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Smart city's trends, architectures, components, and challenges: A systematic review and building an initial model for Indonesia

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Abstract

Smart cities are faced with the challenges of systematically initiating the strategies needed to implement predetermined goals according to their plan. Therefore, this study aims to identify smart cities components and build an initial model that can be used for smart cities initiatives in Indonesia. The systematic review methods were used to overview research trends, architecture, components, and challenges to build an initial model for Indonesia. The systematic review results show popular topics, such as the standardization of a smart city and the strategies used to determine relevant models in each city's uniqueness and context. The results also identified thirteen smart city components and their challenges. Furthermore, this study's novelty is proposed the smart city's initial models with the smart government as a key component and to be a centre of other smart city components. The triangulation method determined the research validation using systematic review finding, expert judgment, and a questionnaire for collecting random data from 66 respondents from various cities in Indonesia. The collected survey data and initial models were validated by expert judgment, which showed that the proposed smart city's initial model component's agreement is 90%. In future, these results may be used to develop an assessment in smart cities implementation.

Keywords: Smart cities, Systematic review, Research trends, Component, Architectures, Initial models

1. Introduction

Over the last decade, topics related to Smart Cities (SC) have become one of the most popular studies for universities, governments, businesses, and researchers. It is quickly gaining global attention as a hopeful response to city development in the world and most cities in Indonesia [1, 2]. SC is an application of the Internet of Things (IoT) notion [3], which increases unrelenting urban population growth and city urbanization to provide an innovative solution to deal with urbanization with profound effect on townspeople lifestyles, environment, and government. The optimization of information and communication technology have developed the telicity, digital, and electronics perspective of cities [4]. Furthermore, its definition has built smart cities and helped with its operations with minimal people intervention. Smart cities are emerging as solutions to overcome challenges associated with a rapid rise in population and urbanization. However, its definitions are still ambiguous, fuzzy and not mainstreamed along with the word due to technological, economic, people, governing constraints, and real-world practice [5]. Therefore, a conceptual model [6] to determine the right strategies to implement for smart cities to succeed.

This study aims to build an initial model for a smart city in Indonesia through a systematic review of relevant research on publications from 2007 to 2020. A systematic review of data extraction in the form of trends, architectures, components, and challenges is identified and used to build an initial smart city's models for Indonesia. The initial model is validated qualitatively with content analysis and expert judgment and quantitatively using an online academic or citizen's survey.

The mix-methods used through qualitative and quantitative approaches aim to define a holistic conceptual view and provide answers to the research question from systematic review design [7]. The research methods stages shown in Figure 1.

2. Materials and methods

This section discusses the systematic review and the methods used to obtain research objectives, such as building an initial model for the smart city. Figure 1 shows the research flow and methodology steps used in this research.

This is qualitative and quantitative research, with the first stage comprising a Systematic Review (SR) used to determine trends, architectures, components, and challenges in scientific databases [7]. In the second stage, SR was used to determine components and sub-components for building an initial model with the results extracted using content analysis. The third stages validated the research with a quantitative approach used to confirm factors and agreements with online surveys in the academic group. Finally, the model was validated by expert judgment with the detailed SR methodology explained in the next section.

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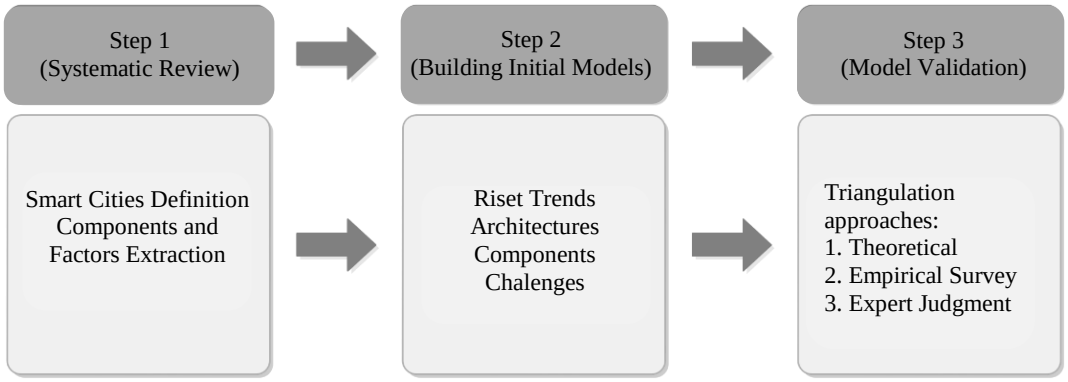


Figure 1 Research methodology steps

2.1 Systematic review protocols

The systematic review (SR) is now a well-established review technique in research methodology used to determine the outlines and resume of a special field of study, thereby allowing readers to establish the reasons for analyzing a specific study, such as the topic on smart city initiatives. The SR is defined as the process of identifying, evaluating, and defining all existing study evidence to provide an argument to a specific pre-designed RQ [8, 9]. The Systematic Review in smart city field study is a critical and in-depth evaluation of previous research on trends, architecture or model, components, conceptual frameworks, and field study challenges [10, 11].

