CHAPTER 1
INTRODUCTION

1.1. Background

In Indonesia, using a manual system for recording water meter causes a lot of customer losses due to inaccurate readings of water meters and miscalculated volumes [1]. This problem is made worse by limited access to the source of water meter, for instance, when no one is at home or the meter is behind a locked fence, which prevents officers from taking direct readings and leads to many complaints from customers about unusually high water bills [2] [3]. Advancements in technology have enabled the creation of a system that can automatically control water meter readings by using the Internet of Things. The Internet of Things is a global infrastructure that connects physical and virtual objects by utilizing the existing information and enabling advanced services. This infrastructure is supported by the IMT-2020 program [4] [5].

The development plan map of *Sistem Pemerintahan Berbasis Elektronik (SPBE)*, also known as e-Government, for 2021-2025 includes an implementation of the Smart City program [6] [7]. The concept of Smart City results from the integration of information systems and the Internet of Things (IoT). Smart City provides real-time information and interactive platforms to manage cities with more effectiveness and efficiency than traditional methods [8]. The Smart City development strategy included Smart Governance, Smart Branding, Smart Economy, Smart Living, Smart Society and Smart Environment, which is a parameter for natural resource management [9]. Among the physical infrastructure, the water supply network is a crucial component and efficient management poses the most significant challenge for Smart City [8]. Smart Water Meter is the proposed solution, which is increasingly being adopted globally for water management. One advantage of using the Smart Water Meter is that it enables remote use, eliminating the need for officers to go to the location directly [10].

Shih-Chang Hsia, Szu-Hong Wang, and Shu-Wei Hsu conducted previous research titled “Smart Water-Meter Wireless Transmission System for Smart Cities”, which proposed a data transmission and correction design using water management software. The proposal involved building a smart control system with the development of water leak detection through a separate water meter. The smart sensing meter achieves a measurement accuracy of 97%. The system can accurately monitor water flow and detect water leaks. The conclusion of this research is that the measurement of water meters can be done by replacing water meters with a new smart control system and assisted by a leakage monitoring system. [11].

In their research titled “Light-Weight Spliced Convolution Network-Based Automatic Water Meter Reading in Smart City”, Chunshan Li, Yukun Su, Rui Yuan, Dianhui Chu, and Jinhui Zhu proposed a light-weight spliced convolution network that can simplify the number of convolutions required to recognize meter numbers. The experimental results demonstrate that the proposed network can precisely identify water meter numbers and require fewer parameters and calculations. The conclusion of this research is that image processing can be used in reading water meters with fewer parameters using a light weight spliced convolutional network. [12].

In the research entitled "Design and Implementation of a Self-Powered Smart Water Meter" by Xue Jun Li and Peter Han Joo Chong studied the design principles of existing water meters, and then presented the design and implementation of a self-powered smart water meter. The proposed water meter is based on a water turbine generator, which has the dual purpose of sensing water flow through adaptive signal processing performed on the voltage generated and generating electricity to charge the battery for the smart meter to function properly. Realtime data transmission is sent using bluetooth and also mobile phone application support is designed to provide a convenient tool for users to monitor water usage. The conclusion of this research is the use of a generator can be a self-powered smart water meter and monitoring can be done in realtime using the application [8].

Then the research by Bayu Saputra, Slamet Winardi and Aryo Nugroho with the title “Rancang Bangun Alat Meteran Air Pintar Berbasis IoT sebagai Penunjang Layanan Distribusi PDAM”, applied the concept of Internet of Things (IoT) in automatic checking of postpaid and prepaid meter devices in households by using ESP32 modules with water flow meters and water valves to send the remaining water consumption data to the server (cloud). The accuracy of the test results has an error tolerance value of 10.6%, in the test results with units of mL. The conclusion of this research is that the use of ESP32 with water flow and water valve can be used as a tool to record water usage [13].

In the research conducted by Achmad Sutanto, Very Kurnia Bakti, Lukmanul Khakim, Ragil Satria Ideantoro and Agung Maulana, with the title "Sistem Monitoring Meteran Air Cerdas pada PDAM Berbasis Internet of Things", made a smart water meter monitoring system at IoT-based PDAM by integrating with NodeMCU ESP8266 as a microcontroller, waterflow sensor device as a measurement of flowing water discharge and battery as a source of electrical power. The waterflow sensor is able to detect water discharge with a difference of 0.36 liters and 95.7% accuracy. Water usage data can be sent to the database and can be monitored via the website in real time. The conclusion of this research is that the microcontroller can be used for water meter reading by sending data to the database in real time [14].

Based on the background and previous research, the development of Smart Water Meter system using ESP32-CAM microcontroller can be proposed. The use of the ESP32-CAM microcontroller was chosen because it can send data to the server. The size of the device designed must be compact considering the location of the water meter is quite limited, so the ESP32-CAM is suitable because it is small and does not take up much space. In addition, in order to avoid difficulties in implementation, the device is designed to be placed above the water meter, without having to replace the water meter. The supporting components on the ESP32-CAM used are the SD card module, camera module and usb module which are protected by a casing and stand. In this research, there is also a business transformation, which initially a traditional business becomes digital, including the role of water meter readers, data data, admin approval and payment counters will be replaced by Smart Water Meter devices, admin approval and websites. The systematic performance of the device is that the device will send images to Firebase Storage then the images will be processed using Google Vision. The results of image processing can be seen through the web and payments can be made immediately. With this technology, customers need less time and money to manage water bills, besides that this technology can also help customers to monitor water usage and can prevent water leaks. In addition, there is also an implementation system that can be developed in this Smart Water Meter, which can be through rental cooperation from a development company with a water company.

