date: 15/12/2024

Dedication

To my mother's soul in heaven.

To the one who believed in me and was the source of my strength, my husband.

To my family.

All loved ones who contribute to this achievement.

Appreciation and love.

Acknowledgment

Gratitude and thanks are always to Allah, my creator and creator of the earth and the heavens. Success and strength always come from Allah.

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Finally, I would like to express my appreciation to all parties that contributed to the success of this thesis, and to the Palestinian Water Authority, and everyone who helped me complete this research.

Abstract

This thesis studies the impact of the use of smart technology on the sustainability of monitoring water quality in Palestine. The study includes the five main domains identified, providing real time data, decreasing the cost, decreasing time consuming for decision maker, and improving accuracy and efficiency.

A qualitative and descriptive analytical method is adapted to study the degree of impact benefiting of using smart technology for water quality monitoring on the direct beneficiaries. These were implemented based on the opinions of the direct beneficiaries of the institutions that monitor water in Palestine. These are the government sector represented by the Ministry of Health, Palestinian Water Authority, and semi-governmental institutions representing 21 semi-governmental institutions or service providers (Municipalities, joint services councils, village councils and associations, and water undertaking). 1,475,152 beneficiaries of these institutions make up the population size in the study, equivalent to 46.24% of the West Bank population. Out of these, 55 representative sample were selected and are assumed to represent the population. The data were collected through structured interviews and subjected to analytical methods by understanding and interpreting the experiences, opinions, and beliefs of the participants, as well as comparing their opinions with literatures and studies.

The study concluded a set of results; the most important of which is that a high degree of positive impact of the use of smart technology on the sustainability of water quality monitoring in Palestine, especially in terms of providing real-time data and reducing the time spent by decision makers in meeting decision. However, cost reduction and improved accuracy and efficiency are not a high positive impact. On the contrary, the introduction of such technologies was considered too expensive due to the lack of

specialized technicians to deal with this technology, the increased reliability of traditional methods of analysis to give accurate results, and due to the scarcity of applications for this technology to achieve these goals.

The study set recommendations to the policy maker; the most important of which is that investing in smart technology may lead to additional cost savings overall. Establish legal regulations and legislation on the safe and responsible use of smart technology in water quality monitoring and ensure the protection of privacy and data security related to water and the environment are also recommended. Companies and organizations working in this field should clarify the benefits of investing in smart technology, provide technical support, and provide the necessary training for users and workers in this field. Encourage local and international cooperation and partnerships to exchange knowledge, experiences and technologies related to water quality monitoring is often and always recommended.

Keywords: IoT technology, Smart Monitoring, Sensors for Water quality, real-time data, Sustainability.

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List of Abbreviations

AI	Artificial Intelligence
IoT	Internet of Things
SCADA	Supervisory Control and Data Acquisition
SDG	Sustainable Development Goals
WHO	World Health Organization
ST	Smart Technology
WQM	Water Quality Monitoring
WSRC	Water Sector Regulatory Council
PWA	Palestinian Water Authority
JSC	Joint Service Council
VC	Village Council
PP	Pilot Project
M (LW)	Municipality (LAB work)
M (NW)	Municipality (LAB does not work)

Chapter One

Chapter One: Background

1.1 Introduction

The World Health Organization (WHO) claims that more than twenty-five million people die each year from diarrhea, and that drinking water is intimately tied to the spread of diseases. Studies and statistics in the United States of America indicate that 59% of diseases are caused by contaminated drinking water. Reports from the United Nations Programs (UNEP) for the year 1999 indicate that more than 80% of diseases and more than 33% of deaths in developing countries are caused by contamination of drinking water. A third of this number are children under the age of five, and they attributed this to pathogens that are transmitted by water.

Safe drinking water access is a fundamental human right, a necessity for good health, and a component of successful health protection policies. Water, sanitation, and hygiene are crucial for health and development. The outcomes of numerous international policy forums showed it. The Sustainable Development Goals (SDGs), which were adopted in 2015 and include a target and indicator for clean drinking water, are included in this. (WHO, 2022).

living in water-stressed or scarce locations because of the expanding global population, climate change, and escalating industry. This makes the creation and application of sustainable water management policy necessary. Urban regions are experiencing significant water imbalances and shortages because of rapid urbanization. Sustainable municipal and/or residential/industrial activities, regulations, and technologies for urban water stewardship are therefore becoming increasingly necessary.

In a broader sense, several digital technologies, including algorithms (such as machine learning) and large data analytics, sensors, and Internet of Things (IoT) networks, cloud-based technologies, and algorithms, have been utilized to achieve water security in urban settings and industrial sites. The implementation of digitalization not only increases the effectiveness and adaptability of urban water systems, but also offers sophisticated, unique services to society at a lower cost (Aivazidou 2021).

Water quality and technology in Palestine are complex and multi-faceted issues. In many parts of Palestine, it is difficult to find clean water, due to limited natural resources and inadequate infrastructure. Over-extraction of groundwater, pollution from agricultural and industrial sources, and inadequate wastewater treatment are among the main challenges facing Palestine. Due to the difficult political situation in the region and the lack of complete control over all sources.

The Palestinian Water Authority's vision is to have sustainable, integrated water resources that can meet the State of Palestine's basic demands as well as its future development needs. The development and protection of Palestinian water resources in accordance with integrated management principles is one of the strategic plan's goals. Along with strengthening the fundamentals of good governance in the water sector and attaining effective management (PWA plan 2016-2018).

The researcher chose SMART technology on sustainable water quality monitoring in Palestine because water quality monitoring is still depending on traditional methods. Samples are collected and then sent to the lab to be examined. Means a lot of time and effort. It is important to evaluate the impact of use SMART technology on sustainable

water quality monitoring in Palestine. The reasons behind choosing SMART in particular are the following:

- Lack of studies on the application of such technology in our region.
- Lack of studies on water quality monitoring by using smart technology, the most studies are on quantity of water monitoring by smart technology.
- There are pilot projects in the region that have ended and not continued.
- Most of the previous studies are on surface water, while the water sources in our region are mainly groundwater wells and springs.

For this, the main question of this study will be revolving around the following:

What is the impact of SMART technology on Sustainable water quality monitoring in Palestine?

Generally; No one would disagree that water is at the heart of sustainable development because energy, food production, socio economic progress, and human survival depend on water, which is at the center of sustainable development. Accordingly, water is a very important strategic resource for the continuation of the life cycle, and the responsibility to preserve it. Rationalizing its use is an obligation to every individual in this world and on all countries and governments, in order to preserve the environment clean and sound as a human right. (Savenije ,1992)

According to estimates from the United Nations, 783 million people do not have access to clean water, and nearly 2.5 billion people do not have access to sanitation and many people around the world still lack these basic water services. sufficient, but six to eight million people per year pass away from diseases and water-related calamities.

Water resources must be handled effectively if fundamental livelihoods and a nation's political and economic stability are to be supported. The constant growth in human population, the expanding demands of agriculture and other industries, the rise in energy use and pollution, and the effects of climate change all contribute to the increasing strains on freshwater supplies. Management is needed to avoid severe water and energy shortages that will eventually result in widespread hunger and disease for hundreds of millions of people around the world.

The majority of countries have prioritized sustainable water management regulations, but SMART technology's promise to enhance water management has not been completely realized. It makes sense to manage and safeguard the world's water supplies by utilizing the potential of smart technology in the water sector. Smart Water Management solves problems in the water sector by enhancing coordination in water development and management.

Smart technologies have played an essential role in managing, distributing and consuming water resources effectively and efficiently. With the use of information and communication technology, it is possible to calibrate, monitor, measure, and control water resources at a lower cost and with greater accuracy. A common example of successful technologies that provide information on water use today is real-time remote sensing. (Yang, 2021)

Water quality is one of the important criteria that affect all aspects of ecosystems and human well-being, such as community health, food produced, and economic activities, in determining the levels of poverty, wealth, and education of a person. As for management, the quality of water is determined through the desired end use.

Thus, we find that the water is used for specific activities such as recreational purposes. For drinking purposes, usually requires high levels of purity, and for this reason the quality of water has a broad definition depending on what according to “the physical, chemical, and biological properties of water needed to promote continuous water use according to the uses required” (UN Economic Commission for Europe, 1995).

Hence, considering the current situation, putting an end to the suffering of the Palestinians, especially in the water issue, is the integrated and sustainable management of water resources to achieve social, economic, and environmental development.

Groundwater is the primary source of fresh water in the state of Palestine, and there is also surface water included in valleys, seasonal streams, and the Jordan River.

Groundwater in Palestine constitutes more than 75% of all water sources in it and depends on receiving by the rains that fall over the West Bank heights and mountains and leak through the water-permeable rocks into the groundwater basins.

The Palestinian Water Authority is responsible for building and developing the water sector, which is one of the most PWA sectors for national sustainable development is the water sector.

The Palestinian Water Authority firmly believes in the necessity of obtaining water and the significance of sustainable water development despite all the limitations and barriers imposed by the Israeli occupation. The Palestinian Water Authority is adamant that water must be made available for all areas for domestic, commercial, agricultural, and tourist uses, among other significant development sectors.

As a result, the Palestinian Water Authority has a number of responsibilities, including managing water resources and working to develop suitable solutions and alternatives in

emergency and crisis situations to ensure that the water service continues to be provided to the public in coordination with service providers and other relevant bodies, such as the Ministry of Agriculture, Environment, Quality Authority, and Ministry of Health.

The laboratory is part of this institution, and its work is consistent with its goals and responsibility. The laboratory monitors and controlling the quality of water for water sources (domestic and agricultural) through chemical and biological analysis and makes recommendations to the relevant departments within the Palestinian Water Authority.

In cooperation with the Ministry of Health and local service providers, it is to ensure that adequate and safe water is provided at the household level in accordance with national drinking water standards.

1.2 The Significance of the Research

This research explores the impact of smart technology on the sustainability of water quality monitoring in Palestine. By integrating advanced technologies like IoT and data analytics, the study aims to provide real-time, accurate, and cost-effective water quality data. This supports Sustainable Development Goals, particularly clean water, and sanitation (SDG 6), and aids policymakers in developing effective water management strategies. Analyzing previous pilot projects, the research offers insights into best practices and challenges, promoting better water resource management and ensuring public health and environmental sustainability.

1.3 The Research Problem

The number of water service providers has reached 300 service providers in the West Bank. There is a difference in the way water service is provided in the West Bank. This is a relatively large number, On the other hand, there are 87 service providers operating

under the umbrella of municipality, whether the water service is in an independent circuit or an independent department or affiliated to the engineering department in the municipalities. There is also one water authority, which is the water authority Jerusalem Governorate, which provides services to more than 100 residential communities in Ramallah and Jerusalem. (WSRC 2021)

Based on data The Palestinian Ministry of Health, where the results of microbial and residual free chlorine tests were obtained in Water supplies to eleven Palestinian governorates represented in more than 440 compounds. The Ministry of Health inspectors were able to

Collecting more than 9,000 drinking water samples taken from various water sources, reservoirs, and distribution networks to be It was examined microbiology, while the free chlorine concentration reading was examined and recorded for approximately 59% of the samples only. (MOH 2021) It is noted that there is a discrepancy in the number of total examinations carried out in the different governorates in general.

This is due to several factors, including the geographical area of each governorate, the number of residents, the political situation, human and material capabilities, in addition to a specific work program approved by each health inspector or quality controller. commensurate with his responsibilities according to the aforementioned factors.

In fact, the total number of tests carried out for water samples in the West Bank in general must be greater if we have considered the water tests carried out by the Palestinian Water Authority for sources, in addition to the water tests the Palestinian Ministry of Health, in addition to the examinations carried out by service providers who have laboratories or who

They approve the water test with an external party. All these tests are from more than one party, and the traditional methods of collecting samples and sending them to the laboratory for analysis may take this process several days, and the results may not be available in time to prevent the spread of waterborne diseases.

So, the powered sensors can continuously monitor water quality and provide real-time data allowing for rapid response to any problems that arise. With challenges related to climate change and population growth, it is necessary that we adopt new and smart technologies to ensure that we have access to safe and clean water.

Studying under uncertain social, economic, and political conditions will help in assessing the lack of use of smart technology in water quality monitoring. Thus, the study problem can be defined in the following question:

What is the impact of smart technology on sustainability for water quality monitoring in Palestine?

1.4 The objectives of the Research

Most of the water service providers do not have a testing laboratory. They depend on the Palestinian Ministry of Health to check the water quality. Some municipalities conduct third-party water quality monitoring, such as universities. Therefore, there is a need for a mechanism for monitoring water quality and approving data and providing data in real-time to take the appropriate decision and avoid problems. This will only happen using smart technology in monitoring water quality. Therefore, the main objective in this study lies in the following:

Demonstrate the impact of smart technology on sustainability for water quality monitoring in Palestine

Out of the above objective the following sub-goals are derived, Domains

1. Demonstrate the impact of using smart technology on providing real-time data for water quality monitoring.
2. Examine the impact of using smart technology on reduced the cost for water quality monitoring.
3. Demonstrate the impact of using smart technology on time consuming for decision makers.
4. Investigate the impact of using smart technology on improving accuracy and efficiency.
5. View previous experiences of use smart technology on WQM in Palestine.

1.5 Research Questions and Hypothesises

Many various questions were raised in the previous studies and research, which shed light to many other questions. After a review of the main problems faced by the society in this context, the study will try to answer the following questions:

The first main question: What is the impact of ST on sustainability for WQM in Palestine?

Out of the above question the following sub-questions are derived.

1. What is the impact of use ST on provide real-time data for WQM?
2. What is the impact of use ST on reduced the cost for WQM?
3. What is the impact of use ST on time consuming for decision maker?
4. What is the impact of use ST on improving the accuracy and efficiency?
5. What is the impact of previous experiences for use ST on WQM in Palestine?

The Second main question: What are the expected difficulties in the application of use ST on WQM?

Hypothesis 1

There is no positive relationship between the use of ST for WQM in Palestine and giving real-time data.

Hypothesis 2

There is a direct relationship between the use of ST for WQM in Palestine and reducing the cost.

Hypothesis 3

There is no relationship between the use of ST for WQM in Palestine and reduce in the time consuming for decision maker.

Hypothesis 4

There is positive relationship between the use of ST for WQM in Palestine and improving the accuracy and efficiency.

1.6 Scope and Limitation of the Study

The study will focus on the impact of the ST's QWM interventions (from the point of view of the direct beneficiaries). In the West Bank from governmental institutions such as the Palestinian Water Authority and Ministry of Health and service providers (From municipalities, joint service councils, village councils, and water undertaking) The study focused on the major governorates that are located on the three major water basins in the West Bank, and these that have laboratories for testing and cover the largest population, As shown in the figure below.

