Systematic Literature Review Implementation of the Internet of Things (IoT) In Smart City Development

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Abstract. Internet of Things (IoT) "The smart city concept has become a dream that big cities in Indonesia want to achieve, basically the smart city concept focuses on developing the human element using technology. IoT opens up many opportunities for new services by connecting the physical world and the virtual world to various electronic devices. IoT aims to leverage cutting-edge technology to support sustainable services for governments and their citizens. Systematic Literature Review (SLR) is one method in conducting an overview of previous interrelated researchers. The purpose of the literature study in this research is to understand trending research topics, methods, and architecture in the development of smart cities with IoT. In this study, various interesting information was found in various research journals regarding the role of IoT in building a smart city that has a role to serve smart city infrastructure, identify and analyze trends, develop smart cities and become innovations for IoT. Based on the research, there are things that need to be done to improve the study to focus more on the role of IoT that can be more utilized. IoT is also one of the technologies that are widely used in several countries in the development of IoT in the future. IoT in smart cities will become an inseparable technology because humans will increasingly depend on IoT in their daily lives.

Keywords: Internet of Things, IoT, Smart City, systematic literature review

I. INTRODUCTION

The Smart City concept has become a dream that big cities in Indonesia want to achieve [1]. Smart city-based development has become a trend in cities or regional development around the world, with the belief that regions or cities and districts throughout Indonesia need to adapt, Smart City emphasizes the importance of innovation in solving problems in every city by using information and communication technologies. (ICT), sensors, and data analysis as supporting factors and facilitating problem solving (realization factor [2]. Basically, the smart city concept focuses on developing the human element using technology.

The Internet of Things (IoT) opens up many opportunities for new services by connecting the physical world and cyberspace to various electronic devices in homes, cars, roads, buildings and many other places is recognized as a major research and innovation stream. A decentralized environment, urban IoT aims to leverage cutting-edge

technology to support sustainable services for governments and their citizens [3]. IoT can also be used to increase transparency and promote local government action against residents, increasing public awareness of their condition. Therefore, the application of the IoT model for smart cities is very attractive to local governments who may be early adopters of the technology, thereby acting as a catalyst for the adoption of the IoT model on a larger scale [4]. With all the conveniences that the Smart City concept gets by using the Internet of Things (IoT) which already covers various circles, if the current technological sophistication looks like competing in realizing its development. Do not escape with all the advantages of the concept with all its sophistication. With all the sophistication of the role of humans as workers can be replaced with machines that have been created. And the worst impact is the loss of jobs and livelihoods for some people, for that we need to be smart enough to be able to go with the flow and take advantage of all the sophistication that exists to make alternative choices for business and develop capabilities [1].

To realize a sustainable city and support improving the quality of life of citizens, but there are shortcomings when implementing IoT such as the risk of system errors that may also arise due to power outages, the system also faces cyber-attack vulnerabilities [1]. Technological developments are now growing rapidly and IoT media as a companion will always be present in all devices that are connected to each other, with IoT expected to solve these problems [1].

This study aims to see the role of IoT in smart cities. Thus, the research question is: "What is the role of IoT in building a smart city?"

II. METHOD

2.1. Study of Literature

Systematic Literature Review (SLR) is one method in conducting an overview of previous studies that are interrelated. SLR is one of the standard methods so that the next research process can be re-done by other people with almost the same results. SLR is a secondary research to map, identify, evaluate, consolidate and collect information from the main study results related to the research topic [5]

The purpose of the literature study in this study is to understand trending research topics, methods, and architecture in predictive analysis with IoT. [6]

2.2. Research Question

The purpose of the Research Question is to maintain the focus of the literature review. This condition facilitates the process of finding the required data. Table 1 shows the research questions for this study [6].

Table 1 Research Question

ID	Research Question	Motivation
RQ1	Which journals most frequently publish topics on the application of the Internet of Things (IoT) in smart city development?	Identify the journals that most frequently publish topics on the Application of the Internet of Things (IoT) in smart city development.
RQ2	Who are the most active and influential researchers on the topic of implementing the Internet of Things (IoT) in smart city development?	Identifying the most active and biggest contributors to the topic of the application of the Internet of Things (IoT) in smart city development.
RQ3	What is the most frequently used topic on Application of Internet of Things (IoT) in smart city development?	Identify the most frequently used datasets in the topic of implementing the Internet of Things (IoT) in smart city development?
RQ4	What methods are often used for the application of the Internet of Things (IoT) in smart city development?	Identify methods that are often used for implementing the Internet of Things (IoT) in smart city development.

2.3. Search Strategy and Selection

There are two criteria in journal selection, namely inclusion criteria and exclusion criteria. Inclusion criteria follow the following points:

1. "smart city", "Internet of thing", "IoT" are in the title.
2. Language: English, Indonesian.
3. Year: 2017 to 2022
4. Publication type: Journal and Book
5. Accessibility: Documents available in Google Scholar.
6. Document types: PDF, HTML.

