

# The Level of Achievement for Assessment of Smart City in Smart Technology: A Literature Review

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**Abstract.** There are many concepts to smart cities, but in general, a smart city is a combination of the use of Information and Technology (IT) with various dimensions to increase efficiency, transparency and service quality. The dimensions of smart cities most popular are six dimensions, namely smart mobility, smart living, smart environment, smart people, smart government, and smart economy. Some literature only mentions the role of IT in the smart technology dimension but has not explained the level of achievement indicators for the smart technology dimension. The dimensions of smart technology and indicators of achievement level are carried out using a Systematic Review (SR), where more than 7.302 papers were found that match the topic and then divided into the 20 main studies based on SR protocol. The indicator of the level of achievement of the smart technology dimension in a smart city is divided into four parts, namely the use of sensors in the smart city, integration between applications (application layer), the use of technological innovations in the intelligent layer such as the IoT, big data, and cloud computing etc., and to improving the quality and scope of applications, increasing the use of AI and engagement with all public stakeholders.

**Keyword:** *Smart City, Smart Technology, Literature Review*

## 1 Introduction

In emerging age, the term smart city has become the centre of attention where in general, the smart city concept is followed by the rapid use of technology to solve city problems from various aspects [1][2]. Smart cities can be seen from various dimensions such as smart mobility, smart living, smart environment, smart people, smart government, and smart economy [3]. Because each city has unique characteristics, each city can choose the focus of smart city development according to these dimensions [4], such as China, Nanjing and Taipei focusing on the smart economy [5], Australia, Australian Capital Territory (ACT) focusing on smart people [6], as well as Spain City, the cities of Valencia and Madrid focus on implementing smart government [5].

The smart city dimensions is often used as a basic concept in assessing smart cities in various countries, such as those used by The IESE Cities in Motion Index (CIMI), Innovation City Index (ICI), The Smart Cities index, The European Digital City Index. (EDCi), Smart City Strategy Index, Global Cities Index, and Global Feasibility Survey [7]. According to Giffinger et al., according to Giffinger et al., the dimensions of smart city assessment can be divided into six dimensions, namely smart mobility, smart living, smart environment,

smart people, smart government, and smart economy [3]. The six dimensions of the ITU-T Focus Group on Smart Sustainable Cities are equal to 6 dimensions of smart city Giffinger et al. but added indicators of sustainability in a smart environment [2], Maria's five dimensions, namely smart technology, smart economy, smart people, smart governance, and smart environment [7], or other dimensions that can be assessed according to the characteristics of the city. will be assessed. After the dimensions are determined, the next step before the assessment is to determine the assessment indicators for each dimension; these indicators can be in the form of achievement level [8], website address or application domain [1], and indicators set with certain criteria [6]. This research has 4 parts, namely introduction, research methodology, analysis and results as well as conclusions, where the way the author conducts a systematic review is contained in part 2, the results of the literature analysis related to the dimensions of smart cities and the level of achievement (especially smart cities and technology) as an alternative to smart city assessments—contained in section 3, while at the end (section 4), the conclusions and future direction of the study will be presented.

Smart technology is deemed necessary to be added to the smart city dimension because ICT has an important role in smart city implementation [13] [14]

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[1]. Some literature only mentions the role of Information and Technology (IT) in the dimension of smart technology, but has not explained the organizer level indicators for the dimension of smart technology. Therefore, in this study, the scope and indicators for the dimensions of smart technology will be determined which will be used as the basis for assessing smart cities.

## 2 Research Methodology

The approach used in this study is the methodology by Kitchenham, where the literature selected based on certain criteria will be used to answer predetermined research questions [9]. These stages are carried out as follows:

### 2.1 Design Research Question

The main objective of this study is to obtain all indicators of the level of achievement of each dimension of smart technology in the context of a smart city with the hope that it can be used as a basis for assessing smart cities. Design Research questions that have been identified in Table I.

**Table 1.** Reseach Question Design.

Aspec	Explanations
Population	Smart City Indicators/Dimensions/ Components (not limited to certain countries, regions or continents).
Intervention	Smart Technology Indicators/Aspects , ICT for Smart City, IoT for Smart City, stc.
Comparison	n/a
Outcomes	Indicators level achievement from all dimensions of smart city (especially in the dimension of smart technology)
Context	Konteks dalam research ini adalah dimensi dan indikator level achievement smart city (terutama pada dimensi smart technology).

