The internet of things (IoT) for flood disaster early warning in DKI Jakarta: prospect and community preparedness

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Abstract. Flooding is the most frequent disaster in the last ten years in Jakarta and has occurred since the colonial era. Jakarta's geographical location is partly below sea level, and its dense population causes Jakarta's vulnerability increases. The study aims to determine the potential of use and development of IoT in flood disaster mitigation systems as an early warning to the public through cell phones, that have become the needs of the urban community to reduce material and non-material losses. This study uses data elaboration methods, using secondary data from the Central Statistics Agency (BPS) on the Information and Communication Technology Development Index (ICT Development Index) published in 2018, survey data from the Indonesian Internet Service Providers Association (APJII) on internet user profiles in Indonesia published in 2015. The results of this study indicate that internet penetration reaches up to 56%, the highest compared to other regions in Indonesia. The ICT Development Index shows that DKI Jakarta is the highest ICT Development Index, with 7.41 out of 10. It indicates that IoT based on flood disaster mitigation has the potential to be applied in DKI Jakarta.

1. Introduction
Flood, one of the most devastating disasters in the world [1][2]. Disasters cannot be predicted, but we can prepare to deal with disasters if they occur at any time to reduce casualties and losses [5]. When a disaster occurs, it will disrupt essential services such as health care, electricity, water, transportation, and communication [6]. It certainly will harm the social life and economy of the community. Jakarta has experienced a very fast development in the last 30 years and has become one of Asia's international power companies to find their manufacturing facilities there. As a mega delta city, Jakarta has become the center of the economy and the central government, with a population reaching 10.4 million in 2017 [3]. The high number of residents makes Jakarta a city that is identified as having a high vulnerability to natural disasters. Natural disasters that occurred in Jakarta included floods, landslides, tornadoes, fires. Flood disaster is the most natural disaster occurring in the last 10 years, according to BNPB. However, large-scale floods occur approximately every five years and create barriers to trade and livelihoods [4].

The number of disasters encourages finding the best solutions to overcome and prevent the occurrence of the disaster. Disaster management planning is very dependent on topology, climate conditions, habitat, available resources in an area [7]. In the industrial era, 4.0 various technologies have developed that have the potential to be used as supporting facilities to increase the success of disaster mitigation [5]. This is in line with the development of IoT technology, which is currently mature and potentially very useful in disaster situations. Besides, the penetration of smartphones and internet use in Indonesia is very high. Figure 1 shows the results of a survey conducted by APJII (Indonesian Internet
Service Provider Association), which released that penetration of internet users in urban areas was 72.41% compared to rural-urban and rural areas of less than 50%. Whereas from Figure 2 shows that smartphone ownership reaches 70.96% in urban areas.

The preparedness of the community to accept new technology will undoubtedly encourage ease of implementation of technological innovation. In addition, the readiness to develop the technology itself is an integral part of the success of technological innovations to be applied. ICT Development Index published by the Central Bureau of Statistics Indonesia in 2018 shown that DKI Jakarta occupies the first position in the information and communication technology development index (ICT Development Index). ICT development index is a standard measure that describes the level of development of information and communication technology, digital discrepancy, and the potential for ICT development in a region.

2. Methods
The method that used in this research is data elaboration. Before that was the exploration stage, where the authors investigated and explored the aim of gaining more knowledge about a case. Then elaborate data with diligent and careful cultivation. At this stage, the author conducts analysis and seeks to deepen the case. The supporting data used is secondary data obtained from the Central Bureau of Statistics in the form of the Development of Information and Communication Technology Development Index (ICT) published in 2018. Then for data of penetration on the internet and smartphone use, using secondary data from the Indonesia Internet Service Provider Association that released in 2017. This research employed a single case study method whose research direction is centered on a case or phenomenon. Generally, the focus of the study immediately paraded to the core of the problem.

The flood case was chosen because the flood disaster was the most frequent in the last ten years. This results in the potential loss of both material and non-material higher than other disasters. The selection of DKI Jakarta as a research location is because DKI has the largest population, this results in a high level of vulnerability to disasters and a more enormous potential for casualties compared to other regions. In addition, DKI Jakarta is known as the capital city of the country with large infrastructure investment which has the potential to experience a greater economic loss compared to other regions. The government center located in DKI Jakarta is also one of the considerations for choosing this place, this makes Jakarta a vital area.
3. Result and Discussion

3.1 IoT Prospect In DKI Jakarta

Internet of Things (IoT) began to develop in the early 1990s and become Information and Communication Technology which has been developed a lot now, starting from the concept of controlling electrical and electronic equipment ("objects") from a distance. Previously it is known as the "Internet of Everything", "machine-to-machine (M2M)", "physical computing" and even "ubiquitous computing". The term Internet of Things appeared in 1999 by Kevin Ashton and began to be famous through the Auto-ID Center at MIT [8]. The development of IoT utilization began to be implemented in various fields ranging from daily life, robotic communication, environmental monitoring, the world of aviation, health, disasters, etc. Table 1 shows that the DKI Jakarta region is the first position in the information and communication technology development index (ICT Development Index).