Exclusion criteria are all journals that are not accessible, all downloaded documents whose publication type does not match the inclusion criteria, all journals with incomplete content, and all journals whose content does not match the theme of the research question.

The search process according to stage 4 in the systematic literature review stage above consists of several processes, including the selection of digital libraries and setting keywords. Before starting the search, it is necessary to determine or select the appropriate database to find relevant journals. The following are the digital libraries in this study:

a. ScienceDirect (http; //www.sciencedirect.com/)
b. IEEE (http://ieeexplore.ieee.org/)
c. Google Scholar (http://scholar.google.com/)
d. Keywords are developed according to the following steps:

1. Identify search terms from the PICOC, particularly from populations and interventions;

2. Identification of search terms from research questions;

3. Identify search terms in the title, abstract and relevant keywords;

4. Identification of synonyms, alternative spellings and anonymous of search terms;

5. Determination of thorough keywords using the identification of search terms bolean AND and OR.

The keywords used for the search are:

2.4. Study Selection

The main study search and selection process at each stage is shown in Figure 1. The selection shown in step 5 was carried out in two steps: exclusion of the main study based on the title and abstract and exclusion of the main study based on the full text.

The study selection used was only journals, while books and proceedings were not used in the study selection:

1. English speaking is preferred.
2. Journals are included in computer science.
3. We get about 1,000 journals about IoT.
   a. Then the selection was made based on the title and abstract of 100 articles.
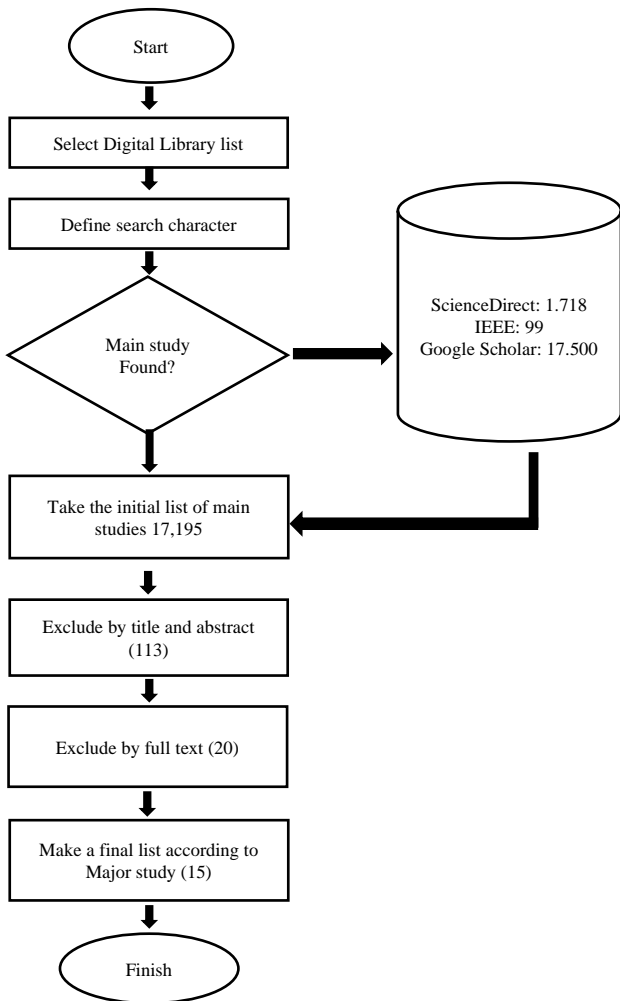   b. The final results of the selection are 15 journals in the main study.

Figure 1. Main Study Search and Selection

Literature Analysis

a. Deep Learning Analysis originated from the study of Artificial Neural Networks (ANN),
b. The most popular Deep Learning methods, especially in smart city research: RNN, CNN, DBN and SAE
c. There are 4 types of RNN: Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU), Bi-directional RNN and RNN encoder-decoder.
d. CNN: consists of a number of convolutional layers connected as hidden layers
e. DBN: a generative graphics model that studies the representation of the given data.
f. SAE: A stacked autoencoder is created by stacking each hidden layer of an AE on top of another.
g. RNN and CNN are methods of Deep Learning that are often used in health research

III. RESULTS AND DISCUSSION

From the search results of scientific publications on a list of digital databases that have been selected, several scientific publications have been selected that can be used as references for authors to answer research questions that have been compiled. There are scientific publications that cannot be used as references because they do not specifically discuss the Internet of Things in Smart City development. A summary of the evaluation results is presented in Table 3.

2.5. Literature Extraction and Analysis

Main Study Ecstasy

Data extraction was designed to collect data from the main study needed to answer the research question.