### 2.2 Search Process

The literature search stage is carried out using digital libraries such as Scopus, Science Direct, IEEEExplore, and SpringerLink. The keywords used to determine are in Table 2. The keywords used in this study are shown in Table 3.

**Table 2.** Keyword and Search String

Stage 1			
AND	AND	AND	Result
OR	OR	OR	
Level*	Smart	City	7.302 Papers
Indica-tor*	Digita-l*	Cities	

Phase*	Elec-tronic*				
Asses-s*	e-*				
	Inov*				
Stage 2					
AND	AND	AND	AND	Result	
OR	OR	OR	OR		
Leve-l*	Smar-t	City	Archi-tecture	2.109 Papers	
Indic-a-tor*	Digit-al*	Citie-s	Techno-log*		
Phas-e*	Elec-troni-c*				
Asse-ss*	e-*				
Stage 3					
AND	AND	AND	AND	AND	Result
OR	OR	OR	OR	OR	
Leve-l*	Smar-t	City	Archi-tecture	Dimen-sion	92 Papers
Indic-a-tor*	Digit-al*	Citie-s	Techno-log*		
Phas-e*	Elec-troni-c*				
Asse-ss*	e-*				

Table 2 shows the stages in the search for papers, the process of filtering papers by reading the titles and abstracts of the papers and sorting based on the ranking of the relevant and most cited papers so that the papers analyzed and considered according to the topic and research questions are not limited to the papers listed in keywords. search results in stage III Table 3. In some conditions, the literature search is not limited to the papers published above in 2016. The final selected papers used as references for this research are 20 main study papers.

### 2.3 Design Criterias

The search for papers supporting this study is limited to the criteria in Table 3.

**Table 3.** Inclusion and Exclusion Criteria

Descriptions	Type
Published research papers starting from 2016 to 2021.	Inclusion
Papers in the type of technical and review articles.	Inclusion
Papers that match the smart city search string and indicator level.	Inclusion
Papers must answer the research question.	Inclusion

Papers published before 2016	<i>Exclusion</i>
Conference papers	<i>Exclusion</i>
Subject areas that are not relevant to the field of General Science (not limited to computer science, social science, environment science, engineering)	<i>Exclusion</i>
Incomplete paper (not full text)	<i>Exclusion</i>

### 3 Result and Discussion

#### 3.1 The Roles of ICT in Smart City

The concept of implementing technology in a smart city, the search for references first focuses on the definition of a smart city. Smart city is defined as the application of technology and infrastructure to improve the quality of life and sustainable resources [10]. Smart cities apply technology with the hope that the technology can solve all daily problems [11]. Smart city cannot be defined only in the context of the application of technology, but also how technology can improve economic growth, competitiveness, health, social, environment and employment opportunities [4][2].

It was found that almost all definitions of smart cities use the term technology, this shows that technology has an important role in realizing a smart city [1]. The application of technology in smart cities such as the Internet of Things, Cloud Computing and Big Data in smart cities is carried out to connect every component in all layers of the smart city [13].

To implementation a smart city, the role of not only the government but also the responsibility of all stakeholders is needed [2]. Details of the role of Information and Communication Technology (ICT) based on the definition of smart city from various literature sources as shown in Table 4.

**Table 4.** Technologies Roles in Smart City

Definitions	Key Term	Reference
Application of technology to increase economic growth, health and employment.	Technology, employment, health and economic growth,	[1]
Implementation of intelligent technology and interactive infrastructure for sustainable quality of life and resource improvement	Technology, infrastructure, smart, interactive, quality of life and sustainable resources	[2]
Smart Technology used to provide services to stakeholders. This technology draws on ambient intelligence for smart energy, smart mobility, and smart healthcare.	Technology, services, stakeholders, ambient intelligence, smart energy, smart mobility, and smart health care.	[3]
The application of technology to solve all existing everyday problems.	Technology, everyday	[4]

	problems, society.	
Application of technology for socio-economic, environmental, and city/local operational aspects.	Technology, socio-economics, environment, and city logistics.	[5]
The implementation of technology in line with policies and strategies for implementing technology and infrastructure in the country.	Technology, policy, strategy, implementation, and infrastructure.	[6]
Implementation of Information and Communication Technology to improve services, especially integration with all domains.	Technology, information, communication, service, integration.	[7]

#### 3.2 The Roles of Smart Technologies in Smart City

Knowing the role of ICT in a smart city, an analysis was carried out with a literature review to determine the dimensions of smart technology in the smart city context. The most popular or most frequently used smart city dimensions are the 6 dimensions of Giffinger et al (smart mobility, smart living, smart environment, smart people, smart government, and smart economy) [3] with smart technology one of the dimensions of the smart city from various other literature perspectives. dimensions of smart technology can be seen in Table 6.