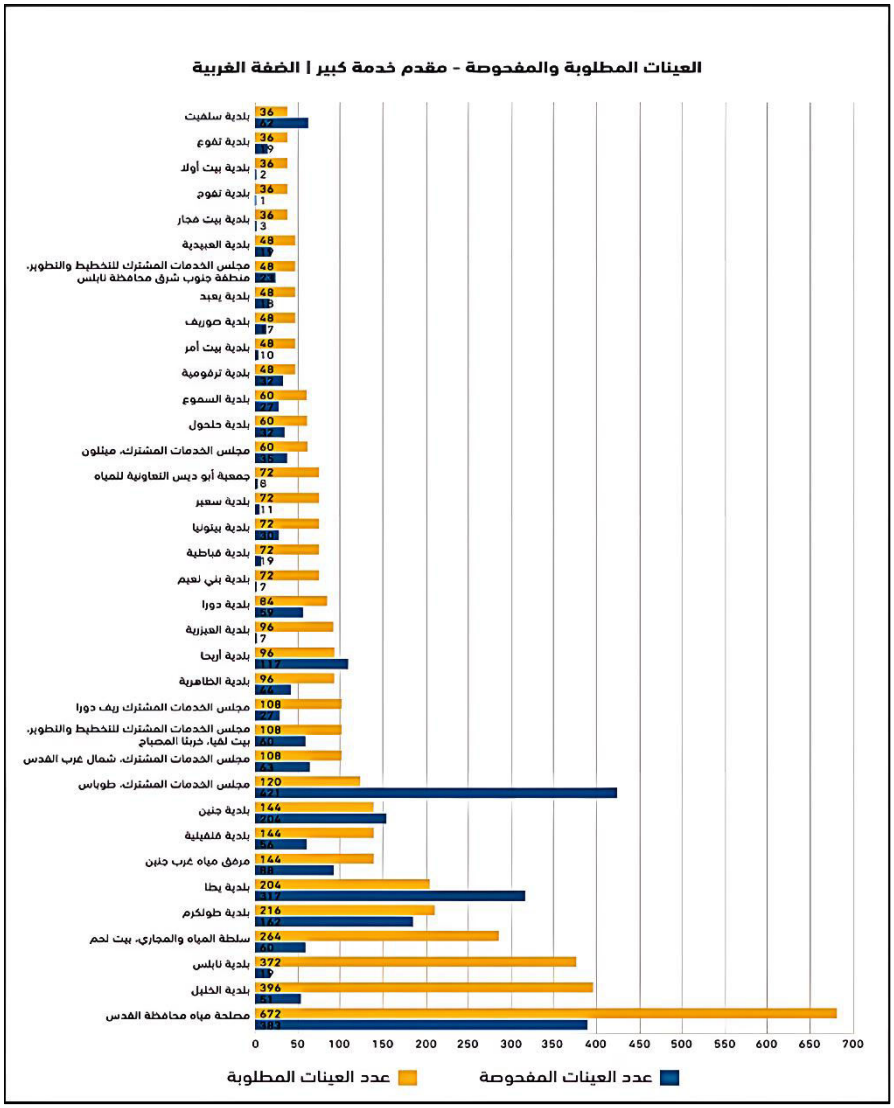

Figure 1: Main Water Samples Number in Palestine

1.7 The Study's Community

The research community will consist of all citizens who directly benefit from the sustainability for water quality monitoring of Jericho Municipality (34,000 beneficiaries) Salfit Municipality (15,000 beneficiaries), Hebron Municipality (232,500 beneficiaries), Jenin Municipality (59,413 beneficiaries), Tulkarm Municipality (90,000 beneficiaries), Nablus Municipality, (208,585 beneficiaries), water supply sewerage authority (WSSA) Bethlehem (11,3052 beneficiaries), Qalqiliya Municipality (59,298 beneficiaries), Jerusalem water undertaking (390,000 beneficiaries).

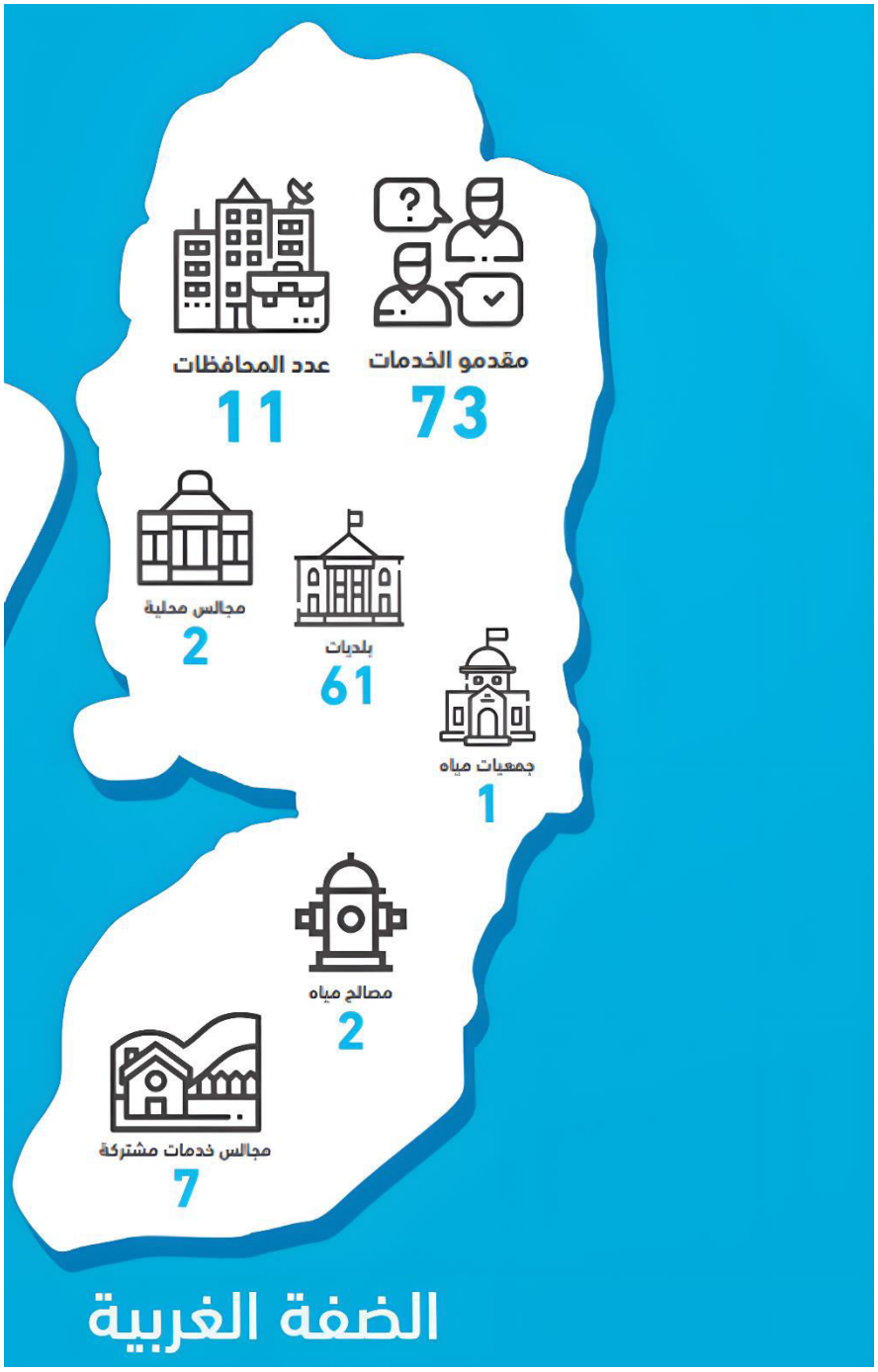

Figure 2: The administrative structure of service providers in the West Bank (WSRC)

Chapter Two

Theoretical Framework

Chapter Two: Theoretical Framework

2.1 Sustainable Water Resource Management

Thinking about ways to satisfy current needs without sacrificing the capacity of future generations to satisfy their own wants is known as sustainable development. (MEWA). The use of smart technology for water quality monitoring can contribute to sustainable development by improving the efficiency and effectiveness of monitoring, reducing the negative impacts of water pollution on human health and the environment, and enabling better management of water resources. (Stefania Anna Palemo 2022)

Poorer nations work hard to sustainably supply clean water and suitable sanitary facilities for all of their residents. Water supply and sanitation service delivery is becoming more than just a service delivery issue; it is also inextricably tied to climate change, water resource management, water shortage, and water quality. As a fundamental human right, having access to clean water and proper sanitation is essential for success in fields including agriculture, energy, disaster resilience, human health, the environment, and eventually economic development. Demand for water has increased due to urbanization, economic growth, and population growth in many nations, but supply has stayed constant or even reduced as a result of climate change. (WHO 2010).

In order to address the broader water context, including water quality, wastewater management, water scarcity, use efficiency, water resource management, and ecosystem protection and restoration related to water, SDGs recognizes that sustainable water management goes beyond just safe water supply and sanitation (targets 6.1 and 6.2). (World Development Indicators 2016). Improving the management of water resources

leads to improved public health and reduces the number of infections caused by water pollution.

Including improved water resources management leads to the promotion of economic growth for developing countries and contribute significantly to poverty reduction (WHO, 2010)

Strategic planning and policy development in the water sector supports the development of technologies and innovative solutions to alleviate water crises and problems.

To present a comprehensive set of principles for assessing sustainable water governance and finding solutions that apply this approach in natural sciences on water management. (Arnim Wiek, Kelli. Larson) It has been observed that freshwater resources will be among the most limited resources in the future, due to increasing demand and increasing population.

It was also noted that there are many obstacles and challenges to which water management systems still struggle to use appropriate responses.

The need to find innovative solutions to reduce these obstacles and challenges in how to develop water management systems, and to achieve the sixth SDG of integrated water management from the sustainable development goals by implementing integrated water resources management and obtaining the necessary indicators to be able to achieve this goal. (Sukuki Yi, Munhyun Ryu) This is to improve the economic and social level in fair ways. It can be achieved using innovative techniques and management solutions as technologies evolve to find solutions to the Palestinian current water challenges.

We note here that strategic planning and policy development in the water sector supports the development of technologies and innovative solutions to alleviate water crises and problems.

The purpose of Decree Law No. (14) of 2014, which relates to water, is to manage and develop Palestine's water resources, increase their capacity, improve their quality, preserve them, protect them from pollution and depletion, and improve and raise the standard of providing water services through the application of these principles.

2.2 Water Quality Monitoring

Water quality monitoring is the process of measuring and analyzing the physical, chemical, and biological properties of water to determine its suitability for different uses (EPA).

The use of smart technology can improve water quality monitoring by providing more accurate and timely data, enabling more targeted and effective responses to pollution events, and reducing the cost and resource requirements of monitoring programs. (Stefania Anna Palemo)

Where a comparison has been made between the existing classical operations approach and artificial intelligence techniques, it has been shown that the existing approaches give a relatively good prediction of water quality parameters. But these approaches rely on long data and require a lot of entry data that is often unknown.

It was also noted that new methods such as artificial intelligence techniques are able to better predict and give indicators of water pollutants. **(**Ali Najah, Ahmad Elshafie)

The results showed the ability of this network to simulate water quality variables and high accuracy. It also showed that this model may provide simulated values for desired sites where measured data are not available but are required for water quality models.

In non-industrial developing nations around 90% of sewage winds up untreated into streams, contaminating water and killing environments. The expense of such contamination is included in billions consistently. Putting resources into water quality would have an amazing monetary effect: The World Health Organization (WHO) appraised that accomplishing the Millennium Development Goal to obtain safe water and sterilization would bring a financial net advantage of US$ 84.4 billion every year. However, if the developing nations pay the greatest expense to bad water quality and absence of sterilization, it is the world in general that is demanded to resolve this issue at worldwide, public, and local level. More studies, checking and administrative capacities and consenting to rules on water quality hold the eventual fate of our prosperity because we live downstream (WHO, 2010).

2.3 Smart technology in water quality monitoring

Smart technology refers to the use of advanced technologies such as sensors, data analytics, and communication networks to create more efficient and effective systems. (P. Rohini; Sachin Tripathi).

In the context of water quality monitoring, smart technology can be used to collect real-time data on water quality, monitor changes over time, and enable more timely responses to pollution events. (Subhas C Mukhopadhyay).

To ensure that the safe distribution of water occurs, the Internet of Things (IoT) is being used in a novel way to observe it in real time as it relates to the current water quality. To

connect the measured data from the sensors, the microcontroller is used remotely and transformed into a simple controller utilizing the WI-FI protocol.

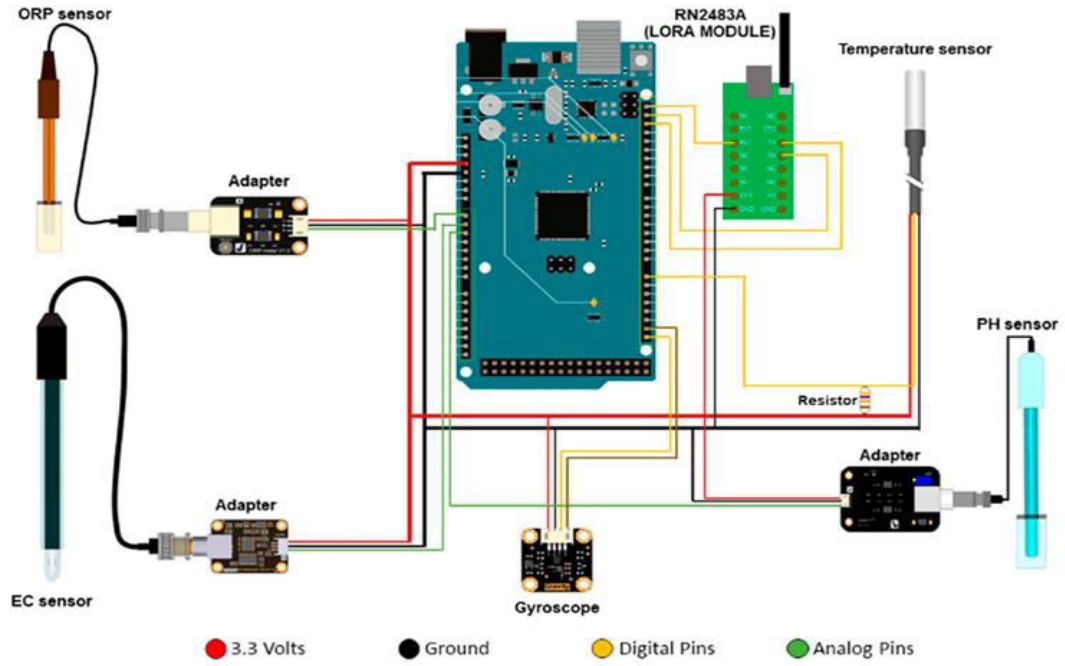

Figure 3: Water quality unit connected sensors (Evagelose Syrmos, 2023)

Some water quality indicators, such as temperature or pH, are specified and this method is sent from the sensor to the web server. Also, if there is a defect in the sensor or a problem in the sensor or if abnormal conditions occur, it gives a bell for the alarm and is running. (Vennam Madhavir eddy, B. Koteswarroa)

Using smart water systems and to give an example, using Internet of Things technology to monitor rivers, waterways, and wells, as well as drilling wells in terms of ensuring safe drinking water. (Environment Agency in the UK).

