Big Data and Internet of Things Web Service Management to Support Salt Agriculture Automation

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***Abstract*—The integration of the internet of things in the information system application service web platform implemented in the supply chain has given rise to new formats and models, which are important manifestations of industry transformation and improvement. In the context of implementing long-term rural development plans, deep integration of the application of information technology and rural revitalization will act as a trigger that drives productivity and the development of other village business industries. The purpose of this research is to build a web service management model that can be used to manage and help optimize IoT-based salt farming production. The model built consists of software and hardware architectures and interconnections between tools. This research is divided into three stages: the first stage is to identify the data sources needed for big data needs, the second stage is to build a big data microservices model and the IoT model, the third stage is to integrate IoT data with the big data microservices model that has been built. The results of this study are in the form of an IoT device that can be run with big data micro services. The resulting IoT device can be used to automate water distribution based on the salinity value measured using a sensor.**

***Keywords*—Web service; big data; salt; IoT**

I. Introduction

Big data and the Internet of things (IoT) are part of the components of the Industrial Revolution 4.0. Growing rapidly and affecting all fields, including business, technology, health, education, agriculture and increasing benefits for many other fields. IoT is contributing to the growth of large amounts of data, and high speeds, which are characteristics of big data, as described by Gartner.

Indonesia is a country that has more ocean area, so of course it is a country that can produce its own salt and even export it to other countries. In fact, Indonesia has succeeded in producing abundant salt in 2012-2015, with a surplus of up to 2.9 million tons. However, the problem occurred in early 2017 that domestic salt production decreased, so we had to rely on imports for industrial salt needs [1].

Salt is a food ingredient that is consumed by all groups which is obtained through the process of crystallization of seawater or brine from sea salt or by the mining process of rock salt [2]. The influencing factor is that salt production in Indonesia has decreased because it still uses traditional salt processing methods such as dependence on sunlight and less use of the latest technology.

The Internet of Things (IoT) describes the ubiquitous connection between common objects and the Internet. IoT works by deploying thousands of smart devices in a living or industrial environment. This device collects information from the surrounding environment, performs desired processing activities on the data obtained and transmits the processed data via a secure and reliable communication channel. Recent advances in software, hardware and communication systems have significantly improved human lifestyles in terms of time, energy and cost savings [3, 4].

Digital farming is one of the key technologies that has gained support through different research initiatives in the last decade. A fundamental digital farm setup consists of a central management platform, a human-computer interface and a dedicated IoT module, which monitors the animals, their behavior and facilities [5]. All of these building blocks are connected into a common platform, using a communications network that, today, is often based on an IoT architecture combined with cloud- or edge-based functionality. A smart atmosphere is, in the digital farming scenario, a more sophisticated concept, which enables information processing from big data, combined with the current context and conditions, and adequate adaptation according to prior knowledge or decisions generated from machine learning algorithms [6].

This research is in line with the demands of industry 4.0 which is characterized by increased manufacturing digitization with four driving factors: 1) increased data volume, computing power, and connectivity; 2) the emergence of business analysis, capabilities, and intelligence; 3) the occurrence of new forms of interaction between humans and machines; and 4) improvement of digital transfer instructions to the physical world. The uniqueness and advantage of this program is that it integrates the application of Internet of Things (IoT) technology. The purpose of the proposed program is to increase salt production, both in quantity and quality through the application of IoT-based information technology.

Web service is an application of a collection of data (database), software (software) or part of software that can be accessed remotely by various devices with a certain intermediary. The use of web services is able to overcome interoperability problems and integrate different systems. In general, web services can be identified by using a URL like just a normal web (eg: www.webname.com). However, what distinguishes web services from the web in general is the interaction provided by web services [7].

This research resulted in an IoT design that can measure salt salinity, temperature and humidity. The salt salinity measure is then used to open the faucet and automatically circulate water for the next production process. The data generated by the sensors is then combined with other data related to the supply chain of salt commodities using big data architectures and application microservices.

