Green city based industry 4.0 through Smart Urban Farming through IoT (SUFI) in Surabaya, Indonesia

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Abstract. Major cities of the world have realized the importance of developing green-minded cities as part of dealing with global climate change. The concept of urban farming as one of the offer solutions that comes with a method of agricultural activities in the city by utilizing limited areas, such as the Surabaya area, as a busy city and a dense road traffic activity is one of the challenges of the Surabaya region in developing green space based on Regional Regulation number 7 of 2002 concerning the management of green open spaces. On the other hand, the development of information and communication technology has stepped in the industrial era 4.0, one of which is the presence of Internet of Things (IoT) technology based on Message Queuing Telemetry Transport (MQTT) protocol. The method used in this paper is descriptive qualitative and experimental-based product development. The focus area of the analysis is the implementation of Regional Regulation 7/2002 and its implementation in the field, while the proposed product development is monitoring environmental parameters such as plant temperature, ambient humidity, soil moisture level and light intensity processed for automation control of urban agricultural irrigation. The results show that the Surabaya city government has consistently implemented the local regulation through various activities and is supported by all components of Surabaya residents, while the IoT-based product development shows that this technology can be applied and accepted by the Surabaya urban farming community.

1. Introduction
Indonesia is a developing country, with various challenges including, social and environmental problems, especially population increases, and decreases in agricultural land. The fact shows that the Gross Regional Domestic Revenue (GRDP) has a negative and significant effect on the area of agricultural land, while the population and number of industrial companies do not have a significant effect on the area of agricultural land [1,2]. Surabaya is a city located in the province of East Java, Indonesia. As the provincial capital city with an area of 350.5 km², Surabaya is the second largest city in Indonesia after Jakarta with a population density of more than 9,900 people / km² in the middle of the city, and descending towards 2,200 people / km² on the edge of the metropolitan area. A big challenge for Surabaya is increasing population [3]. Based on data from the last 5 years from the Central Statistics Agency (BPS) of East Java Province, the city of Surabaya has always experienced an increase in population from year to year [4,5] (See Figure. 1).
Surabaya has issued a city government policy regarding green open space in Surabaya through Regional Regulation No. 7 of 2002 concerning green open space management [6,7]. The regulation also includes green open spaces that represent landscaped green areas, urban forest green areas, urban recreation green areas, cemetery green areas, agricultural green areas, green belt green areas, and green yards.

In 2018 according to the Environment Agency. The city of Surabaya has various problems from the previous years from 2012 to 2017, namely various environmental problems such as those that occur on a number of green land or agricultural land which will become settlements or industrial establishments and infrastructure development that is not in accordance with their capacity. By considering various kinds of problems, the Surabaya city government decided to make an effort to overcome these problems by realizing Sister City cooperation with the city government of Kitakyushu, Japan [8].

Urban farming is defined as growing crops and raising animals in and around cities. The most striking feature of urban farming, which distinguishes it from rural farming is that agriculture is integrated into the city's economic and ecological system [9]. These two links include the use of urban dwellers as workers, use of resources, direct relations with urban consumers, direct impacts on the positive ecology of the city, being part of the city's food system, competing for land with other urban functions, and being influenced by policies and city plan.

Implementation of the industrial revolution 4.0 one of which is the use of the internet of Things (IoT). IoT has been in the spotlight for the past decade, it is considered as one of the technologies that will develop rapidly this century and so far, has attracted the attention of the community, industry and academia as a way to improve daily activities technologically, the creation of new business models, products and services, and as a broad source for topics and research ideas [10]. Some alliances, institutions, companies and even governments have understood the importance and identified the potential benefits that can be obtained from IoT, directing them to carry out projects and strategic initiatives aimed at developing this field and profiting from its existence (See Figure. 2).
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Figure 2. The interpretation in which IoT becomes a fabric of dependency and impact affects many existing and future markets and technology verticals [10].

Here, the target of this research is to monitor the environmental parameters of urban farming through the implementation of IoT technology by monitoring the temperature, soil moisture level and light intensity processed for automation irrigation control in community of Surabaya urban farming.

2. Methods
Steps to develop a model of Internet-based urban agricultural technology industry 4.0 based on Internet of Things (IoT) using experimental research methods [11]. Experimental research is a study that answers the question "are we doing something under controlled conditions so will it happen?" [12]. To find out whether there is a change or not in a situation that is strictly controlled it is necessary to treat these conditions and this is done in experimental research.