A set of criteria can be identified that can be used to assess water quality.

Internet of Things technology can give solutions as indicators of the quality of drinking water and alert the competent authorities in the event of a low quality and reach an unacceptable level.

Information driven applications are agitators to our daily lives. Inventive water utilities can profit from this advanced innovation transformation to work on their presentation. By tackling the force of artificial intelligence (AI) calculations and large information examination, water utilities can boost data and information accessible to settle on better choices while upgrading administration conveyance and diminishing expenses.

This short briefing presents the standards of AI for water utilities setting out on this advanced change to further develop their water dispersion activity as a rule, and to address unaccounted issues of water specifically. The short information depicts the absolute most expanded utilizations of huge information examination and AI related calculations in water supply, talks about how water utilities can steer AI toward the prediction of for water, and presents suggestions for execution and fundamental expense approximation (Jenny et al., 2020)

It is noted that the use of such a method gives an indication in real time in the event of a malfunction. This helps in solving the problem with less time and damage.

2.4 Pilot project for using smart technology in WQM

2.4.1 Pilot project in Jordan

An electronic system to monitor Jordanian waters remotely.

The Supreme Council for Science and Technology and the Royal Scientific Society have developed a monitoring system that includes modern and advanced technology for environmental monitoring and protection, through a grant from the Japanese government through the Japan International Cooperation Agency (JICA). It was agreed to support and establish a "water pollution monitoring system", consisting of a system for monitoring

water quality automatically in real time and remotely through a computer network (Kanamaru, 2005).

The central unit manages, operates, and maintains the "National Project for Real-time and Remote Water Quality Monitoring". It provides data on water quality in Jordan through an environmental database, which can be accessed through the internet to facilitate and maximize the use of that data quickly and reliably. The data is placed at the disposal of the authorities concerned with the application of environmental laws and regulations and decision makers in government institutions, in addition to farmers, academics and researchers in universities and scientific centers, and can also be accessed by citizens in general Three groups of measures are measured: first, temperature, pH, conductivity (salinity), and turbidity.

Second, the total nitrogen and total phosphorus. Third, chemically required oxygen.

These stations operate automatically by the devices equipped inside them, which withdraw water samples at an hourly rate from the water source and perform physical and chemical analyzes on them and send the results via the computer network to the database at the headquarters of the central unit in the Royal Scientific Society.

The monitoring system aims to collect and prepare data related to water quality in the main surface sources in the Kingdom and evaluate them. As well as collecting data on water quality in Jordan in one place, which supports decision-making processes through the automatic provision of data and through the modeling of water systems. (Royal Scientific Society, Jordan).

2.4.2 Pilot project in Palestine

Despite the scarcity of water resources in Palestine and the difficult conditions facing the Palestinian, whether it is the repeated objection from the Israeli side or by increasing the demand for water, the Palestinian Water Authority works to develop and protect water resources that are in accordance with the rules of Integrated management of water (Kornfeld, 2014).

The traditional methods are used to check and control water resources, through biological or chemical tests in the laboratory.

One of the goals of the Palestinian Authority's strategy is to achieve water security in the short and long term, to protect and develop water resources and to maintain their sustainability.

The current situation in the Water Authority is the presence of the water Resources Department, which monitors drinking water from various sources in all governorates and takes samples and transports them to the laboratory for examination and this routine process is done twice a year.

Water quality and technology in Palestine are complex and multi-faceted issues. The availability of clean water is a challenge in many areas of Palestine, due to limited natural resources and inadequate infrastructure. Over-extraction of groundwater, pollution from agricultural and industrial sources, and inadequate wastewater treatment are among the main challenges facing the country.

There have been efforts to improve the situation, including investment in new water treatment facilities and the implementation of regulations and policies to better manage and protect water resources. For example, the Palestinian Water Authority has developed

a National Water Strategy, which includes plans for improving the efficiency of water use, increasing access to safe drinking water, and reducing water pollution. (Shobaki)

There were previous experiences in Palestine using the smart water monitoring system and it was supported by the Water Authority such as:

2.4.2.1 Real time water quality quantity and weather monitoring project –Anabta Station in Tulkarm city.

The real-time water quality and quantity monitoring and weather monitoring Project was launched in 2012 because of joint interest by the Government of the Hashemite Kingdom of Jordan, and the Palestinian Authority. The project is implemented by the Parties, with technical expertise from the U.S. Department of Agriculture and the U.S. Environmental Protection Agency, and funding from the U.S. Department of State (DOS) and the Norwegian Ministry of Foreign Affairs.

The project is to acquire and analyze surface and groundwater quality and quantity data at multiple locations. The pilot studies provide a comprehensive set of data available for analysis among the technical experts to share knowledge gained from these monitoring stations with a purpose to establish uniform protocols for future water data sharing efforts across the region. Four real-time water quality and quantity and weather monitoring sites have been established in Jordan, and Palestine (one in each location). Data acquisition was initiated in September 2012.

The pilot project phase I officially began in May 2013 and ended in May 2014. Monitoring data acquired by the stations are recorded and retrieved via an iridium modem. Solar-powered batteries are used to supply power to each unit, allowing continuous collection and analysis of water samples as well as data transmission to a

central computer hosted by each of the Parties. A web-based platform has been established for data sharing.

The innovative aspect of this demonstration project is the technical and data management collaborative capability developed for collecting, transmitting, and storing real-time monitoring results. The Parties are able to share water quality and weather data on a real-time basis for the first time using the protocols developed through this project.

Water depth, temperature, dissolved oxygen, conductivity, pH, salinity, and turbidity are just a few of the water quality and hydrological data that are monitored in real-time online at the groundwater wells. Grab samples are periodically taken, and the macronutrients ammonium, phosphate, and nitrate are measured using handheld devices. This location was chosen because it is adjacent to the Western Mountain Aquifer's recharging zone in the northwest, of the West Bank. The main supply of drinking water for Palestinians in the West Bank now is this aquifer. This site is equipped with a guard room which assures the security of the equipment to be installed in the well, and on the roof of the building (weather station). (Salam Hantash-PWA)

2.4.2.2 Jericho springs: Sultan and Duyuk

The transit statistics allow researchers, specialists, and water professionals to examine the vulnerability of spring sources and provide essential data for water supply management. Furthermore, the coherence of the two artesian Jericho springs, Sultan and Duyuk, which were 3500 meters apart, was established. (Schmidt. 2014).

This area was part of a study for Schmidt, and it was supported by the Water Authority. Some of the parameters were read and it was a successful experiment, but it was stopped due to some sensors being stopped working and they were not followed up or maintained.

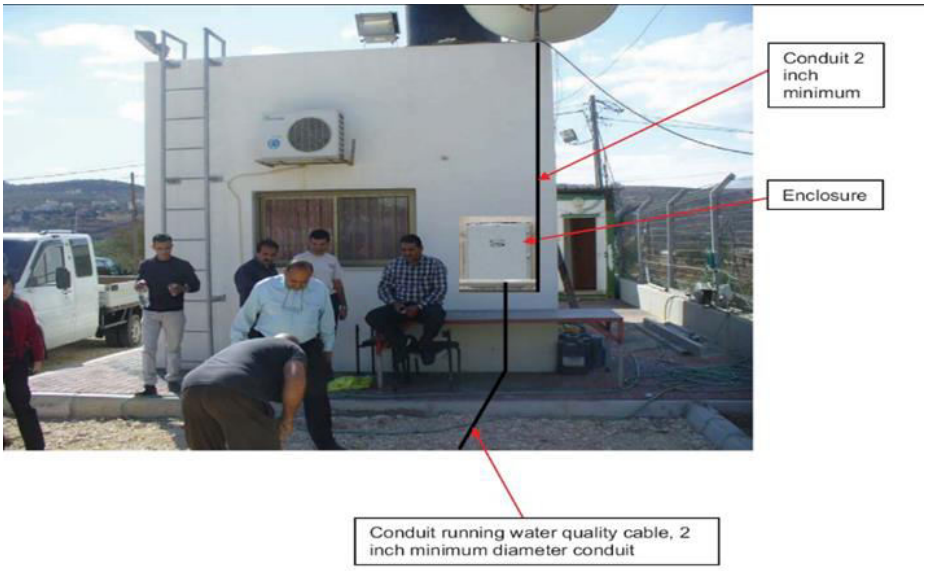

Figure 4: Anabta Station in Tulkarm city (PWA)

All these previous experiences in Palestine, springs and even some wells, are considered successful to some extent, but they did not continue, perhaps because of the lack of follow-up or the lack of funds. The crews were not sufficiently trained to continue the project and deal with the problems in an appropriate manner (Omer Zayed, PWA).

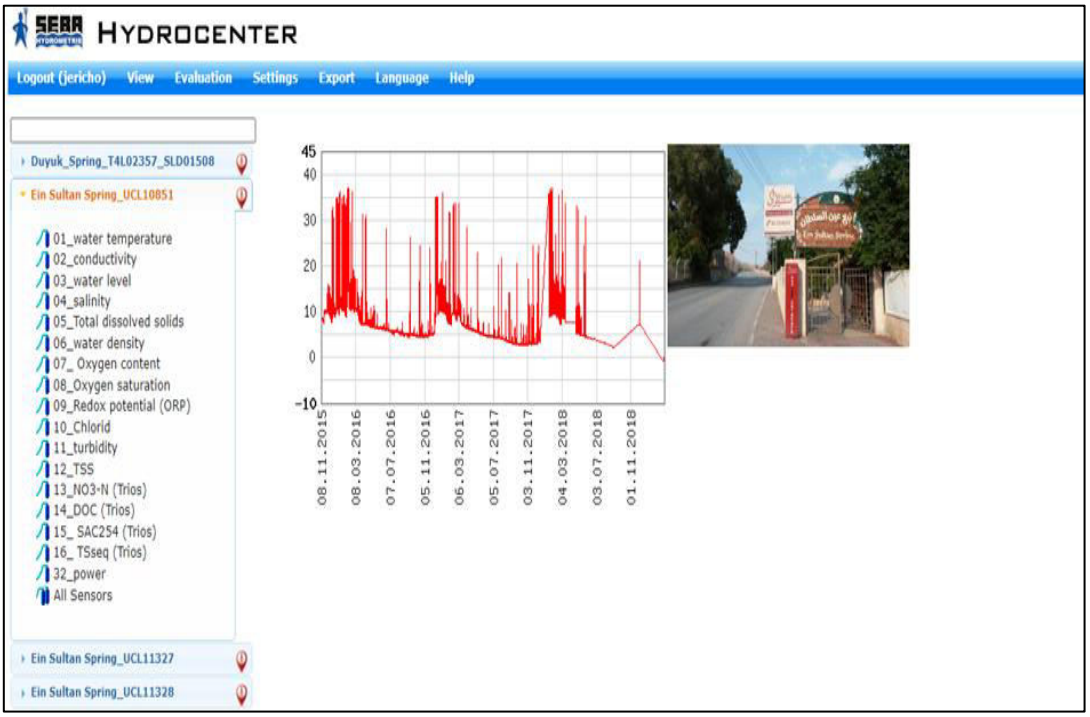

Figure 5: Ein Sultan Spring sepa program. (Jericho Municipality)

2.4.2.3 SCADA system in West Bank Water Department

According to Samir Tumah, the IT manager at the WBWD and the coordinator for the SCADA project at the Palestinian Water Authority, the monitoring and management of the Palestinian water sector heavily relies on the essential data of flow rates.

The value for flow rates gives an idea of the amount of water produced in the West Bank. A solid foundation for statistics and analyses is provided by the precise data from the 46 sites included in the SCADA project. Experts from the WBWD examine and evaluate all data relevant to total flow rates and provide tailored reports that they can utilize for water planning. In order to facilitate data collection and transmission for the SCADA project, USAID set up electromagnetic flow meters and communications equipment at each of the 46 stations.

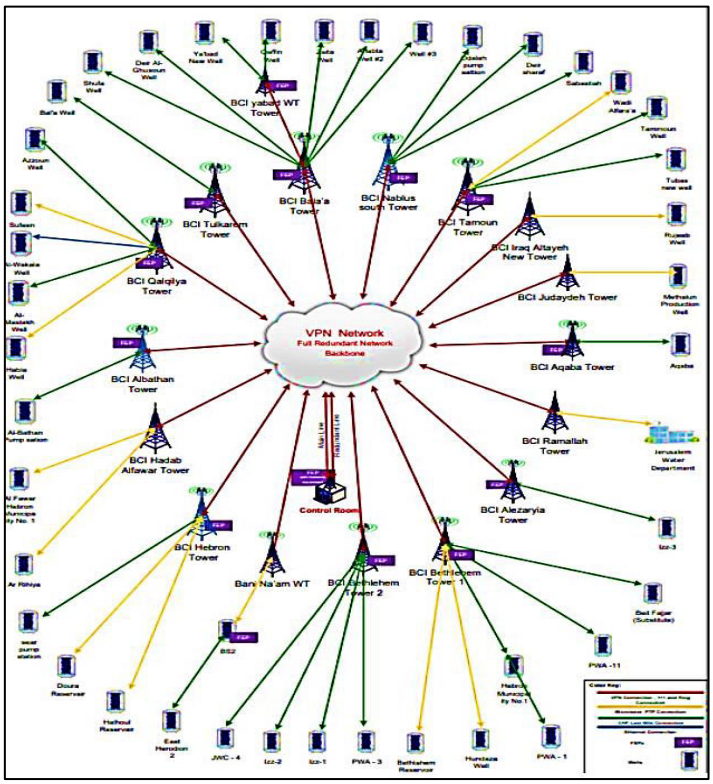

Figure 6: SCADA system in West Bank Water Department

Radio and microwaves relay flow rate data in real time to the WBWD control room in Ramallah with the assistance of thirteen towers located throughout the West Bank. Additionally, project sites use UHF transmission to relay the data. The information can be received, recorded, tracked, and managed in the control room. The data is automatically organized and backed up once it is in the control room.

This system is used only to read the water flow and there is no remote-control system, they need more servers, and this needs funding, and most municipalities do not follow it.

2.5 The potential benefits and risks with the use of smart technology

Water utilities overall are going through a computerized change, driven by the web, enormous information, and AI algorithms. To stay competitive and further develop client support conveyance, water utilities need to move from an "old school" activity, because of working a syndication with minimal outside pressure, or Hydraulic Modeling 1.0, to another period of productivity and responsibility, or Hydraulic Modeling 2.0.