The SR stage includes three phases, namely: planning, implementation, and reporting. In the first step, the SR requirements are defined (Stage 1) with the background and motivations objectives for reviewing the literature discussed in the introduction sections. This is followed by the definition and evaluation of smart city components. The study mechanism is designed to direct the review protocol's implementation and reduce the possible occurrence of the author's bias (Stage 2). This stage was used to identify research questions, investigate strategies, determine the screening process with inclusion and exclusion protocol, evaluate quality, and extract data at the synthesis stages. Furthermore, after the majority of the study was found manually and in the automatic search and the selected paper, the last stage was conducted (Stage 3). This stage is the retrieval stages and excludes the primary studies based on the keyword, title and abstract. Figure 2 shown a final study base on the review' protocol.

2.2 Research questions

In the previous section, the authors formulated the Research Question (RQ) in the systematic review method, which was primarily based on their passion. A systematic review is used to identify an existing basis for the research work and state of the art. Furthermore, a list of the RQ was determined to keep the study focused on the RQ planned based on Population, Intervention, Comparison, Outcome, and Context (PICOC) [8].

Table 1 shows the (PICOC) structure of the RQ, which is the result of identifying research problems from the literature with similar topics in order to determine future directions. This study also identifies critical factors or components that build an initial model on a smart city's topics. It is also essential to know each factor or components that have their challenges. Therefore, the RQ also shows the different relevance of each local contextual solution for each challenge.

Table 1 Criteria of review with PICOC

Criteria	Keyword term
Population	Smart city, smart cities, digital city, ubiquitous city, sustainable city, smarter city, intelligent city
Intervention	Smart city trends, smart city architectures, smart city components, smart city framework, smart city model and challenges.
Comparison	n/a
Outcomes	Smart city factors and indicators, smart city components, smart city model
Context	Case studies in smart cities theoretical and practice in the real world.
Criteria	Keyword Term

Table 2 Research questions design

ID.	Research Questions (RQ.)	Motivations
RQ1	What kind of research trends are most selected by the researcher in the smart city field?	to identify research trends in the smart city field
RQ2	What kind of architecture is the most popular for the smart city?	to identify architecture commonly used in the smart city field
RQ3	What kind of components are used for smart city initiatives?	to identify components for smart city
RQ4	What kind of framework or models are used for the smart city?	to identify a framework or model for smart city
RQ5	What kind of challenges are most often in a smart city?	to identify the most challenges in the smart city
RQ6	How does to build an initial model for smart cities initiatives in Indonesia?	to propose an initial model for a smart city in Indonesia

Table 2 shows smart city research trends, architectures, components, frameworks/model, and challenges to answer RQ1 to RQ5. RQ6 was designed to provide answers to the proposed initial model for smart cities initiatives in Indonesia.

The effectiveness of the RQ formulation needs to focus on five elements known as PICOC:

- Population (P)-It defines the target group for the investigation. The search formulation is smart city OR smart cities OR digital city OR ubiquitous city OR sustainable city OR smarter city OR intelligent city.
- Intervention (I)-It specifies the investigation aspects or issues of interest to the authors, and the search formulation is Smart city trends OR smart city research OR smart city architectures OR smart city component OR smart city framework OR challenges.
- Comparison (C)-It defines aspects of the investigation in which the intervention is compared.
- Outcomes (O)-It defines the effect of the intervention, and the search formulation is Smart city factors OR smart city components OR smart city indicators OR smart city solutions OR smart city model.
- Context (C)-It is defined as the setting or environment of the investigation.

2.3 Search strategy

The search process strategy was performed in three phases, consisting of more detailed form activities. These include identifying all sources published in the online database libraries, define the search string and selection, carry out an initial search, filter the search keyword, and analyze the initial list of main studies from the online database that fit the keyword string. Before starting the search, a suitable set of the scientific library was chosen to increase the potential of determining highly relevant papers. In the last stage, a final list of 40 articles is included in the primary studies. The most popular literature databases searched to have the broadest set of studies with extensive and broad coverage are shown in Figure 2. The online databases searched consist of Scopus (scopus.com), IEEE Xplore (ieeexplore.ieee.org), ACM Scientific databases (dl.acm.org), Science Direct (sciencedirect.com) and Springer (springerlink.com).