Experimental-based product development in the form of an industry-oriented urban farming technology model 4.0 based on the Internet of Things (IoT), the entire system will be connected to the internet. Sensor readings obtained will be displayed through the internet network for the benefit of users to monitor the system in the form of log data sent [13]. Users will also be able to control the system via the internet by MQTT (Message Queuing Telemetry Transport) protocol. There is also a 16x2 LCD screen on the device. In addition to getting sensor readings on the internet the latest condition readings from the sensors will also be displayed on the LCD screen (See Figure. 3).

Figure 3. Illustration of SUFI communication using the MQTT protocol.
The system proposed from the experimental results in this research contains sensors such as temperature, humidity, connected to Arduino as a microcontroller and then connected to an SBM (Single Board Computer) based on the ARM board namely Raspberry Pi 3 b+ which communicates via 4G HAT modem internet network. The sensor converts various physical parameters into electrical signals and eventually becomes digital data units. Power consumption in this system uses solar power which is controlled by the Solar Charge Controller.

MQTT broker uses service from Thingspeak broker which integration with MATLAB and focuses on performing the role of a broker with the main task being to multicast information to subscribed gadgets [14]. In addition, in the midst of ongoing observations, the information collected is sent to the web server and SQL server where the information is stored. Data collected from sensors are displayed and stored on the web part of the information system in graphical form and based on motor threshold values turned on or off automatically or manually (See Figure. 4).

![Figure 4. Raspberry Pi 3 b+ as core of the system.](image)

The sensor is placed near the plant root nozzle, the area to be irrigated. This sensor will later detect and measure data from the ground and the sensing data is forwarded to the Raspberry Pi. There are 2 (two) main parts here, the central server called broker and client application, namely publisher / subscriber. Sensor devices whose basic job is to consistently create and send information to the server are marked as MQTT publishers. The central server, the MQTT broker, collects messages from the publisher and checks to whom the messages must be sent. On the opposite side, every subscriber that has registered its interest with the server will continue to receive messages until the time the membership is destroyed. Here the researchers provide some threshold values for soil moisture based on an irrigation motor to be turned on and off automatically or manually.

3. Results

In this experiment, the main control is the change in soil moisture as a trigger for the relay. The humidity sensor consists of two probes that are used to measure the volumetric content of water. The two probes allow the current to pass through the soil and then it gets the resistance value to measure the moisture value. When there is more water, the soil will conduct more electricity that means there will be less resistance. Therefore, the moisture level will be higher. Otherwise, dry soil conducts electricity poorly, so will conduct less electricity which means there will be more resistance.

To determine the threshold, a monitor is needed for the sensor. By using thingspeak server, the threshold value is set to 0 to 120, the sensor is placed at the soil and then the program code is run for approximately 15 days with treatment in the middle of the time given additional water. By knowing the threshold, the value for the on / off relay program code is determined (See Figure. 5).
Figure 5. Changes of sensor values to changes in soil conditions.

The existing IoT-based urban farming system on farmland must publish data to the previously assigned id that is the destination address. Web applications that are designed using PHP scripts and become subscriber on unique topics and received values are entered into the appropriate table in the database. Information collected from the sensor controller on urban farming land is transmitted remotely using a 4G HAT modem and then stored on the Mysql web database server at the receiving end (See Figure 5).

Figure 6. SUFI Web Interface.

With the presence of IoT, it allows interconnection between various machines, devices, and Internet-based services and also this technology also helps further the utilization of internet-connected hardware and software technology to be better utilized in facilitating work, especially in an industry. In Indonesia, at least in the last three years the development of IoT-based solutions continues to grow beyond expectations, but this positive development is a problem for system developers due to the lack of local manufacturers that produce IoT hardware or components.

4. Conclusions

Based on the focus of research, data and findings as well as research discussions, the results of this study can be concluded as follows:
Although regulations have not been clearly written related to urban agricultural policy. Surabaya is committed to the development of an environment-based area, and has carried out activities in an effort to build a green and green city planning. The development of industrial-oriented urban agricultural technology models based on Internet-based (IoT) based experiments can be carried out well through the application of the MQTT protocol. This open source based platform promises future growth and development that is increasingly popular and can be further developed in accordance with the development of hardware, software, and urban agricultural land requirements. Looking at the opportunities for using this technology, this study recommends open opportunities for the Surabaya city government to apply this technology to green open land, especially in city parks.

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