The accessibility of reasonable large information from sensors, clients, and employees drives this change. Admittance to data is not knowledge, as large information should be handled further for functional and arranging decisions. AI calculations help the water utility to turn out to be more information proficient by changing data into a more streamlined activity, boosting information driven dynamic through a blend of AI mathematical instruments and human functional abilities.

Such advanced change to turn into a smart water utility goes past the specialized test of incorporating information, yet additionally requires another association structure. New arrangements of functional methodology with support from the staff and the clients is also required. Another arrangement of public and sector approaches is expected to help this

computerized change of the water sector; explicitly, to further develop administration coming about because of the authoritative rebuilding and improved guideline for practical and low-cost execution (Jenny, 2020).

Most water utilities start their computerized progress with a SCADA connected to an organization control center; then, at that point, sort out some way to transform these ICT interests into genuine advantages. Therefore, the advanced capabilities of many water utilities, especially in developing nations, are not really valuable for everyday activities and do not lead to an advantage to the clients. The computerized change of water utilities ought to be developing, practical, and target situated. (Vallabhaneni and Johnson, 2017)

Water utilities can test the expected advantages of the AI strategies by setting out on less dangerous, small experimental programs that can likewise be utilized to evaluate their innovative capabilities and characterize a reasonable ICT guide. Huge information and AI calculations are promising devices for water utilities and ought to be directed in today's tasks of any government in any country.

Water utilities, as profoundly specific associations, assemble information through measurements from their competitive surroundings and their clients to settle on essential decisions and convey a superior service. All things considered; a significant number of the current business instruments can be taken on in the water sector.

The advanced discipline of exploring the period of large information at the management level. Business intelligence apparatuses incorporate a blend of the accompanying provisions identified with information (Jenny, et al., 2020). Advanced pattern prediction (AI stage). Progressed business intelligence devices use AI calculations to recognize inward examples and distinguish concealed connections among data (Preciado, 2019).

Using illustrative factors, for example, schedule occasions, financial turn of events, climatological factors, and so on outside to the water utility, the AI stage can foresee the advancement of its activities far past pattern analysis.

A portion of the uses of AI raise moral concerns, especially the issue of organization (who is responsible for AI blunders bringing about significant harms?). In any case, water utilities will likely apply these new innovations after they have been generally tried (and conceivably controlled) in different fields and businesses. Expanding the extent of network safety and the utilization of block chains (a system for storing data in a way that makes changes to it difficult or impossible) can secure individual and business information (Patabendige, 2018).

All ICT frameworks, including AI stages and AI apparatuses, require dynamic and cutting-edge insurance measures against outer assaults. Online protection is of specific worry in water supply since water is a basic resource with a high general wellbeing risk; and on the grounds that water utilities oversee client data sets with classified and private data, from monetary information to water utilization designs.

Without suitable measures, smart water expands the danger of cyberattacks, with Internet of Things (IoT) giving an opportunity to computer hackers. Artificial Intelligence is taking network protection higher than ever, utilizing profound learning calculations applied to social investigation to recognize unusual activities and robo-trackers (AI apparatuses continually searching for and gaining from dangers). Block chain innovation is a disruptor in network safety generally, and client information management specifically, by shielding data (Arnold, 2019).

2.6 Literature Review

1. **Evangelose Syrmos, Vasileios Sidiropoulos (2023):** This paper introduces a modular IoT water monitoring system that measures both the quantity and quality of water. The system aims to enhance water infrastructure reliability by providing robust smart water metering solutions. The modular approach facilitates customer profiling, environmental stewardship, and emergency response while reducing initial costs. The architecture includes consumption and quality meters and machine learning capabilities for intelligent invoicing and user profiling, addressing urbanization challenges and advancing smart water metering.
2. **Stefania Anna Palermo, Mario Maiolo (2022):** This study examines the application of smart technologies in water resource management, enabled by advancements in ICT and IoT. Smart water management technology empowers users to manage water usage better, enhancing sustainability and addressing environmental challenges like population growth and climate change. The study provides an overview of smart and sustainable water management technologies for building-scale usage, highlighting resource conservation and recovery.
3. **Stavroula Tsitsifli, Vasilis Kanakoudis (2022):** This study identifies suitable locations for water quality sensors in small water supply networks. It addresses the challenge of detecting contaminants due to the complexity of water distribution systems and limited resources. The proposed methodology considers various objectives and demand-driven conditions to optimize sensor placement, enhancing monitoring efficiency.
4. **Kawalanathan Shanmugam (2021):** This research highlights the impact of rapid development on Malaysia's raw water sources, leading to widespread contamination.

The proposed IoT-based solution allows individuals to monitor water quality easily, addressing issues like illegal garbage dumping and industrial waste. This system aims to improve water quality monitoring and prevent shortages caused by contamination.

5. **Vaishnavi V. Daigavane, Dr. M.A Gaikwad (2017):** This article presents a cost-effective IoT solution for real-time water quality monitoring. The system uses multiple sensors to measure water's chemical and physical characteristics, such as temperature, pH, turbidity, and flow. The primary control unit processes sensor data, and an Arduino model with a Wi-Fi system enables remote monitoring and control, ensuring continuous water quality assessment.
6. **Kofi Sarpong Adu-Manu (2017):** This study emphasizes the importance of managing and preserving fresh water due to its limited availability. It explores methods for water quality measurement, from manual techniques to advanced wireless sensor networks (WSNs) for in-situ monitoring. The study highlights advancements in sensor devices, data collection, communication, and power management systems necessary for sustainable water quality monitoring.
7. **Mahmoud Kkaki, Ismail Bin Yousof, Nur Islami (2014):** This study adopts smart technology for predicting water quality using artificial neural networks and neuro-fuzzy systems. Conducted in Malaysia's Langat basin, it successfully indicates water quality parameters. The study concludes that artificial intelligence can explain water quality behaviors, aiding in water resource management.
8. **Arnim Wiek, Kelli Larson (2012):** This study implements integrated water resources management to meet sustainable development goals, aiming to improve economic and social standards equitably. It suggests that technological advancements and innovative management solutions can address current water concerns and achieve

sustainable water governance.

9. **André Lermontov et al. (2011):** This study finds that artificial intelligence (AI) effectively models complex water quality correlations. It compares several AI techniques, such as neural networks and support vector machines, to forecast water quality indicators. The research focuses on Johor River, highlighting AI's potential to reduce time and costs in water quality monitoring.
10. **Sundarambal Palani, Shie Yuiliong (2008):** This study explores using artificial neural networks (ANN) to forecast water quality in coastal waters of Singapore. The model demonstrated high accuracy and the ability to replicate water quality variables, offering simulated values where measured data is unavailable, enhancing water quality models.

Comments on the Literature Review

In general, all the previous studies agreed on the importance of Smart technology, such as sensors and monitoring systems, especially the IoT, which can play an important role in improving water quality monitoring and management (Kamalanathan, 2021). By providing real-time data on water quality parameters, such as pH, dissolved oxygen, temperature, and turbidity (Vishanavi V. Daigavane, 2017). These systems can help identify potential problems and allow for faster response times to mitigate any negative impacts on the environment or human health.

It makes water monitoring a major concern since it can be used to track how the quality of the water varies over time, spot problems as they develop, and create successful intervention plans to address water pollution. 2017's Kofi Sarpong Adu-Manu to ensure adequate treatment and deter contamination, it is crucial to have in-depth understanding of the quality of potable water. Review WQM techniques, comparing manual techniques

that are more traditional with. That stressed the importance of accuracy and efficacy of data to predicting water quality and making it a useful tool for managing water resources. To provide low-cost design and development IoT.

However, it is important to note that the implementation of smart technology alone is not enough to ensure sustainable water management. It must be accompanied by effective policies and regulations, as well as public education and engagement to promote responsible water use and conservation. It can be achieved using innovative techniques and management solutions as technologies evolve to find solutions to the Palestinian current water challenges. Overall, the use of smart technology for water quality monitoring has the potential to improve sustainability and promote more efficient use of water resources. It must be part of a holistic approach to water management that considers social, economic, and environmental factors. All studies agreed with this study in general, but most of them used the quantitative approach and some of them adopted the qualitative approach. They were also similar in selecting the direct beneficiaries of the WQM intervention as the study population.

This study presents the target group that experts, technicians, and decision-makers represented from SMART Technology interventions on WQM. It will cover part of a gap resulting from the lack of previous studies in the region on the use of SMART Technology in monitoring water quality and its impact on sustainability and improving water resource management. Moreover, the impact of the sustainability of water monitoring will be linked to a range of interventions that have been implemented between the government sector and service providers. The factors that will contribute to providing an impact assessment. As well as the expected challenges and difficulties.

Chapter Three

Methodology

Chapter Three: Methodology

3.1 Introduction

This study aims to measure the impact of smart technology on the sustainability of water monitoring in Palestine. To achieve our goal, the researcher chose twenty-one semi-governmental institutions or service providers, two governmental institutions and WBWD, which is on its way to become a company.

These sectors that implement water quality monitoring are represented as follows: Ministry of Health and PWA representing the government sector, Hebron Municipality, Tulkarm Municipality, Salfit Municipality, Nablus Municipality, Qalqilya Municipality, Jericho Municipality, Jenin Municipality. And the Bethlehem Water and Sewage Authority, the Jerusalem Water Undertaking, the Municipality of Dura, the Municipality of Allar, the Municipality of Beit Ummar, the Municipality of Qabatiya, the Municipality of Baqa al-Sharqiya, the Municipality of Surif, and the Municipality of Balaa and Ya`bad. represent the semi-governmental sector.

The joint services councils such as: The Joint Services Council for Planning and Development in the southeastern region of Nablus Governorate, the Tubas Joint Services Council, the Joint Services Council for Drinking Water and Wastewater in the southwestern Jenin Villages, the Joint Services Council for West Jenin Water. The community benefiting from these institutions to measure the impact of use smart technology on sustainability for water quality monitoring they are 1,519,152 beneficiaries make up the size of the population in this study. A causal sample was selected from the employees of these institutions, including inspectors, laboratory technicians, managers, and decision makers. Fifty-five interviews were valid for analysis.

3.2 Research Approach

Since smart technology for water quality monitoring are not yet mature enough in Palestine, there is a lack of literature on this topic, so our research would be exploratory research that will help in conducting further research regarding smart technology for water quality monitoring and their future in Palestine.

The study aims to employ qualitative data collection techniques for identifying the impact of use smart technology on sustainability for water quality monitoring. The qualitative data of the study is collected with help of the interview approach, more than any other tool that achieves the most important goal, which is obtaining the correct information from experienced people.

3.3 Procedures of the Study

The research tool was structured questions, the questions were reviewed by the thesis supervisor Dr. Abdulrahman Al- Tamimi and other experienced academics in this field. The questions consisting of two sections, the first section focuses on areas related to WQM as follows: The impact of use ST on real-time data, reduce the cost, reduce time consuming time consuming for decision maker, improving the accuracy and efficiency, and previous experiences for use ST on WQM in Palestine. The remaining second sections on expected difficulties in the application of use ST on WQM.

To support the researcher, use Nvivo program, which is a computer program to analyze the interviews and produce results for the qualitative analysis through a clear methodology in analysis. This program is accredited by academic institutions and business institutions that deal with research writing and qualitative analysis, can also be imported, and participants' reports can be compared with existing literature on the subject.

Another feature of the program is subgroup analysis. The character coding is done with highlighters just as it is on paper copies.

3.4 Data collection and sample

To get a deeper and well understanding of smart technology' impact on water quality monitoring in Palestine. interviews were conducted with experienced representatives of the water quality monitoring to obtain highly valid data for analysis. Thematic analyses were done after conducting interviews. Nvivo software was used as the tool for thematic analysis.

The researcher chose this sample based on the relationship of these institutions with WQM. 8 municipalities have laboratories that monitor water quality, and their data is approved. Except for the municipality of Nablus, which takes its data from An-Najah National University. 9 municipalities have laboratories, but they do not have equipment or employees in the laboratory. 4 joint services councils and 2 village councils and Association. Also, experts in areas specialized in water quality and monitoring, as well as in technology sciences and their applications regarding water, In the Palestinian Water Authority and the West Bank Water Department, as well as in the Ministry of Health.

Table 1: Municipalities that have laboratories and approved data Interviews

Municipalities that have laboratories and approved data	**Beneficiaries**	**Interviews**
Jericho municipality	34,000	2
Authority WSSA Bethlehem	113,052	2
Jerusalem Water Undertaking	390,000	3
Jenin municipality	59,413	2
Hebron municipality	232,500	2
Tulkarm municipality	90,000	2

Salfit municipality	15,000	2
Nablus municipality	208,585	2
Qalqiliya municipality	59,298	2
Total	**1,201,848**	**19**

Table 2: Municipalities that have laboratories but not work Interviews

Municipalities that have laboratories But not work	**Beneficiaries**	**Interviews**
Dura municipality	45,000	1
Allar municipality	8,050	1
Qabatiya municipality	28,000	1
Beit Ummar municipality	19,200	1
Baqa al-Sharqiya municipality	5,000	1
Surif municipality	18,700	1
Bala municipality	8,500	1
Yabad municipality	18,000	1
Tubas Joint Service Council	51,000	2
Total	**201,450**	**10**

Table 3: Number of interviews at Joint Services Council Interviews

Joint Services Council	**Beneficiaries**	**Interviews**
West Jenin Joint Service Council	60,000	2
Meithalun JSC	25,854	1
Southeast Nablus JSC	30,000	1
Total	**61,854**	**4**

Table 4: Village Council (VC) and Association Interviews

Village Council and Association	Beneficiaries	Interviews
Azmut VC	4,000	1
Bartaa Sharqiya water Association	6,000	1
Total	**10,000**	**2**

Table 5: Palestinian Water Authority PWA and West Bank Water Department WBWD Interviews

Name of Government	Position	Interviews
West Bank Water Department	IT manager and Control Department	Samer Tomeh
West Bank Water Department	General Manager of Stations in the North	Fadi Abdelghani
West Bank Water Department	General Manager of Stations in the South	Esam Erman
West Bank Water Department	Quality Unit Manager	Mouhammed Hdaidoun
West Bank Water Department	Quality inspector	Ali Ahmad
West Bank Water Department	Maintenance Department Manager (North, South)	Fadi Abdelghani
Palestinian Water Authority	Data Bank Manager	Ashraf Dwakat
Palestinian Water Authority	Director General of Resources and Control	Omar Zayed
Palestinian Water Authority	Manager of water harvesting	Salam Hantash
Palestinian Water Authority	Director General of Planning and Sanitation	Adel Yasein
Palestinian Water Authority	Water Planning Manger	Rehab Thaher

Palestinian Water Authority	Projects Unit Director	Zeiad Daraghmeh
Palestinian Water Authority	Director of the research unit and laboratory	Dr. Subhi Samhan
Palestinian Water Authority	Laboratory technician	Hanadi Bader and Azhar Sharef
Palestinian Water Authority	Technical advisor and planning	Dr. Mouath Abu Saadah
Palestinian Water Authority	GIS and System Analyst	Ihab Sweiti
Total		**18**

The Ministry of Health performs most of the drinking water tests, meaning that it examines the rest of the areas that were not mentioned here in the sample.