1.2. Problem Identification

The problem identification in this thesis includes:

1. Errors in reading and data collection of water meters using traditional methods cause bill spikes and incur cost losses for customers.
2. Limited access to the source of the water meter prevents officers from taking direct readings.
3. The need for devices that can support Smart Environtment in Smart City to manage water resources.
4. How to implement a Smart Water Meter device by considering effectiveness in cost and time.

1.3. Objective

The purpose of this final project is the development of a compact and inexpensive Smart Water Meter to support the transformation of traditional businesses into digital businesses by reading water meters automatically and scheduled to avoid difficulties in reading water meters, bill spikes, monitoring water usage and water leaks. The solution

for limited land and avoiding difficulties in implementation, water meter reading uses an ESP32-CAM microcontroller device that is placed on top of the water meter without replacing the existing meter making it easier for water companies to obtain meter data, image processing using OCR is also carried out so that there are no reading errors and there is no need for manual input and is supported by a web application to view reading and billing results and customers can make direct payments so that customers will save time and money.

1.4. Scope of Work

The scope of work of this thesis is as follows :

1. Research focuses on the development of Compact Smart Water Meter using Image Processing with Web Development.
2. Image Processing method is Optical Character Recognition from Google Vision.
3. Database using Firestore Database from Firebase.
4. Cloud Storage using Storage from Firebase.
5. Authentication using Authentication from Firebase.
6. Web Development using React, Node JS and API.
7. Case and holder design using software and printing using third party facilities.
8. Not focused on system security.
9. The specifications for the Smart Water Meter device are as follows:
    a. Microcontroller (MCU) ESP32 Cam, Wifi+Bluetooth 4.0 32 bit,
    b. USB Connector CP2102, USB to TTL serial converter module,
    c. Camera Module OV2640 2 MP,
    d. Secure Digital (SD) card module,
    e. SD Card 32 GB,
    f. Case,
    g. Holder.
10. The parameter to be analyzed is:
    a. Image Processing Result Error $\leq 10\%$ and Accuracy $\geq$ 97%,
    b. Data Transfer Cost,
    c. Power Requirements.

1.5. Research Methodology

The research methodology adopted in this thesis is divided into various stages, including:

1. Literature Study

The purpose of conducting a literature study is to gain a better understanding of the concepts and theories that are essential for developing IoT-based Smart Water Meters. This process involves collecting various references and literature to address issues related to analog water meters. Furthermore, this stage encompasses an exploration of the work process of the ESP32 microcontroller, the mechanism of image processing using Optical Character Recognition, website development and the process of implementing Smart City technologies.

2. Design

In this project, we will design an IoT-based Smart Water Meter, including all of the necessary components and software. To accomplish this, we will determine the scheme, system design and device design. In addition, we will use software to create a predetermined shape prior to beginning the design process. After designing, the Smart Water Meter will be assembled and installed.

3. Implementation

Implement the Smart Water Meter to the water meter by placing the device above the water meter. Communication system configuration is also carried out so that the device can read and send the required data. In this implementation stage, web server and web application development is also carried out.

4. Analysis

The simulation results of the working parameters of the Smart Water Meter deployment are compared with the parameters determined before.

5. Reports

The results of the previous stages will be compiled into a thesis report, followed by the drafting of conclusive remarks related to the research.

1.6. Hypotesis

Based on previous research, there is a proposal to design a separate water meter by replacing the existing meter. In order to make it easier for customers to install the device and not incur large costs, a device is needed that can be placed above to the water meter without having to replace the existing water meter. The size of the device designed must be compact considering the location of the water meter is quite limited, it make the ESP32-CAM is suitable to used because it is small and does not take up much space. This research focuses on developing a compact Smart Water Meter using the ESP32-CAM microcontroller and image processing to support the transformation of traditional businesses into digital businesses. The device will send images to Firebase, then the images will be processed using Google Vision. It is expected that the error results of the image processing less than 10% and accuracy more than 97%, result can be seen through

the web and direct payment can be made. The implementation of the Smart Water Meter will be through lease cooperation from the development company with the water company.

1.7. Stucture of Thesis

The structure of thesis is as follows:

CHAPTER 2 SMART WATER METERS

This chapter contains the basic concepts and theories related to the research of this thesis such as internet of things, microcontroller and image processing.

CHAPTER 3 SMART WATER METER SYSTEM DEVELOPMENT

This chapter discusses the research flow diagram, specification, design and implementation of Smart Water Meter.

CHAPTER 4 RESULT AND ANALYSIS

This chapter contains the test results and analysis of the test results obtained.

CHAPTER 5 ANALYSIS OF SYSTEM IMPLEMENTATION

This chapter contains the test results and analysis of the test results obtained.

CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

This chapter contains the conclusions and suggestions of this thesis research.