II. Big Data

The term Big Data is often used to describe a variety of different concepts, from the collection and processing of large amounts of data to the various techniques used to process data [8] (Favaretto, 2020). The use of this term is often popularly used in various fields such as: health [9], geography [10], psychology [11], and social life [12]. The term Big Data has been used since the 1990s as technical and marketing jargon by silicon graphics. The use of this term in academia began to emerge in the 2000s on the topic of computer science [13] and statistics/econometrics [14]. Then, in subsequent years, as it develops, the use of big data is increasingly used, especially in conducting data analysis [15].

Weiss and Indurkhya [14] stated that a very large data set and compiled in a centralized data warehouse allows analysis using more complex techniques to analyze more comprehensive data. In theory, big data is able to provide more comprehensive conclusions. However, in practice, there are various problems that arise.

There are various definitions of big data. However, basically, big data has three attributes known as 3Vs, namely volume (large amount), velocity (fast processing), and variety (various data) [16]. Then, along with the larger amount of data, big data attributes are growing with additional attributes to the three previous attributes, such as: veracity, value and variability. Even with various definitions, big data is a large amount of data that comes from various sources [8].

One application of big data technology is in enterprise systems. For example, big data can be applied to manufacturing systems. Big data can help predict manufacturing equipment failures. Potential problems can be found by analyzing structured data (year, equipment make, and model) and unstructured data (log entries, sensor data, error messages, engine temperature, and other factors). With this data, manufacturers can maximize parts and equipment uptime and implement maintenance costs more effectively.

In the village there are several applications of big data in rural areas. For example, big data can be used to automate agriculture. Agricultural automation uses various tools connected to the internet/ internet of things (IoT). The use of various kinds of sensors and tools certainly produces various kinds of data that need to be controlled to automate agriculture [17].

III. Methodelogy

The stages of program implementation can be divided into several parts, namely:

1) Requirements gathering and analysis: Requirements Gathering and Analysis or mapping and analysis to get needs is the initial stage of the prototype model. In this stage the system requirements are defined in detail. In the process, developers and users provide feedback to each other. At this stage the required data sources are also identified, namely:

- Internal Data, The majority of internal data will come from database systems Gadingsari Village. This data includes production data, stock data, company financial data, as well as data from various instruments contained in village business units.

- External Data, this data includes raw material prices, selling prices, weather predictions, and input from related departments. There are various data sources that can be used to support the business units that are owned. These data can be collected from various sources and then analyzed which can produce conclusions that can help village businesses. These data are generated at different times. For example: weather data can be retrieved 7 days in advance while raw material data is sometimes available 1 month later. Of course this time difference can provide imperfect comparisons between data. Data types are also different. The average external data is unstructured, where the data does not have a fixed structure.

2) Design model: The second stage is to build a microservices model and an IoT model. Creating a micro service model design that will provide a brief description of the applications contained in the web service management system that you want to create. IoT model design: namely the IoT model that will be implemented in optimizing salt production. The IoT model will then be run using the proposed web service.

3) Integration: Design of Microservice System Integration and IoT technology in Web Service management.

IV. Result and Discussion

At the initial stage of the design is to build a microservices model and an IoT model, at this stage it is necessary to design a microservices model which will provide a brief description of the applications contained in the web service management system that you want to create. The Webservice Model Design created can be seen in Fig. 1.

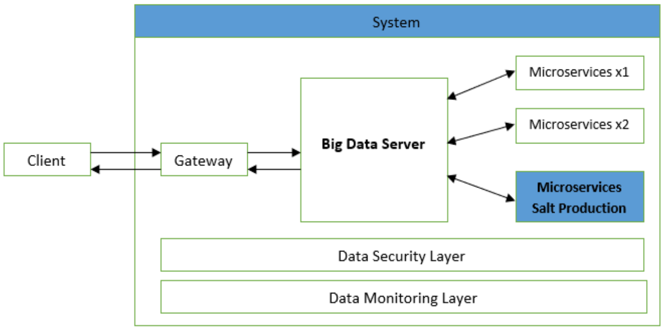

Fig. 1. Salt production webservice model design

A. Application Program Construction

Program construction is a codification process, namely building application programs based on designs that have been made at the application design stage. There are several stages in this activity, namely:

1) The first stage, the application program is to build a data ingestion application, to integrate data from various sources using the Application Programming Interface or API, as shown in Fig. 2. In this section, big data processing is carried out using several layers, such as the data visualization layer, analytical storage , analytical engine, data processing layer.