Table 6: Ministry of Health Interviews

Name of Government	**Position**	**Interviews**
Ministry of Health	Health and water quality inspector	Hazem Shbaib
Ministry of Health	Lab technician	Nour Halayqah
Ministry of Health	Health official	Sanabel Abubaker
Ministry of Health	Director of the Ramallah and Al-Bireh Health Department	Dr. Mahdi Rashed
Ministry of Health	Head of department water quality control and health	Baha Swalha
Total		**5**

Table 7: Interviews of previous pilot projects that used the technology in water quality monitoring.

Pilot project	Position	Interviews
Ein al-Sultan project	Lab Technician + Manager of Water and Sanitation Department	Subhi Yaghi and Muhammad Fetyani
Anabta Well project	Lab Technician + Water Resources Manager	Azhar Sharef and Salam Hantash
SCADA program in the West Bank Water Department	IT manager	Samer Tomeh
Remote chlorination monitoring program in Ein Samia well, Ramallah	Engineer + Water Resources Manager	Muhammed Ayash and Yahia Zuhdi
Total		**7**

3.5 Survey validity

The validity of the content in the survey (interview) should be relatively acceptable, given that it was all based on a review of the literature and on the opinions of many experts in the field and with direct beneficiaries who items will be checked.

3.6 Overcome

The data and opinions of the above-mentioned people have been adopted and are sufficient for the researcher because they are from different sources, including laboratory technicians or those who can make decisions. Some of them have previous experience in this field. They have certified data and represent governmental and semi-governmental institutions in the West Bank.

Chapter Four

Analysis and Discussion

Chapter Four: Analysis and Discussion

4.1 Results

This study aims to explore the impact of ST on sustainability for WQM; to examine the impact of ST on the sustainability for WQM according to the factors as (real- time, reduce cost, time consuming for decision maker, improving accuracy and efficiency, and Previous pilot projects for use smart technology of water quality monitoring).

The results related to the first main question and its sub-questions:

What is the impact of ST on sustainability for WQM in Palestine?

Out of the above question the following sub-questions are derived.

1. What is the impact of use ST on provide real-time data for WQM?
2. What is the impact of use ST on reduced the cost for WQM?
3. What is the impact of use ST on time consuming for decision maker?
4. What is the impact of use ST on improving the accuracy and efficiency?
5. What is the impact of previous experiences (pilot project) for use ST on WQM in Palestine?

It is noted in the figure that the most percentage of the agreed answers was the factor of taking the time for the decision maker to figure out the problem and solve it by making the appropriate decision as little as possible with 95%, followed by real-time knowledge of the data or the actual time of the problem or pollution with 78%. This means that the impact of using smart technology on the sustainability of water monitoring is positive and that answers the first main question. And then comes 46% for accuracy, and efficiency. This is due to the uncertainty of stakeholders and beneficiaries about the efficiency and effectiveness of such technology.

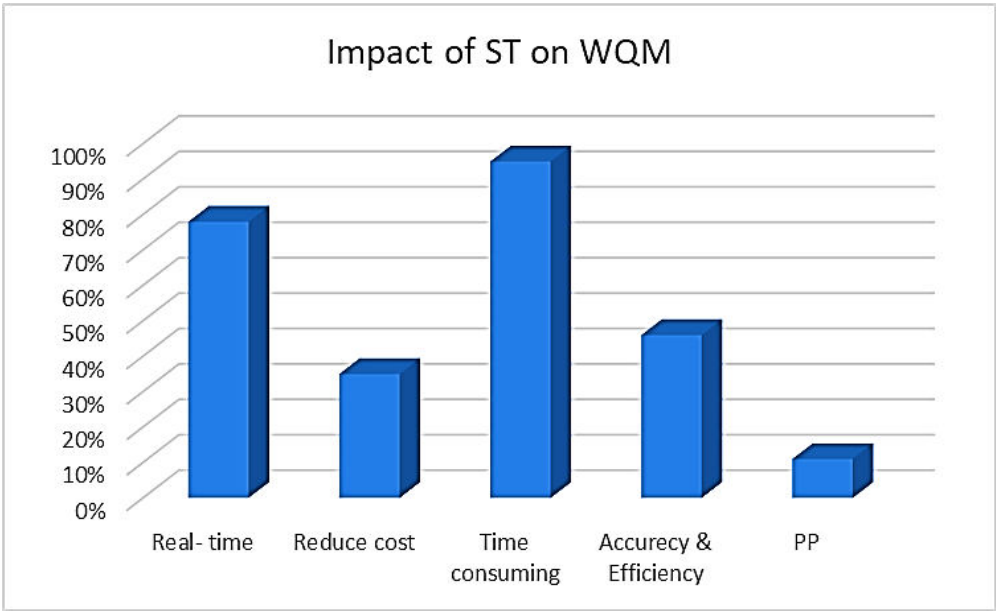

Figure 7: The result for impact of use smart technology on sustainability for water quality monitoring in Palestine

Then comes a few to reduce the cost with only 35% of opinions about the possibility of this technology to reduce the cost in monitoring water quality, and at least with those projects that have been tried before, which is very few, with 11% is basically not completed or continuing because it stopped.

The researcher justifies these results to the nature of the sample as they are all direct beneficiaries of WQM interventions. This can be considered as an indicator of the efficiency of these interventions and their convenience to the sustainability for water quality monitoring in Palestine. Therefore, continuing and expanding these interventions will lead to improve QWM in Palestine.

In comparison with smart technology there is an agreement between the results of this study and ST benefits on sustainability of water quality monitoring which sought to a common framework for relevant institutions working in protect and monitoring of water sources. According to the water law, which aims to manage and develop water sources in Palestine, increase their capacity, improve their quality, conserve, and protect them from

pollution and depletion, and improve and raise the level of water services through the application of the principles of integrated and sustainable management of water sources. (Palestinian Water Law No. 14 of 2014).

1. What is the impact of use ST on provide real-time data for WQM?

To answer this question, it was noted that most of the supporters who agree that the use of smart technology is the best option to give data in real time. The large percentage of agreement with this question was the Palestinian Water Authority (Figure 7).

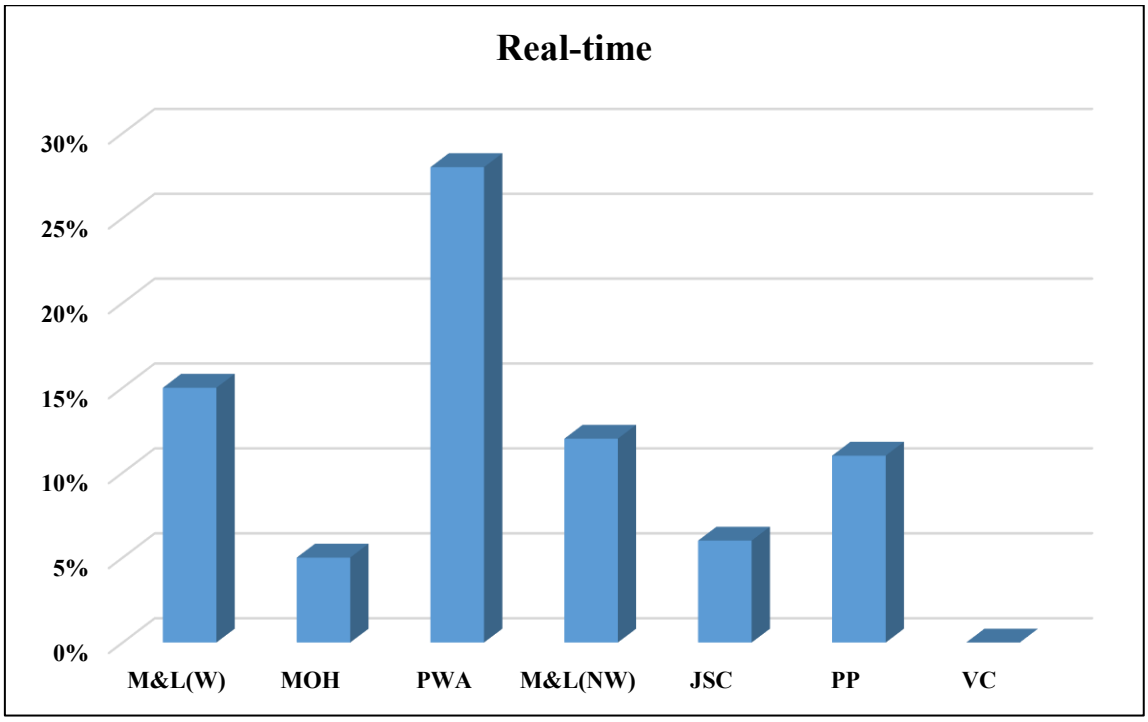

Figure 8: Result of impact for use ST on provide real-time data for WQM in Palestine

We note from the figure shown above that the highest percentage of response that technology has a significant impact on the provision of real-time water data was at the PWA with a high percentage of 28%. This is explained by the presence of experts and specialists who answered this question and because they knew the importance of such technology and because they were followers and supporters of such technologies to provide real-time data and rapid detection of problems to take appropriate action.

Some municipalities that have laboratories and consider their data to be certified agree that smart technology has a great impact by giving real-time data in order to act appropriately, which is 15%. The next percentage was for the municipalities that have a laboratory but do not have staff to analyze and give the results, it was 12%. Then comes the rest of the percentages for the previous pilot projects, which is 11%, The Joint Services Council by 6%, which is considered low, same as for the Ministry of Health. The percentage of the impact of using real-time technology was as low as 5%. Thos is due to the fact that most of the supporting answers were provided by technicians in the laboratory only, and not by managers or decision makers. This is due to their lack of knowledge of the importance of this technology and the extent of its impact on water health and safety.

The impact of real-time knowledge of data on the sustainability of water quality monitoring is considered positive. The highest percentage of the water authority is 28%, which is considered a very significant impact. It has the power to set policies and guide the rest of the institutions. Whether in the government sector or semi-government in municipalities and other service councils.

The researcher believes that the impact was strong for real-time data, which is a problem faced by everyone in how to collect samples and move with difficulty due to the political situation. The lack of the appropriate staff and enough to cover all governorates and gatherings. Especially as the researcher mentioned earlier, most of the areas that are not sampled by municipalities are covered by the Ministry of Health. This is a great pressure on the staff of the Ministry of Health to control pollution problems and act quickly to stop the problem.

This corresponds to the literature that was mentioned earlier about the impact and importance of using smart technology by giving real-time data to act faster and prevent the problem from worsening, and greater management and control over sources, such as sensors and monitoring systems. The IOT can play an important role in improving water quality monitoring and management. By providing real-time data on water quality parameters, such as pH, dissolved oxygen, temperature, and turbidity these systems can help identify potential problems and allow for faster response times to mitigate any negative impacts on the environment or human health.

2. What is the impact of use ST on reduced the cost for WQM?

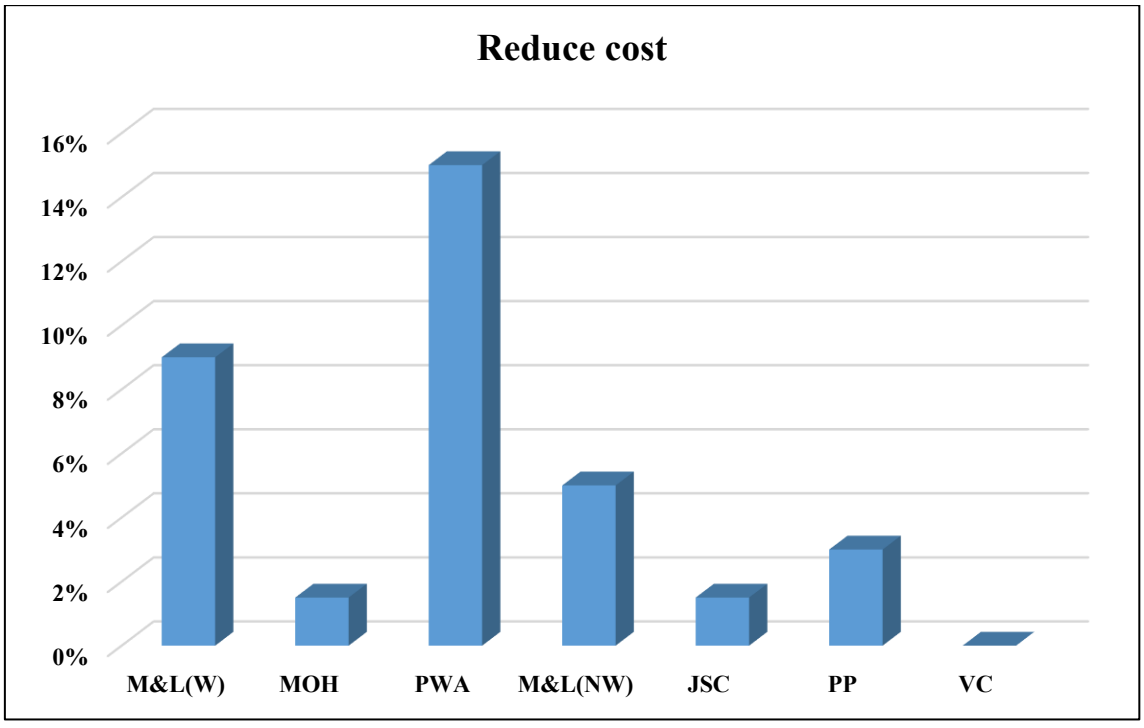

Figure 9: Result of impact for use ST on reduced the cost for WQM in Palestine

There are also challenges associated with the use of smart technology for water quality monitoring. One of the main challenges is the cost of implementing and maintaining this technology. The sensors, data analytics, and communication technologies required for smart water monitoring can be expensive. There may be additional costs associated with

data storage and analysis. It is noticeable in the figure above that there are low percentages in responding or agreeing to the question that smart technology reduces costs. The answers that agree with this very remarkable were few, while they were considered somewhat acceptable by 15% for the water authority. The presence of technical experts and also experts in technology at the water authority and the West Bank, and they have knowledge of the development and what smart technologies have reached and that there are types of such technology, and it is the best and least expensive in the sustainability of water quality monitoring.