**Table 5.** Deskripsi dimensi smart technology

Dimensi	Components	References
Smart technology	<ul style="list-style-type: none"> <li>• The use of smart computing for government services.</li> <li>• The use of renewable technologies such as internet of things, big data, sensing, and business intelligent.</li> <li>• Service and technology interconnection.</li> <li>• System integration.</li> <li>• Focus on data.</li> <li>• The use of architectures such as cloud computing, fog computing and edge computing.</li> <li>• Provision of electronic-based applications for government services (Government to Government (G2G), Government to Business (G2B), Government to Citizen (G2C), and Government to Employee (G2E)).</li> </ul>	[8]
	<ul style="list-style-type: none"> <li>• Integration of technology and architecture.</li> <li>• increased information security and data privacy.</li> <li>• Data exchange, big data.</li> <li>• Improve cyber security and data privacy.</li> <li>• Data processing.</li> <li>• Data storage.</li> <li>• Technologies for smart cities (Internet of Thing, Sensing, smart grid).</li> </ul>	[2]
	<ul style="list-style-type: none"> <li>• Technology and infrastructure investment.</li> <li>• Integrated technology.</li> <li>• Security information.</li> <li>• Digital administration and services.</li> <li>• Mobile and web technology.</li> </ul>	[6]

	<ul style="list-style-type: none"> <li>• Data storage, processing and visualization.</li> <li>• Strengthening the network or ICT network.</li> </ul>	
	<ul style="list-style-type: none"> <li>• Use of renewable technologies such as Internet of Thing, Big Data, Sensing, and Business intelligent.</li> <li>• Use of cloud computing.</li> <li>• Use of artificial intelligence</li> </ul>	[5]
	<ul style="list-style-type: none"> <li>• Use of smart box mesh network.</li> <li>• Use of software architecture.</li> <li>• Use of Data collecting, storage, and decision making.</li> <li>• Use of wireless communication technology.</li> </ul>	[9]

The relationship smart technology based on Table 5 and Table 6, the dimensions of the smart city can be explained in Table 7.

**Table 6.** Deskripsi dimensi smart city based [Griffger]

Dimensions	Descriptions
<b>Smart Mobility</b>	Leads to creation <i>smart transportation</i> teknologi seperti <i>smart route, smart vehicle, smart traffic management</i> and <i>smart alert driving system</i> .
<b>Smart Living</b>	Leads to improving the quality of life such as <i>smart home, smart health, smart education, smart culture</i> atau <i>tourism, dan public safety</i> .
<b>Smart Environment</b>	Leads to environmental efficiency such as resource management, maintaining green open spaces, use of renewable energy, green and clean energy, emission control, pollution, air quality, and water quality.
<b>Smart People</b>	Leading to community involvement for government services, data privacy, as well as increasing expertise, skills, intelligence, creativity, and technology adaptation in society.
<b>Smart Government</b>	Leads to the provision of government services, openness, transparency and accountability of data, information between departments, communities, and businesses.
<b>Smart Economy</b>	Leads to supporting local businesses to increase productivity, competition and global markets.
<b>Smart Technology</b>	Leads to the use of renewable technology and infrastructure, system integration, focus on data development, artificial intelligence and provision of electronic-based government applications.

The main dimensions of a smart city, such as smart technology [10] [7] [1] [2] [11] [12] [17] are important to add considering that the basic component of a smart city is technology as the results of the literature review determine the role of ICT based on the definition of smart. city in table 5. The technology in question is not the main component of a smart city, but is a basic component for implementing all components/dimensions in a smart city [12], therefore in this study the dimensions of smart technology will be added.

### 3.3 The Level Achievement Indicators in Smart Technology

To implementing a smart city, indicators are needed to assess whether the goals of smart city development have been achieved from all aspects that have been set [19]. These assessment indicators may vary as shown in Table 7.