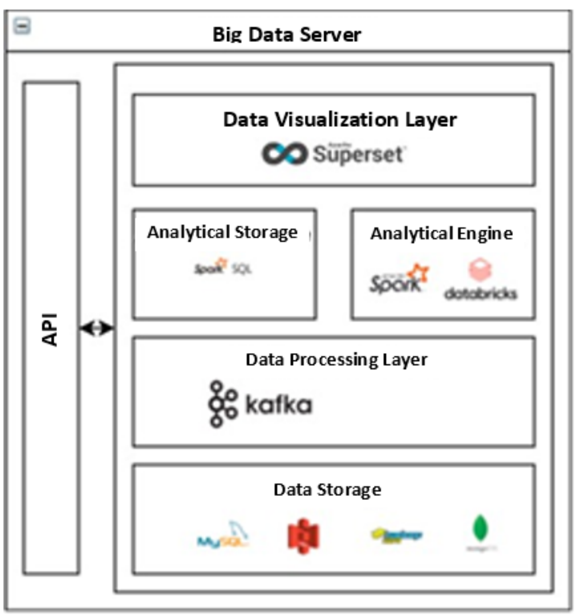

Fig. 2. Big data server architecture design

2) The second stage provides micro service services for users or business actors. At this stage, program construction is carried out to build application services. The target to be achieved is the availability of application services that can be connected to the IoT system for monitoring the salt production process, as shown in Fig. 3.

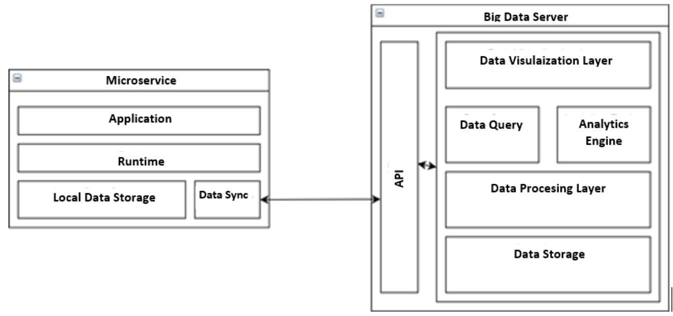

Fig. 3. Big data architecture microservice design

B. IoT Model Design

The conceptual design of the IoT model that will be implemented in optimizing salt production can be seen in Fig. 4, and the IoT design can be seen in Fig 5. The IoT model will then be run using the proposed web service. The picture shows the ESP32, which is a low-cost, low-power system on a chip (SoC) series with dual-mode Wi-Fi and Bluetooth capability! The ESP32 family includes the ESP32-D0WDQ6 (and ESP32-D0WD), ESP32-D2WD, ESP32-S0WD, and ESP32-PICO-D4 system-in-package (SiP) chips. At its heart is a dual-core or single-core Tensilica Xtensa LX6 microprocessor with a clock speed of up to 240 MHz. The ESP32 is highly integrated with a built-in antenna switch, RF balun, power amplifier, low noise receiver amplifier, filter and power management module. Engineered for mobile devices, wearable electronics, and IoT applications, the ESP32 achieves extremely low power consumption through power-saving features including smooth resolution clock gating, multiple power modes, and dynamic power scaling.