The rest of the percentages are very low for those municipalities that have laboratories, and their data are certified 9%, while 5% for municipalities that do not have staff for testing. They consider the use of this technology very expensive, while the Ministry of Health was very low 2%, and for previous pilot projects it was also low 3%, this is due to the use of technology that depends on the annual subscription from the satellite. It was expensive and the projects failed to continue. When a malfunction occurred and maintenance was needed, the project stopped due to the lack of trained and experienced staff. Other projects such as those that relied on the SCADA system were not completed due to high costs. It is important to note that the implementation of smart technology alone is not enough to ensure sustainable water management. It must be accompanied by effective policies and regulations, as well as public education and engagement to promote responsible water use and conservation. It can be achieved using innovative techniques and management solutions as technologies evolve to find solutions to our current water challenges. (Arnim Wiek, Kelli. Larson ,2012).

There may be several reasons why some stakeholders are not convinced of the benefits of this technology and have not fully adopted it. These include Lack of technical

awareness. Some stakeholders may lack sufficient technical awareness to understand the benefits of smart technology in water quality monitoring and how to achieve cost savings. Comparison of costs with traditional methods, some stakeholders may think that smart technology costs more than they expect. Some see it as requiring a high cost in the initial investment. In fact, it saves more time and money in the long run. Confidence in traditional methods, some consider traditional methods of water quality checks to be familiar and habitual. Therefore, they prefer to continue using them instead of switching to new technology. and for sure training and maintenance costs, Smart technology in water quality monitoring can require intensive training and regular maintenance. It can increase the overall cost of the technique. Smart technology in water quality monitoring can face some legal barriers in some countries. This can lead to its not being fully adopted.

3. What is the impact of using ST on time consuming for decision maker?

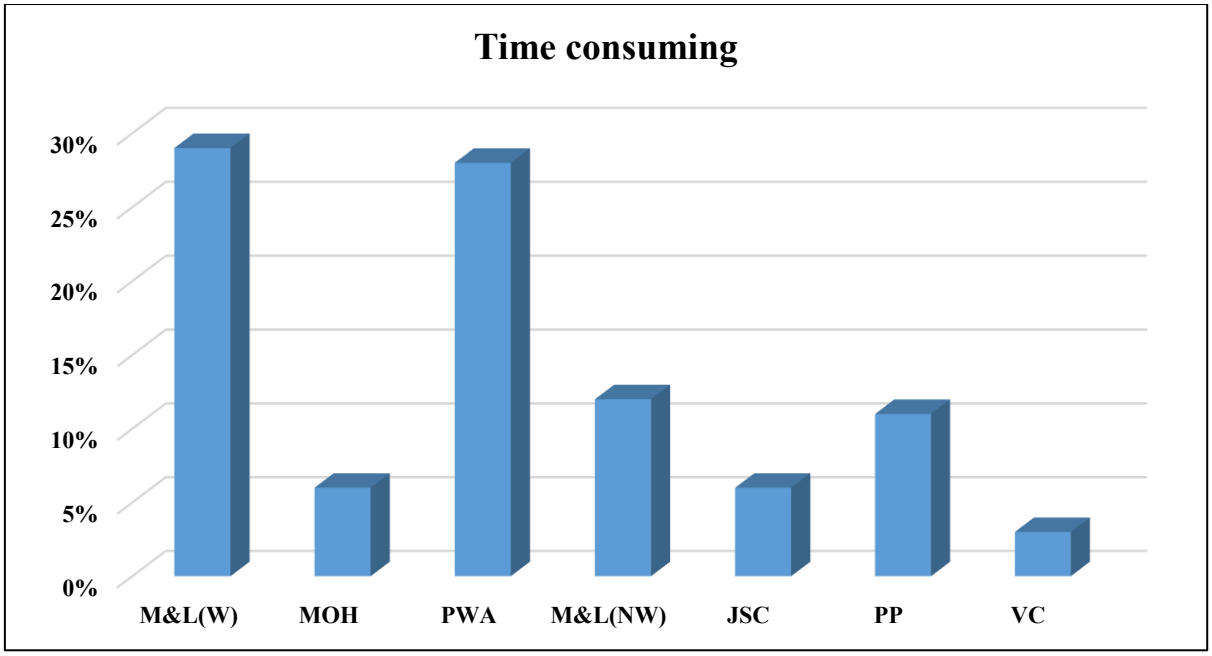

Figure 10: Result of impact for use ST on reduced time consuming for decision maker

The agreement of most stakeholders that the use of smart technology in water quality monitoring reduces the time taken for the decision-maker to solve the problem and act in

a timely manner reflects the importance of smart technology. The largest percentage of municipalities that have laboratories and carry out water testing and monitoring was 29%, followed by the PWA by a small margin of 28%. The countries that do not have an examination staff by 12%, followed by the previous pilot projects by 11%. The Ministry of Health's answers were somewhat approved, 6% at about the same as the village councils, even by a small percentage, believe in the importance of using smart technology in reducing the time it takes to find out the problem and reach the decision maker to solve it. The percentage was 3%, indicating the great importance of such a technique and its great impact on the sustainability of water quality monitoring. All suffer from the same reasons for the constant delay in responding to the problems, namely the sterile procedures that occur in the event of a problem or emergency. Bureaucratic matters and lack of coordination between the relevant sectors and other institutions is the main point.

In traditional methods, the process of water quality checks can take many days or even weeks to get a full response. In comparison, intelligent technology can analyze data and generate reports in a short time and even instantly. This enabling the decision-maker to act quickly to solve the problems related to water quality.

It is important to quickly solve problems to preserve the health and safety of the public. Water contamination with pathogenic substances can lead to negative health effects. Therefore, analyzing data and generating reports quickly and on time is very important for making the right decisions at the right time.

The use of intelligent technology in water quality monitoring can save a lot of time, effort, and resources, as the data can be analyzed more accurately and quickly. This can help save overall costs and improve productivity efficiency in laboratories.

In general, the use of smart technology in water quality monitoring can help improve work efficiency and increase productivity, reduce costs and human errors, improve data accuracy and quality, and enable the decision maker to act quickly and effectively to solve the water quality problems. This is consistent with the previous literature of the importance of using smart technology in the sustainability of water quality monitoring to reduce the time taken by decision-making to solve the problem. Water utilities can test the expected advantages of the AI strategies by setting out on less dangerous, small experimental programs that can likewise be utilized to evaluate their innovative capabilities and characterize a reasonable ICT guide. Huge information and AI calculations are promising devices for water utilities and ought to be directed in today's tasks of any government in any country. (Jenny, et al., 2020)

Water utilities, as profoundly specific associations, assemble information through measurements from their competitive surroundings and their clients to settle on essential decisions and convey a superior service. All things considered; a significant number of the current business instruments can be taken on in the water sector.

The advanced discipline of exploring the period of large information at the management level. Business intelligence apparatuses incorporate a blend of the accompanying provisions identified with information (Preciado, 2019).

4. What is the impact of use ST on improving the accuracy and efficiency of WQM?

It is noticeable in figure 11 the few percentages agree with the question of improving the efficiency and accuracy of the use of smart technology in monitoring water quality. Most of the answers where I do not know, and we have no idea. This is due to the lack of previous experiments using such a technique in the region. The percentages were as

follows: the highest percentage was taken by the water authority at 15%, followed by the previous pilot projects that were originally supported by the water authority at 11%, then municipalities with lower percentages, for example, municipalities that monitor water at 9%, followed by the Ministry of Health at 6%. The municipalities that have a laboratory and do not conduct testing were at 3%, and finally the Joint Services Council at 1.50%.

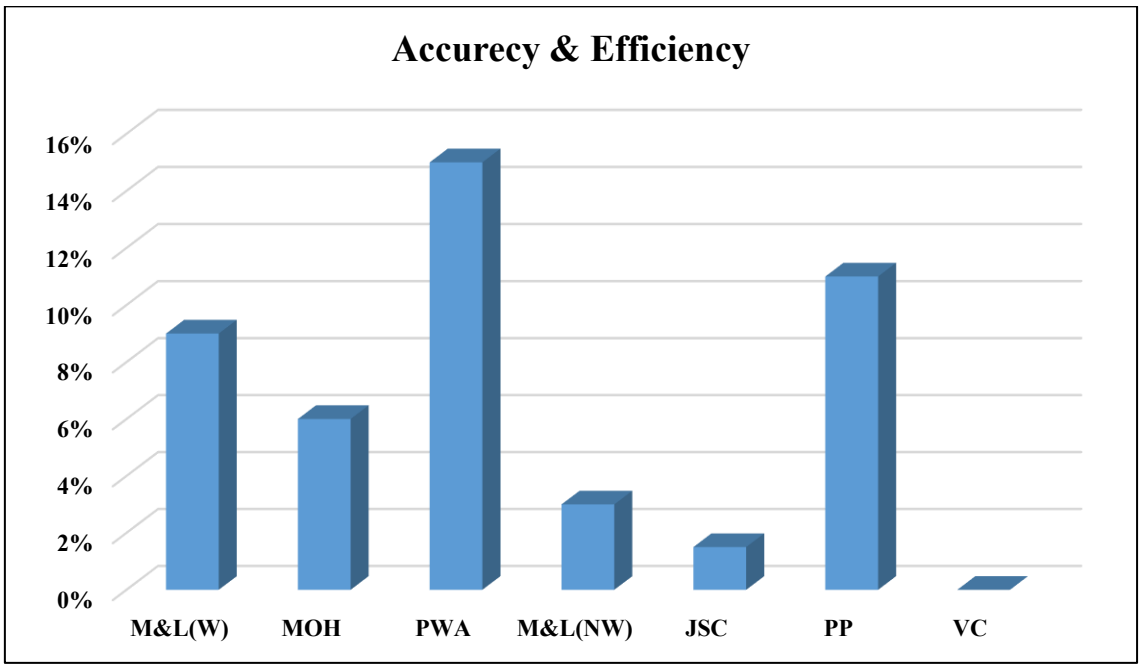

Figure 11: Result of impact for use ST improving the accuracy and efficiency

This contradicts the current literature on the impact of the accuracy and high efficiency of such a technology in the sustainability of water quality monitoring due to the large number of data, analysis, and evaluation of all these data, as well as in predicting for the future any problems that may occur. These results make water monitoring a major concern since it can be used to track how the quality of the water varies over time, spot problems as they develop, and create successful intervention plans to address water pollution. To ensure adequate treatment and deter contamination, it is crucial to have in-depth understanding of the quality of potable water.

Review WQM techniques, accordingly, comparing manual techniques that are more traditional with approaches that use more cutting-edge technology. This stressed the importance of accuracy and efficacy of data to predicting water quality and making it a useful tool for managing water resources. This is due to the reason the researcher mentioned earlier in the cost factor. That most people do not have technical awareness, the greatest confidence in traditional methods and their refusal to use smart technology. It is also because of the costs, smart technology in water quality monitoring can require additional costs in the initial investment and periodic maintenance. Some stakeholders may be unwilling to bear these additional costs, because they are concerned about privacy and security and are afraid of security breaches or data leaks.

5. What is the impact of previous experiences for use ST on WQM in Palestine?

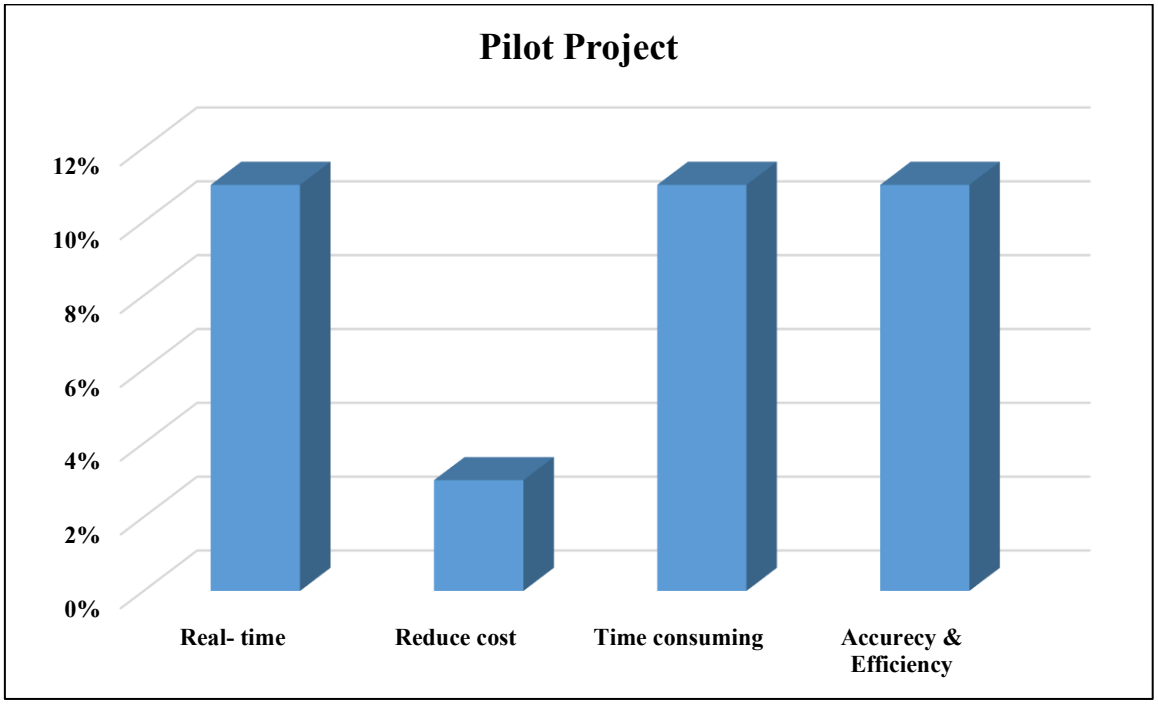

Figure 12: The impact of previous experiences for use ST on WQM in Palestine

In figure 12 the great impact of using smart technology to monitor water quality is answered by the previous pilot projects that used such technology. It has a greater impact

and almost the same degree on both giving real-time data in the event of a problem and reducing the time taken by making the appropriate decision to solve the problem. Improving the accuracy and efficiency of the data by giving much data can be studied and analyzed and predict some of the occurrence of problems.

It agrees that the impact of using smart technology on the sustainability of water quality monitoring has a positive impact, even if the number of such projects is limited and few. But at a low rate. This technology reduces costs in monitoring water quality. Most of them answered that the costs are the main reason for not completing the projects, as well as the lack of technical experts in this field. It is advisable to reconsider the choice of the type of technology to be used in monitoring water quality, which is the Internet of things. Most of the literature has agreed that it is inexpensive.

With reference to the first main question (What is the impact of ST on sustainability for WQM in Palestine?) the answer to the sub-questions, there is a strong impact of the importance of using smart technology on the sustainability of water quality in Palestine. The areas that support such technology, the most important of which is to reduce the time it takes to decide to solve the problem and know the problems in real time and improve the accuracy and effectiveness of data and finally reduce the cost.