**Table 7.** Assessment Smart City Indicators

Indicators	Ref
Using 4 levels of achievement indicators with basic, medium, advanced, and state of the art levels in every dimension of the smart city (smart mobility, smart living, smart environment, smart people, smart government, and smart economy).	[10]
Using 5 levels of maturity indicators for each dimension of smart city (smart mobility, smart living, smart environment, smart people, smart government, and smart economy) with details: <b>Level 1:</b> Smart city implementation <10%, where there is no system to support services. <b>Level 2:</b> Implementation 10%<x<40%, where ICT integration is limited and the concept of a smart city implementation strategy is found. <b>Level 3:</b> Implementation 40%<x<=70%, where the smart city basis has been implemented, ICT integration, and smart city goals are documented. <b>Level 4:</b> Implementation of 70%<x<=90%, where the results of Strategic PlanI can be measured, documentation is clear, evaluation of implementation is carried out, and continuous improvement is carried out by learning or adopting from other cities, stakeholders, and best practice cases. <b>Level 5:</b> Implementation >90%, where continuous planning is carried out with real time data, the use of artificial intelligence, and integration with all stakeholders. The city focuses on sustainability that prioritizes quality measurement and improvement.	[11]
The indicator value is from 1-100 with certain dimensions of the smart city, where the number 100 is the ideal smart city condition.	[6]
Using indicators that represent 26 factors in each dimension of a smart city (smart mobility, smart living, smart environment, smart people, smart government, and smart economy).	[12]
Using 3 main work areas in each dimension of the smart city (smart mobility, smart living, smart environment, smart people, smart government, and smart economy).	[13]

In this study, the indicator level will be divided into 4 parts as the concept of Y. Mohd Adnan et al refers to Table 9. The indicator level of each smartcity dimension is divided into 4 parts where level I represents the basic level, level II represents the intermediate level, level III represents the advanced level, and level IV states the level of state of the art. The use of the concept of Y. Mohd Adnan et al in this study was carried out because the concept presented by Y. Mohd Adnan et al is a simple concept modified from the Giffinger concept with leaner data (mainly using qualitative data and heuristic concepts). In addition, the application of the concept of indicators of the level of achievement of smart cities by Y. Mohd Adnan et al. has been carried out in the cities of Iskandar Malaysia, Singapore, and Seoul, where the characteristics of the city resemble other cities in Asia Pacific such as cities in Indonesia. The details of each indicator of the level of achievement of the smart city as a concept by Y. Mohd Adnan et al can be seen in Table 8.

**Table 8.** The level achievement smart technology

Dimensions	Level	Description
Smart Technology	Level 1	The use of layer sensors in smart cities[14][15].
	Level 2	Integration between applications [14][15].
	Level 3	The use of renewable technology at the intelligent layer such as internet of things, big data, cloud computing services and intelligent grid[14][15].
	Level 4	Improving the quality and scope of applications, increasing the use of artificial intelligence and accommodating citizen feedback (citizen centric) as well as all stakeholders who use the system[[15][14].

Table 8 Showed the indicators for the level of achievement of smart cities listed in Table 10 do not show smart technology as one of the dimensions of a smart city. Indicators of the level of achievement of smart cities for the dimensions of smart technology are also determined by the concept approach of Y. Mohd Adnan et al which is carried out heuristically based on the smart city roadmap and industrial development 4.0.

#### 4 Conglusion and Future Work

The concept and definition of a smart city from various sources is very diverse, but it can be concluded that a smart city is the use of smart and integrated technology and infrastructure to solve everyday problems and improve the quality of life in a sustainable manner. Given the very large role of technology in smart cities, the dimensions of smart technology were added to the smart city which previously referred to the 6 dimensions by Giffinger [Reff].

The dimensions of the smart city are analyzed in terms of the scope and indicators of the level of achievement by using a heuristic approach as the concept of indicators of the level of achievement of the smart city by Y. Mohd Adnan et al [Ref]. In determining the scope and indicators of the level of achievement of a smart city, the research also focuses on determining the scope of dimensions and indicators of the level of achievement of smart technology. The phase or level that occurs in smart technology starts from the use of sensing technology, then continues with integration between applications and the use of smart and innovative technology to support the creation of a smart city. The last stage or the highest level of smart technology is the evaluation and continuous improvement of the applications and technologies used by involving all stakeholders and focusing on the needs of stakeholders.

For future work, the study aims to introduce the concept of Y. Mohd Adnan et al, where the concept of determining the level of smart city assessment indicators is carried out using a heuristic approach by modifying the Giffinger concept for smart city assessment by adding dimensions to the smart city with the dimensions of smart technology. The approach to determining the

indicator level of the smart city assessment with other concepts such as a quantitative approach with more complex indicator data.

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