Table 2 Data Extraction for Questions

Property	Research question
The year of publication and the most active researchers	RQ1, RQ2
Datasets used	RQ3
Methods that are often used for implementing Internet of Things in Smart City development	RQ4

Table 3 Summary of Evaluation Results

Reference	Research purposes	Research result	The Role of IoT
[3]	Showcasing the role IoT can play in smart cities.	The application component contains the rules governing the decisions made on the smart home control. It is estimated that the application will also receive information from the electric utility regarding the supply of electricity, and information from the weather bureau.	Play a role in serving smart city infrastructure
[4]	Discusses urban IoT design models by describing the specific characteristics of urban IoT, and services that can drive the adoption of urban IoT by local governments.	Most smart city services are based on a centralized architecture, where dense and heterogeneous devices placed in urban areas generate various types of data which are then sent via appropriate communication technologies to a control center, where data storage and processing takes place.	Utilization of IoT to make design and other application characteristics more attractive.
[6]	Predict data based on patterns extracted from historical data derived from IoT data.	There are six research areas that are trending in predictive analytics with IoT, namely Transportation, Agriculture, Health, Industry. Smart Home, and environment.	Identify and analyze trends, methods and architectures used in predictive analytics with IoT.
[1]	Providing solutions that make it easier for humans in several sectors of work.	Infrastructure, management, regulation and citizens are the main components that are very efficient when viewed from the needs of the city of Jakarta itself in implementing a smart city.	Playing a role in the development of a smart city, with a fast internet network, supervision of all cities can be done quickly.
[5]	Applications improve services and help simplify decision making	IoT with a very heterogeneous network application with various types of objects. Provide opportunities and challenges in the decision-making process.	The main trends in the application of IoT to support decision making are in the health, manufacturing and industry sectors, transportation, agriculture and smart home.
[2]	Creating integration, synchronization, and synergy between smart city development planning at the central and regional levels, encouraging an effective, efficient, inclusive and participatory smart city development process	There are 5 factors that support smart cities in Temanggung Regency, namely nature factors, structural factors, infrastructure factors, superstructure factors, cultural factors.	Temanggung Regency has quite good regional readiness, especially in terms of regional digital infrastructure
[7][8]	A communications infrastructure that provides unified, simple and economical access to a large number of public services, thereby unleashing potential synergies and increasing transparency to citizens	Build a multipurpose IoT mode even from very limited devices. Using information schema & XML schema	Analyze solutions for urban IoT deployments. Starting from field trials which are expected to eliminate the uncertainty that still hinders the IoT paradigm

[9]	Making the Internet more immersive and pervasive. Allows easy access and interaction with a wide variety of devices.	Padova Smart City was successfully realized in the city of Padova which specializes in the development of Innovative IoT solutions, which has developed IoT mode and control software.	Analyze available solutions for urban IoT implementation.
[10]	Provide an evaluation of the readiness level for implementing smart mobility in Jakarta	Measurement of Jakarta's smart mobility is carried out using the indicators contained in smart mobility	In Jakarta, it can be said that they are ready to implement smart mobility in terms of accessibility and connectivity as well as the use of information and communication technology
[11]	IoT extends the benefits of continuously connected internet connectivity	Cities in Indonesia accept the concept of adaptation from a country that has successfully implemented the concept of a smart city	The development of IoT-based infrastructure will facilitate the development of smart cities in Indonesia.
[12]	The realization of a smart city to create a city that is comfortable, safe, efficient and sustainable, as well as increasing transparency and efficiency of government governance in the city of Bandung	The IoT concept in Bandung is designed based on the results of a review of the theory and the development of previous research	IoT requires a framework or concept to be implemented because of the many concepts, models and hardware and software devices that have a very broad scope in IoT technology.
[13]	Creating an intelligent environment by utilizing various smart objects/devices that have sensory and communication capabilities to generate data and send it over the internet to make decisions	An IoT system can be represented and described in 3 main layers, namely the transportation layer and the application layer. Each has a different technology	Researchers have shown issues regarding privacy, security and energy management that are still the main focus in the development of IoT in the future.
[14]	IoT using fog computing architecture offers a very feasible design study which is expected to be more satisfying with the new concept	The results of the smart city design will be divided into 2 parts, namely smart city design in fields and architectural designs in all fields	IoT is chosen by using fog computing architecture to reduce latency, simplify communication between central devices
[15]	Significant developments in smart cities, IoT, Crowdsourcing with a focus on technology, challenges and the latest developments related to smart cities.	IoT development and crowdsourcing are important drivers for smart city development.	Smart Cities act as innovations for IoT and Crowdsourcing.
[16]	To synthesize developments in the field of IoT and smart cities and advance the existing knowledge base by providing some recommendations for future research.	Assist researchers who are actively investigating IoT in a smart city context.	Fills gaps in the literature by uncovering various IoT and smart city research issues and topics.

IV. CONCLUSION

In this study, based on the results of SLR searches conducted, found various interesting information in various journals that were studied about the role of IoT in building smart cities, namely serving smart city infrastructure, identifying and analyzing trends, developing smart cities, and being an innovation for IoT.

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