Table 1. ICT Development Index in Java (2015)

| Prov/Dist/City | ICT development index | usage | expertise | access and infrastructure |
|---------------|-----------------------|-------|-----------|--------------------------|
| DKI Jakarta   | 9.25                  | 9.61  | 7.13      | 9.96                     |
| Jawa Barat    | 5.03                  | 3.61  | 6.63      | 5.65                     |
| Jawa Tengah   | 4.41                  | 2.48  | 6.63      | 5.22                     |
| Jawa Timur    | 4.74                  | 3.23  | 6.63      | 5.31                     |
| DI Yogyakarta | 6.45                  | 4.86  | 8.21      | 7.17                     |
| Banten        | 5.35                  | 4.05  | 6.67      | 6.00                     |

Source: ICT development index 2016

This statement shows that Jakarta is very potential in IoT development. This can be seen from the data of the ICT Development Index. The ICT Development Index is a measure to describe the level of information and communication technology development in a region, the digital gap and the potential for ICT development developed by the International Telecommunication Union (ITU) and issued by the local government. Jakarta is the province with the highest ICT development index in Indonesia at 7.61 in 2017, 7.41 in 2016 and 9.25 in 2015. ICT Development Index is compiled by 11 indicators which are combined into 3 compiler subindexes, i.e. access and infrastructure, usage, and expertise. The highest subindex value in 2017 is the expertise of 5.75, followed by the entrance and infrastructure of 5.16, and the usage of 4.44.

3.2 Concept and Implementation of IoT in Flood Disaster

Internet of Things (IoT) was initially defined by Kevin Ashton as a connected object that can be uniquely identified using radio frequency identification (RFID) technology. The development of definitions of IoT occurred, such as in 2009 by the International Telecommunication Union (ITU) and in 2013 by the European Research Center (IERC). In principle, IoT can be defined as a communication protocol concept where an object can transmit a number of data without passing human or human interaction to a computer through a network, whether wireless or not [6][9][10]. In the beginning, IoT used RFID technology that was read using RFID reader, as the current development of knowledge there have been many technologies that can be utilized to develop IoT systems as RFID, Auto ID, ITU IoT, RFID CMOS, Barcodes, Smartphone, WSN, Could computing, Location-based service, SoA, Near Field Communication, Social network, Internet(IPv6), 3G/4G, WiFi, ZigBee, WiMax. The purpose of IoT is a variety of information in real-time from "things" effectively to the broader community.

Currently, Android-based smartphones are the most common technology used in the community. The penetration of internet usage is increasingly widespread and reaches all levels of society with a fairly large composition both in the lower to the upper classes community. Internet usage is very high, especially among productive age, which is 19-34 years old reaching 49.52% of total internet users in
Indonesia in 2017. The duration of internet usage among users reaches 65.98% who use the internet every day. The high number of smartphone users based on Android using internet networks encourages developers to develop various types of applications that support this device. Knowing this reality helps to maximize the potential of existing conditions to improve the performance of disaster mitigation by utilizing all available resources through the use of internet networks and the use of high-Android-based smartphones by making a flood early warning system [17].

The idea of this concept is to use sensors to record hydrological data used as parameters for flood monitoring. The data is then stored in a shared storage system, and then through the internet can be accessed by the public via a smartphone. This technology development has been done a lot. In Indonesia, several institutions like government, university or other have developed smartphone applications such as Flood Monitoring System is flooding monitoring system by KeiAl, FEWEAS is flood early warning information system with a combination of weather prediction and inundation resolution by ITB, “Sistem Peringatan Dini Banjir DKI JAKARTA” that inform about rivers water level status in Jakarta by DKI Jakarta water resources service office. That application based on an android phone system with a rating of more than four and an average of downloader more than 1000. In general, the concept of a flood early warning system can be seen in Figure 3.

Even so, the question is whether this innovation will be accepted and utilized by the community at large. This will have a very significant impact, especially in the success of flood disaster mitigation.

3.3 Community Preparedness for IoT

Along with the development of technology will undoubtedly change the way people perceive a problem. The emergence of innovations about information technology must be coupled with the preparedness of the community so that it is necessary to do a study of community behavior and evaluation of public acceptance of information technology so that it can be utilized as well as possible [13]. Based on APJII data, internet service users in the urban area 72.41% with 56% internet usage penetration and 70.96% smartphone use, this certainly makes Jakarta a potential city in the application of IoT because of the supporting facilities are already very qualified. However, this does not necessarily make the application of IoT-based information systems acceptable to the public. It is necessary to study how public acceptance of these technologies. One theory that explains the approach to technology acceptance is the Technology Acceptance Model (TAM). In addition to TAM, the Theory of Reason Action (TRA), Theory of Planned Behavior (TPB) by Ajzen and Fishbein had been developed and the Technology Readiness Index (TRI) [14],[15]. TAM introduced by Davis is an adaptation of the TRA precisely to model user acceptance of an information system.
In this article, we will discuss the components of TAM compilation. In Figure 4, a model Fred Davis proposes three factors that influence the use of a system that is Perceived Usefulness, Perceived Ease of Use, Intention To Use. Perceived Usefulness is defined as the level of trust that using the system can improve its performance at work. Perceived Ease of Use is the level of ease of using the system. Intention To Use is the tendency of behavior to use technology. The three factors are variables in determining how the user receives from a system/information system that wants to be built or already running. This is very important because community acceptance and how people can use information technology is the key to the success of a technology [16]. The use of technology that is needed by the community and right on target can maximize the potential of the benefits of the technology and improve the sustainability of the objectives to be achieved. In this case, it is important in the application of flood early warning technology to improve the sustainability and effectiveness of flood disaster mitigation to reduce losses and loss of life.

4. Conclusion
The application of an information system as an early warning system for mitigating floods in Jakarta in an infrastructure manner has been competent. This is evidenced by the many internet and smartphone users in urban areas compared to other regions. In addition, the development of the concept of IoT as a means of mitigation has been carried out in various countries with various forms and models so that it can be easier to apply in Jakarta because there is a lot of literature that can be used. A more in-depth study needs to be done by using technology acceptance theory to see the preparedness of the community in using applications in the form of an IoT-based Early warning system that utilizes internet and smartphone networks. In addition, it can evaluate it so that it can optimize its benefits to the wider community.

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