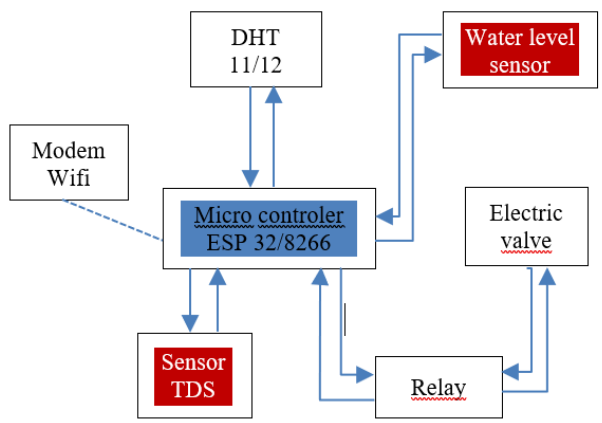

Fig. 4. Conceptual design diagram of the IoT model

Some of the functions of the IoT model design with web services are as follows:

1) The controller is an IoT tool that will automatically control the valve based on sensor conditions. All automation occurs at the controller level to save traffic going out through the modem

2) The controller will be connected to the web service via the tcp protocol. It should be noted that the controller can first connect to the local server or go directly to the web service.

3) The service data will be received. This service also allows the system to send messages to IoT devices.

4) Finally, the management system allows the use of data to and from IoT devices. The system for will also simplify the management of IoT devices

Fig. 5. IoT design

DHT22, shown in Fig. 6, is a digital relative humidity and temperature sensor. The DHT22 sensor uses a capacitor and thermistor to measure the surrounding air and output a signal on the data pin. DHT22 is claimed to have good reading quality, judged by the fast response of the data acquisition process and its minimalist size, and the price is relatively cheap when compared to a thermohygrometer [18].

Fig. 6. DHT22: Temperature and humidity module

Furthermore, the program is run based on program construction using the Python programming language as shown in Fig. 7.

```
from machine import Pin, ADC
import network
import dht
import ujson
import time
from umqtt.simple import MQTTClient

# VOID
# Register All Pin
sensor = dht.DHT22(Pin(12))
pmeter = ADC(Pin(13))
pmeter.atten(ADC.ATTN_11DB) # Set Analog to 3.3V
relay = Pin(15,Pin.OUT)

# Parameter to control Relay
relay_state = 0

# MQTT

# MQTT Server Parameters
MQTT_CLIENT_ID = "device1"
MQTT_BROKER    = "localhost"
MQTT_TOPIC     = "iot/device/1"

print("Connecting to WiFi", end="")
sta_if = network.WLAN(network.STA_IF)
sta_if.active(True)
sta_if.connect('Wokwi-GUEST', '')
while not sta_if.isconnected():
  print(".", end="")
  time.sleep(0.1)
print(" Connected!")

print("Connecting to MQTT server... ", end="")
client = MQTTClient(MQTT_CLIENT_ID, MQTT_BROKER,
port=1883)
client.connect()

print("Connected!")

    # LOOP
while True:

  # Pasive Sensor
  print("Measeuring Data....")
  sensor.measure()
  message = {
    "temp": sensor.temperature(),
    "humidity": sensor.humidity(),
    "pmeter": pmeter.read(),
  }
  # Some Logic Sensor
  relay_state = 0
  if(message["pmeter"] >= 1000):
    print("ook")
    relay_state = 1

  # Active Sensor
  relay.value(relay_state)
  message["relay"] = relay_state

  print(ujson.dumps(message))

  print("Reporting to MQTT topic {}: {}".format(MQTT_TOPIC,
  message))
  client.publish(MQTT_TOPIC, message)

  # Looping
  time.sleep(3)
{
  "version": 1,
  "author": "Choirul Imam",
  "editor": "wokwi",
  "parts": [
    {
      "type": "wokwi-esp32-devkit-v1",
      "id": "esp",
      "top": 0.67,
      "left": -28.67,
      "attrs": { "env": "micropython-20220618-v1.19.1" }
    },
    {
      "type": "wokwi-dht22",
      "id": "dht1",
      "top": 7.13,
      "left": -172.4,
          "attrs": { "temperature": "-11.5" }
    },
    {
      "type": "wokwi-slide-potentiometer",
```

```
     "id": "pot1",
     "top": 186.68,
     "left": -331.47,
     "attrs": { "travelLength": "30" }
    },
    {
     "type": "wokwi-resistor",
     "id": "r1",
     "top": 58.91,
     "left": 169.7,
     "rotate": 90,
     "attrs": { "value": "220" }
    },
    {
  "type": "wokwi-resistor",
      "id": "r2",
     "top": 56.91,
     "left": 218.18,
     "rotate": 90,
     "attrs": { "value": "220" }
    },
    { "type": "wokwi-ks2e-m-dc5", "id": "relay1", "top": -32.09,
     "left": 206.97, "attrs": {} },
    {
     "type": "wokwi-led",
     "id": "led1",
     "top": 108.25,
     "left": 219.88,
     "attrs": { "color": "green" }
    },
    {
     "type": "wokwi-led",
     "id": "led2",
     "top": 106.41,
     "left": 177.85,
     "attrs": { "color": "red" }
    }
   ],
   "connections": [
    [ "esp:TX0", "$serialMonitor:RX", "", [] ],
    [ "esp:RX0", "$serialMonitor:TX", "", [] ],
    [ "esp:3V3", "dht1:VCC", "red", [ "v0" ] ],
    [ "pot1:VCC", "esp:3V3", "red", [ "h0" ] ],
    [ "pot1:SIG", "esp:D13", "blue", [ "h0" ] ],
    [ "r1:2", "led2:A", "green", [ "h0" ] ],
    [ "led2:C", "esp:GND.1", "black", [ "v0" ] ],
    [ "led1:C", "esp:GND.1", "black", [ "v0" ] ],
    [ "relay1:NO1", "r1:1", "gray", [ "v0" ] ],
    [ "r2:2", "led1:A", "green", [ "h0" ] ],
    [ "relay1:NC1", "r2:1", "gray", [ "v0" ] ],
    [ "relay1:COIL2", "esp:GND.1", "green", [ "v0" ] ],
    [ "dht1:GND", "esp:GND.2", "black", [ "v0" ] ],
    [ "pot1:GND", "esp:GND.2", "black", [ "v0" ] ],
    [ "dht1:SDA", "esp:D12", "green", [ "v0" ] ],
    [ "esp:3V3", "relay1:P1", "red", [ "v0" ] ],
    [ "esp:D15", "relay1:COIL1", "orange", [ "h0" ] ]
   ]
```