Interview analysis using Nvivo application.

To support the researcher, Nvivo software was applied. Nvivo is a computer program to analyze the results of the interviews and produce results for the qualitative analysis through a clear methodology in analysis. The researcher found through the interviews that there is a clear effect of the real-time and time consuming for decision maker factor in the first place on the water quality monitoring. There remains an effect, but to a lesser extent,

for other factors such as the cost factor, and the accuracy and efficiency. The whole matter and all its axes show that there is a strong need to use smart technology to sustainably monitor water quality. There are factors as the research refuted all of them through the following analysis.

Figure (12) shows that appeared in each of the domains according to the interview that took place. For example, a group of vocabulary is repeated more than others. It is the one that appears in the distinctive color. With these vocabulary, Real-time data availability factor:

Files\\MandLW> - § 5 references coded [23.16% Coverage]

Reference 1 - 8.61% Coverage

Current problem with the Ministry of Health is the weak data received from various municipalities

Reference 2 - 14.55% Coverage

Not to mention the Ministry's focus on addressing the Corona epidemic in the past period, which led to the lack of modernization of laboratories with new technology

<Files\\PWA> - § 18 references coded [22.29% Coverage]

Reference 1 - 16.38% Coverage

Installed a sensor to monitor chlorine and calculate the quantities of water, in managing networks. Most are only concerned with quantities and not quality.

Reference 2 – 3.61% Coverage

Lack of awareness and awareness of the importance of these smart technologies

Reference 3 – 2.30% Coverage

Ein al-Sultan project in Jericho by operating it through the second-generation network at the time.

<Files\\MandL(NW)> - § 10 reference coded [11.30% Coverage]

Reference 1 – 4.19% Coverage

The municipality prefers to include modern technology that helps more in completing these operations immediately and then send it via a modern Internet or strong connections to Laboratories to see results and develop solutions as quickly as possible.

Reference 2 – 7.11% Coverage

It cooperates with laboratories from various Palestinian universities sometimes because of the relatively advanced technology in testing.

<Files\\MOH> - § 5 references coded [5.63% Coverage]

Reference 1 - 2.49% Coverage

The most important reason is the lack of awareness from the government of the role of technology in finding a solution to this problem.

Reference 2 - 2.40% Coverage

Centralization of a decision from the Ministry of Local Government to all municipalities of the country to adopt this technology.

Reference 3 - 0.74% Coverage

Efforts are combined to adopt technology.

<Files\\JSC> - § 4 references coded [13.85% Coverage]

Reference 1 - 3.34% Coverage

Who do not test water quality; we only rely on the results of the Ministry of Health.

Reference 2 - 4.47% Coverage

They had no idea about the subject or any previous experience with this technology.

Reference 3 - 6.04% Coverage

There are no support projects in the matter of providing the necessary maintenance or applying modern technology.

<Files\\Pilot project> - § 7 references coded [17.50% Coverage]

Reference 1 - 6.09% Coverage

Change is required so that the possibility of maintenance is only available within very precise limits and the existing technology is not updated. Currently, it is not under development.

Reference 2 - 3.67% Coverage

There are no support projects in the matter of providing the necessary maintenance or applying modern technology.

Reference 3 - 4.26% Coverage

Some municipalities pay attention to the issue of progress and technology.

Reference 4 – 2.22% Coverage

Their interest in reading the quantities of water and calculating the losses using technology.

Reference 5 – 1. 25% Coverage

The lack of a strong communications infrastructure.

Reduce the cost factor.

<Files\\MOH> - § 5 reference coded [9.23% Coverage]

Reference 1 - 9.23% Coverage

They only check the chemistry tests once a year and not periodically or monthly. This is because the tests are expensive.

Figure 13: Frequency of words that appeared in the interview about the use of smart technology in water quality monitoring.

<Files\\PWA > - § 2 reference coded [6.69% Coverage]

Reference 1 - 4.47% Coverage

He told me it was a possible cause of a shortage of money.

Reference 2 – 2.22% Coverage

The problem is that there is no maintenance available for these sensors.

<Files\\LandW Municipality> - § 2 references coded [11.48% Coverage]

Reference 1 - 5.22% Coverage

Lack of readiness of the rest of the municipalities in the other areas in the governorate in terms of testing them.

Reference 2 - 6.26% Coverage

The governorate in general suffers from a shortage of clean water sources, and consequently frequent interruptions in the service provided.

<Files\\LandNW Municipality> - § 4 references coded [4.25% Coverage]

Reference 1 - 0.82% Coverage

This is costly for us in terms of the water.

Reference 2 - 2.14% Coverage

Effort and costs Emptying the tank. This is added to the set of burdens that the municipality is already facing.

Reference 3 - 0.78% Coverage

The financial crisis is always the reason.

Reference 4 - 0.52% Coverage

We have no information or experience about whether such a technology will reduce costs.

<Files\\JSC> - § 3 references coded [18.71% Coverage]

Reference 1 - 6.63% Coverage

We resort to Al-Najah University to provide us with an examination service, but at a certain cost, which is relatively high.

Reference 2 - 5.28% Coverage

The event of water turbidity for a specific reason. This comes with a lot of time and cost.

Reference 3 - 6.79% Coverage

And will reduce the costs of tests because they deal with the university in doing the full tests.

<Files\\VC> - § 1 references coded [6.03% Coverage]

Reference 1 – 6.03% Coverage

We resort to the Palestinian universities so that they provide us with the tests service, at a certain cost.

<Files\\Pilot project> - § 3 references coded [17.80% Coverage]

Reference 1 - 7.85% Coverage

It is very expensive and expensive for the PWA, as it is from more than one governorate and in more than one source.

Reference 2 - 1.44% Coverage

As well as poor funding

Reference 3 - 8.51% Coverage

Anabta project, which was linked to satellite and was expensive and did not complete the project because it needed an annual subscription.

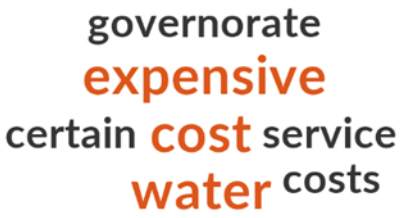

Figure 14: Frequency of words that appeared in the interview about reducing the cost.

Time consuming

Files\\MOH> - § 1 reference coded [11.98% Coverage]

Reference 1 - 11.98% Coverage

They also take the cost and time of each examination they carry out, which comes to them from municipalities or from individual sources.

<Files\\PWA> - § 2 references coded [14.34% Coverage]

Reference 1 - 4.76% Coverage

It puts more pressure on the municipal laboratories and the laboratories of the Ministry of Health.

Reference 2 - 9.57% Coverage

If we do not have sensors to check quality now, samples are taken for examination to the laboratory. This sometimes causes disruption of the water supply until the results of the examination appear.

<Files\\LandNW Municipality> - § 3 references coded [7.69% Coverage]

Reference 1 - 5.65% Coverage

The fact that it takes time and requires a higher effort, as it is not without bureaucracy and needs to be fanned by administrative infiltration. The terms of communication outside the municipality, which is a stressful and time-consuming matter that will not be in the interest of serving the citizen.

Reference 2 - 0.76% Coverage

The water that we lose and the time.

Reference 3 - 1.28% Coverage

We stop the flow of water into the tank until the problem is resolved.

<Files\\LandW Municipality> - § 3 references coded [21.99% Coverage]

Reference 1 - 7.06% Coverage

Other examinations, which are very urgently needed at certain times of the year, or during the spread of some diseases in the water.

Reference 2 - 5.28% Coverage

The event of water turbidity for a specific reason, and this comes with a lot of time and cost.

Reference 3 - 9.65% Coverage

This problem needs to be made urgent tests and cannot wait, as the passage of more time is not in our favor because of the damage to cutting the water source Until we do what we need.

<Files\\JSC> - § 4 references coded [10.45% Coverage]

Reference 1 - 2.39% Coverage

The most important of which are the time spent in the water quality testing process.

Reference 2 - 3.11% Coverage

If the water is polluted for a certain reason, it takes a lot of time to make the right decision.

Reference 3 - 1.54% Coverage

This problem needs urgent tests and cannot wait due to a lack of water.

Reference 4 - 3.41% Coverage

More time is not in our favor because of the damage to cutting the water source until we do what we need.

Figure 15: Frequency of words that appeared in the interview about time consuming.

Accuracy and efficiency

<Files\\MOH > - § 1 reference coded [10.53% Coverage]

Reference 1 - 10.53% Coverage

There is also a shortage of trained staff because there are not enough staff for all control operations. There is great work pressure on the currently available staff.

<Files\\LandW Municipality> - § 1 reference coded [6.36% Coverage]

Reference 1 - 6.36% Coverage

There is also no clear reference, which is supposed to follow up and work-related projects.

<Files\\Pilot project> - § 1 reference coded [3.41% Coverage]

Reference 1 - 3.41% Coverage

They also have previous project experience, which is to install sensors to read water parameters.

<Files\\PWA> - § 1 reference coded [12.34% Coverage]

Reference 1 - 12.34% Coverage

To train university students and benefit from cooperation so that the university obtains training for students and from our side we get the desired results and to use large data in the research.

Figure 16: Frequency of words that appeared in the interview about accuracy and efficiency.

The Second main question: What are the expected difficulties in the application of use ST on WQM?

Through the interviews conducted by the researcher with the persons specialized in the fields, most agreed that there are three main obstacles to the use and adoption of smart technology to maintain the sustainability of water quality monitoring in Palestine, which are presented in the following figure:

It turned out regarding the second question about the obstacles that the PA may face in the use of smart technology. It was revealed through interviews about three main

obstacles that were repeated in the interviews, namely the political and economic problems in Palestine, the highest percentage was 95%, followed by the lack of funding from donors to governments and municipalities, at 92%, as indicated by the lack of technical experts in this field. The largest percentage was the follow-up and maintenance of smart technology in monitoring water quality in Palestine.

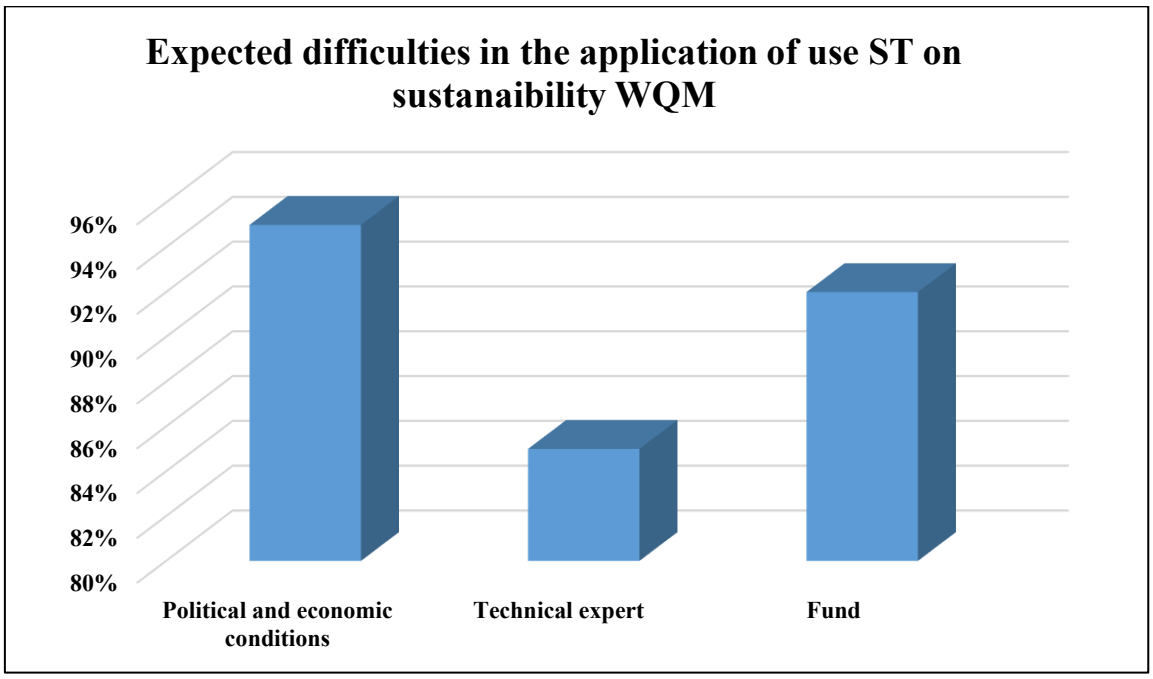

Figure 17: Expected difficulties in the application of use ST on WQM?

The above results show a higher impact of smart technology on the time consumed by decision makers to act at the time of problems and reduce the bureaucracy involved and also in providing real-time data in the sustainability of water quality monitoring in Palestine compared to its impact on other fields (accuracy and effectiveness, reducing cost in

Water quality monitoring, pilot projects that were using such technologies). Projection that knowledge of the importance of using smart technology needs accumulated time and effort more than the time needed to make a change. The existence of political and economic obstacles, confirm the need to develop a solution for the sustainability of water

quality monitoring in Palestine, especially in the knowledge of reducing costs and giving more accurate and effective data.

The researcher stresses that the method of monitoring water quality in Palestine to maintain sustainability must change in the first place. The more we provide real-time data and reduce the time taken to act in the event of problems such as pollution, the better recognition of maintaining sustainability for water quality and predicting future problems due to the presence of larger and real-time data. Palestine will be able to bring about the needed change in the way water quality is monitored to maintain sustainability using smart technology.

To answer this question, we need to test the hypothesis:

Hypothesis 1

There is no positive relationship between the use of ST for WQM in Palestine and giving real-time data.

According to the results of the research, it can be said that there is a positive relationship between the use of smart technology in monitoring water quality in Palestine and giving real-time data. The use of smart technology helps to improve the accuracy and effectiveness of data collection and analysis in real time.

Hypothesis 2

There is a direct relationship between the use of ST for WQM in Palestine and reducing the cost.

According to the results of the research, it can be argued that there is no direct relationship between the use of smart technology in water quality monitoring in Palestine and cost reduction, but it can contribute to improving efficiency and reducing costs in the long run.

Hypothesis 3

There is no relationship between the use of ST for WQM in Palestine and reduce in the time consuming for decision maker.

According to the results of the research, it can be argued that the use of smart technology in monitoring water quality in Palestine can lead to a reduction in the time it takes for a decision maker to make the appropriate decision. Immediately and accurately available information can help in making the right decisions about water management.

Hypothesis 4

There is positive relationship between the use of ST for WQM in Palestine and improving the accuracy and efficiency.