Fig. 7. IoT program construction

Furthermore, the design of the IoT model that has been built with the Python program is run using a server with web service management (Fig. 8).

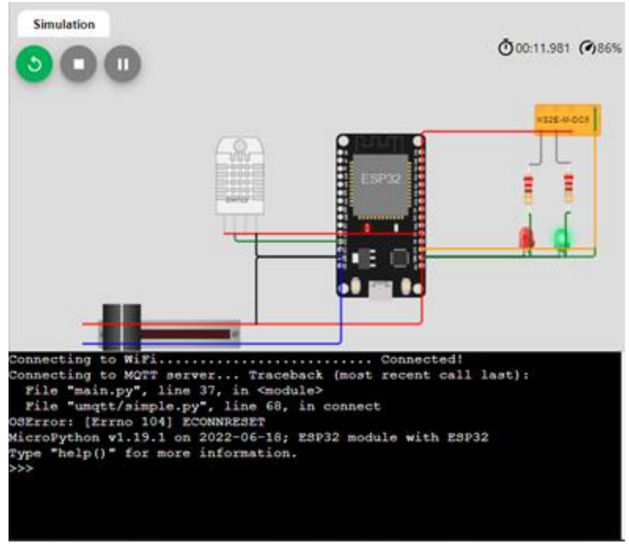

Fig. 8. Running IoT program design with web service management

The program that is run shows the results that the system design is in accordance with the expected goals. Each module of connected devices, such as temperature sensors, humidity, wifi servers can communicate with each other and provide information in the form of the desired report. This proves that the designed web service management model is running as expected.

V. Conclusion

The web service model with IoT has been successfully built and can be run with the Web Service management model. The web service is run using a Public IP server, making it easier to run additional applications. Application programs run well with time optimization, as expected. The test results show that the sensor valve can function automatically based on the water level measurement sensor.

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