It is expected that the use of smart technology in water quality monitoring in Palestine will improve the accuracy and efficiency of the data and make it more accurate and reliable. According to the research results, it was found that there is a weak relationship between the use of smart technology in water monitoring and improving the accuracy and efficiency of the data. This is because there is no application of such technology to prove it in Palestine and compare it with traditional methods, especially in the absence of an effective infrastructure to support this type of technology.

Chapter Five

Conclusions and Recommendations

Chapter Five: Conclusions and Recommendations

5.1 Discussion of the Results

Considering the analysis of the achieved results, it was found that the use of smart technology has a significant impact on the sustainability of water quality monitoring in Palestine.

Smart technology includes various sensors, data analytics and communication technologies that allow monitoring water quality in real time. Water quality standards. This can be used to identify potential pollution events and take quick action to prevent further pollution. Moreover, the ability to monitor water quality in real time can improve the accuracy of water quality data, leading to more informed decision-making and better resource management.

The study concluded that the factor of providing real-time data on water quality, and the factor of reducing the amount of time it takes to respond to pollution incidents, has a significant impact on the fact that smart technology helps to improve water resources management, by providing accurate and timely information about water quality, managers have to make informed decisions about the allocation, treatment, and distribution of water. This can lead to more efficient use of Water Resources and reduce waste. While the factor of reducing the cost of using smart technology and accuracy and efficiency has had a negative impact on beneficiaries and stakeholders.

This is due to some stakeholders may lack sufficient technical awareness to understand the benefits of smart technology in water quality monitoring and how to achieve cost savings. They believe that smart technology costs more than they expect compared to traditional methods, as some believe that it requires a high cost in the

initial investment, and that traditional methods of checking water quality are familiar and usual, so they prefer to continue using them instead of switching to new technology.

There are also challenges associated with using smart technology to monitor water quality. One of the main challenges is the cost of implementing and maintaining this technology. Another challenge is the need for skilled personnel to operate and maintain the technology.

Intelligent water monitoring systems require trained personnel who can interpret data, troubleshoot problems, and maintain equipment. This is a challenge, in Palestine, which suffers from unstable political and economic conditions and limited resources.

In conclusion, the impact of smart technology on the sustainability of water quality monitoring is significant, with potential benefits for both the environment and public health. However, there are also challenges associated with the implementation and maintenance of this technology that must be addressed. In general, smart technology has the potential to revolutionize the way water quality is monitored and managed, leading to more efficient and effective management of Water Resources.

5.2 Recommendations

1. Focus on awareness and education about the benefits of smart technology in water quality monitoring, and how it can improve the accuracy and efficiency of data.
2. Clarify that smart technology can increase the accuracy and efficiency of data collection and analysis of data related to water quality and improve the quality of the results obtained.

3. Clarify that investing in smart technology may lead to saving additional costs in the long run, improving work efficiency and quality of results.
4. Develop legal regulations and legislation on the safe and responsible use of smart technology in water quality monitoring and ensure the protection of privacy and data security related to water and the environment.
5. Improve cooperation and coordination between the different institutions responsible for monitoring water quality, so as to achieve better water sustainability and quality.
6. Companies and organizations working in this field should clarify the benefits of investing in smart technology, provide technical support and the necessary training for users and workers in this field.
7. Encourage local and international cooperation and partnerships to exchange knowledge, experiences and technologies related to water quality monitoring.
8. Analysis of the cost of investing in smart water quality monitoring technology: analytical studies can be conducted to assess the real cost of switching to the use of smart water quality monitoring technology and estimate the resources required to apply this technology sustainably in the state of Palestine.
9. Improving security and Privacy: conducting research to improve security and privacy in the use of smart water quality monitoring technology, including the development of strong protection and encryption programs, and improving privacy policies.
10. Conduct research to analyze the big data collected from the use of smart technology to monitor water quality and extract useful patterns and formulas to improve water quality.
11. Improve efficiency and sustainability: conduct research to improve the efficiency of the use of smart technology for water quality monitoring, including the development

of hardware and software, improve maintenance and modernization processes, and improve the environmental sustainability of monitoring processes.

12. Take advantage of innovative technologies: research can be conducted to take advantage of innovative technologies, Internet of things (IoT), to improve water quality monitoring and increase the effectiveness and sustainability of the processes used in this field.

5.3 Obstacles and Challenges

The researcher faced several obstacles of challenges while collecting the data, these are:

1. The researcher was unable to reach all service providers because they do not have data, water quality is not monitored, and they depend on the Ministry of Health.
2. Lack of access due to the political situation and check points.
3. Some of them did not pay attention to the issue of smart technology, so the researcher could not take the data due to its lack of availability and lack of interest in it.

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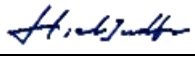
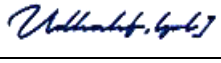
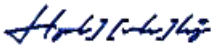
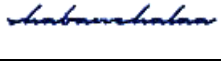
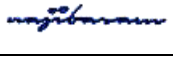
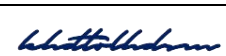
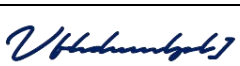
Appendices

Appendix (A)

Municipalities that have laboratories and approved data	Position	Interviewee	Signature
Jericho municipality	مسؤول جودة المياه	صبحي ياغي	
	مدير دائرة المياه والصرف الصحي	محمد امين الفتياني	
Authority WSSA Bethlehem	مسؤول قسم المياه	جورج ابراهيم	
	محاسب	اكثم دعيبيس	
Jerusalem Water Undertaking	مدير دائرة المياه	محمد ابو عياش	
	مسؤول قسم المياه	يحيى زهدي	
	مدير IT	احمد جرادات	
Jenin municipality	مدير دائرة المياه	عبد الهادي حج	
	فني مختبر	ريما الاحمد	
Hebron municipality	مدير دائرة جودة المياه	عادل سلايمة	
	محاسب	علاء شبانة	
Tulkarm municipality	مدير دائرة المياه	بسام ناجي	
	مدير دائرة الصحة	اسامة شيخ ناصر	
Salfit municipality	مدير دائرة الصحة والبيئة	اشرف زهد	
	رئيس قسم نظم المعلومات	فراس	
Nablus municipality	مسؤول جودة المياه	علي قرقش	

	مهندسة اسكادا	ايمان محسن	
Qalqiliya municipality	رئيس قسم المياه	اشرف ابو دية	
	مدير جودة المياه	خالد شلبي	

Municipalities that have laboratories but	Position	Interviewee	Signature
Dura municipality	رئيس قسم المياه والتخطيط	عبد الرحمن شرحة	
Allar municipality	رئيسة شعبة المياه	منال قشوع	
Qabatiya municipality	رئيس قسم المياه	صالح ابو عساف	
Beit Ummar municipality	مدير الصندوق	تيسير فهمي	
Baqa al-Sharqiya municipality	محاسب	احمد شرشير	
Surif municipality	علاقات عامة	اماني الحيح	
Bala municipality	محاسب	علي ابو يونس	
Yabad municipality	مدير دائرة IT	رامي حمارشة	
Tubas Joint Service Council	رئيس المجلس	عيسى ضبابات	
	فني مختبر	رشا بشارات	

Joint Services Council	Position	Interviewee	Signature
West Jenin Joint Service Council	رئيس المجلس	نايف خمايسة	
	مسؤول قسم المياه	حسني ربايعة	
Meithalun JSC	رئيس المجلس	محمود ربايعة	
Southeast Nablus JSC	مدير دائرة IT	مهندس رضوان ملحس	

VC and Association	Position	Interviewee	Signature
Azmut VC	محاسبة	اسماء علاونه	
Bartaa Sharqiya water Association	مسؤول قسم المياه	احمد هاني	

Appendix (B)

الجامعة العربية الأمريكية
ARAB AMERICAN UNIVERSITY
FACULTY OFGRADUATE STUDIES

السيدات/ السادة المحترمون

تجري الباحثة دراسة بعنوان:

تأثير التكنولوجيا الذكية على مراقبة استدامة جودة المياه في فلسطين

حيث تهدف هذه الدراسة الى فحص تأثير استخدام التكنولوجيا الذكية على استدامة مراقبة جودة المياه في فلسطين في المجالات التالية: التزود بالوقت الحقيقي للبيانات، وتقليل استغراق الوقت لصانع القرار باتخاذ القرار المناسب، وتقليل التكلفة، وايضا تحسين الدقة والكفاءة للبيانات. ومعرفة الصعوبات المتوقعة من تطبيق مثل هذه التكنولوجيا في فلسطين.

وتأتي هذ الدراسة استكمالاً لمتطلبات الحصول على درجة الماجستير في برنامج (التخطيط الاستراتيجي وتجنيد الاموال) من الجامعة العربية الأمريكية.

ومن أجل تحقيق هذه الغاية، أرجو مساعدتكم في توفير إجابات صادقة، دقيقة، وموضوعية على الأسئلة الواردة في هذه المقابلة والتي تعتمد على خبرتكم.

مع التأكيد على أنه سيتم التعامل مع جميع البيانات بسرية تامة ولن يتم استخدامها الا لأغراض البحث العلمي. اذا كان لديكم أي استفسار، يمكنكم مراسلتي على البريد الإلكتروني المرفق

البريد الالكتروني: rasha.salfiti@student.aaup.edu

الطالبة: رشا سلفيتي

الجامعة العربية الأمريكية

كلية الدراسات العليا

تأثير التكنولوجيا الذكية على مراقبة استدامة جودة المياه في فلسطين

إعداد

رشا سلفيتي

إشراف

د. اياد يعقوب

مشرف مساعد

د. عبد الرحمن التميمي

قدمت هذه الأطروحة استكمالاً لمتطلبات الحصول على درجة الماجستير في برنامج التخطيط الاستراتيجي وتجنيد الاموال بكلية الدراسات العليا في الجامعة العربية الأمريكية- رام الله – فلسطين- 2023

الاسئلة الموجهة للخبراء

1. **هل هناك تأثير لاستخدام التكنولوجيا الذكية على استدامة مراقبة نوعية المياه؟ اذا كان نعم كيف؟**
2. **هل يوجد قيمة مضافة لاستخدام التكنولوجيا الذكية على استدامة مراقبة نوعية المياه**
   - الوقت الحقيقي لاعطاء البيانات
   - تقليل الوقت المستغرق لصانعي القرار
   - تحسين الدقة والكفاءة للبيانات
   - تقليل التكلفة
3. **ما هي الصعوبات المتوقعة في تطبيق التكنولوجيا الذكية في مراقبة نوعية المياه؟**
4. **هل تعتقد انه في الظروف الفلسطينية (السياسية والاقتصادية) سيكون استخدام التكنولوجيا هو الافضل؟**

5. **ما هي المتطلبات الفنية لتطبيق استخدام التكنولوجيا في استدامة مراقبة نوعية المياه؟**
6. **ما هي المتطلبات البشرية لتطبيق استخدام التكنولوجيا في استدامة مراقبة نوعية المياه.**
7. **ما هي المتطلبات المؤسساتية لتطبيق استخدام التكنولوجيا في ادارة نوعية المياه.**
8. **هل سيساهم استخدام التكنولوجيا في تحسين اليات صنع القرار: كيف؟**
9. **هل سيكون لاستخدام التكنولوجيا الذكية في استدامة مراقبة نوعية المياه تأثير على البحث العلمي، كيف؟**
10. **كيف يكن الاستفادة من التكنولوجيا في جعل المعلومات متاحة**

- مع الجمهور
- للباحثين
- لدوائر صنع القرار
- للاقسام والوزارات

الملخص

تهدف هذه الدراسة إلى إظهار تأثير استخدام التكنولوجيا الذكية على استدامة مراقبة نوعية المياه في فلسطين، وتغطي بذلك المجالات الخمسة الرئيسية المحددة في هذه الدراسة وهي: توفير البيانات في الوقت الحقيقي، خفض التكلفة، تقليل الوقت المستغرق لصانع القرار، وتحسين الدقة والكفاءة. تهدف الرسالة كذلك الى التعرف على المشاريع التجريبية السابقة التي استخدمت مثل هذه التقنيات. ولتحقيق هذا الغرض، اعتمدت الدراسة طريقة تحليلية نوعية ووصفية لدراسة درجة تأثير فوائد استخدام التكنولوجيا الذكية لمراقبة جودة المياه على المستفيدين المباشرين منها: القطاع الحكومي ممثلتان بوزارة الصحة الفلسطينية، وسلطة المياه الفلسطينية، والمؤسسات شبه الحكومية الممثلة ب 21 مؤسسة شبه حكومية أو مقدمي الخدمات (البلديات، مجالس الخدمات المشتركة، المجالس والجمعيات القروية). ويصل عدد المستفيدين من هذه المؤسسات الى 1,475,152 مستفيد يشكلون حجم عينة السكان في هذه الدراسة، أي ما يعادل 46.24% من سكان الضفة الغربية. من بين هؤلاء، تم اختيار 55 عينة تمثيلية. وتم جمع البيانات من خلال مقابلات منظمة وخضعت لأساليب تحليلية من خلال فهم وتفسير تجارب وآراء وخبرات ومعتقدات المشاركين، وكذلك مقارنة آرائهم بالدراسات الأدبية.

خلصت الدراسة إلى مجموعة من النتائج أهمها: على الرغم من وجود درجة عالية من التأثير الإيجابي لاستخدام التكنولوجيا الذكية على استدامة مراقبة جودة المياه في فلسطين، لا سيما من حيث توفير البيانات في الوقت الحقيقي، وتقليل الوقت الذي يستغرقه صناع القرار في اتخاذ القرار المناسب. ومع ذلك، فإن خفض التكاليف وتحسين الدقة والكفاءة لم يكن لهما تأثير إيجابي كبير. وعلى العكس من ذلك، اعتبر إدخال مثل هذه التقنيات مكلفا للغاية، بسبب نقص الفنيين المتخصصين للتعامل مع هذه التكنولوجيا وزيادة موثوقية طرق التحليل التقليدية لإعطاء نتائج أكثر دقة وبسبب ندرة التطبيقات لهذه التكنولوجيا التي تحقق هذه الأهداف.

قدمت الدراسة مجموعة من التوصيات أهمها: توضيح أن الاستثمار في التكنولوجيا الذكية قد يؤدي إلى وفرة إضافية في التكاليف على المدى الطويل، وضرورة وضع اللوائح والتشريعات القانونية بشأن الاستخدام الآمن والمسؤول للتكنولوجيا الذكية في مراقبة جودة المياه، وضمان حماية الخصوصية وأمن البيانات المتعلقة بالمياه والبيئة. يجب على الشركات والمؤسسات العاملة في هذا المجال توضيح فوائد الاستثمار في التكنولوجيا الذكية وتقديم الدعم الفني والتدريب اللازم

للمستخدمين والعاملين في هذا المجال. وكذلك تشجيع التعاون والشراكات المحلية والدولية لتبادل المعارف والخبرات والتكنولوجيا المتعلقة برصد نوعية المياه.