The text string was afterwards adjusted to suit the fixed requirements of each scientific databases sought by text title, keyword, and abstract. This research was limited by the year of publication 2007-2020 (13 years) by only articles published in English. Moreover, the last steps were defined by determining relevant articles or primary studies with full skimming searching. The following search string was used in this study.

(Smart city OR smart cities OR smarter city* OR ubiquitous city* OR digital city) AND (initiative* OR measurement* OR factors *OR indicator * OR model* OR framework) AND (trends* OR architectures* OR component OR framework* OR challenges).* Construct a current keyword string using the text search term, Boolean AND's and ORs.

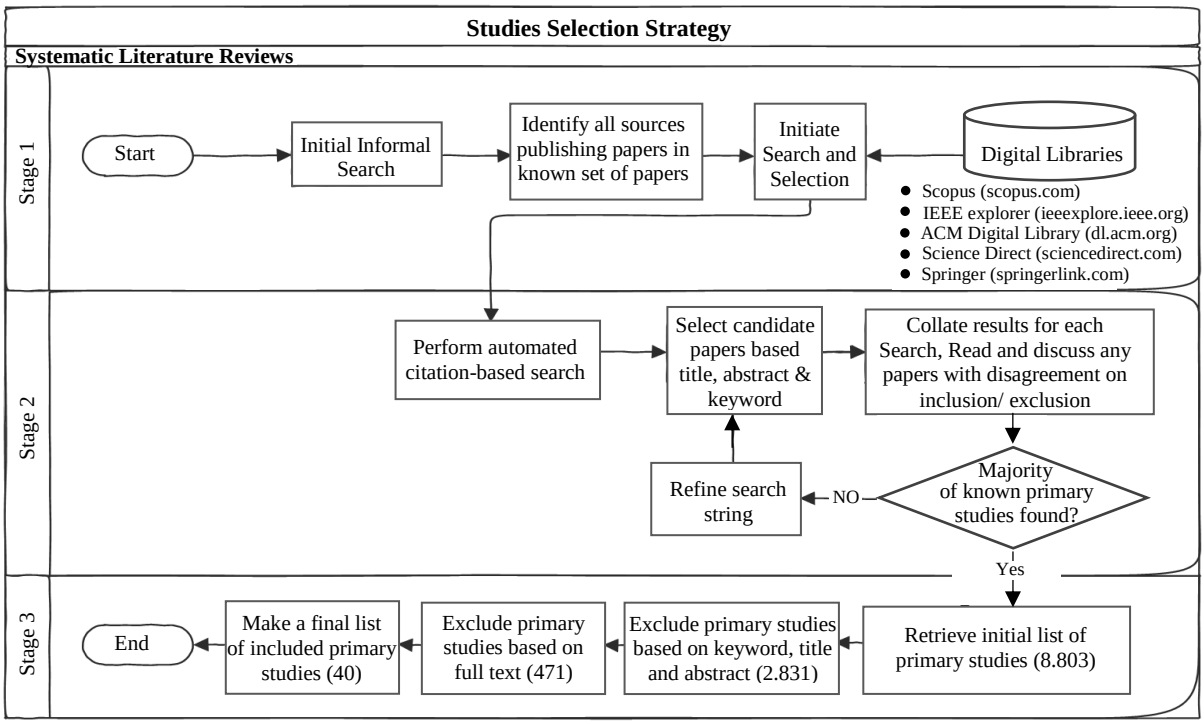


Figure 2 Protocol review of primary studies

Figure 2 shows that the search technique was developed based on the following stages:

- Identify the terms from PICOC formulations.
- Define the terms from RQ formulations.
- Define the terms from relevant paper titles, abstracts, and keywords.
- Define antonyms, alternative text, and synonyms

The selections process and the number of primary studies were identified at each stage, as shown in Figure 2. Stages 1 - 3 were established in two aspects, namely the exclusion of primary studies based on the title, abstract and the full text of the article. The systematic review and subsequent literature studies that do not include tentative results are excluded. In the last step, the result of selected papers for the first stage was 8.803 obtained from full texts of 40 primary papers. In addition to the inclusion and exclusion criteria, the authors analyzed their relevance to the RQ and study similarity while considering the primary studies' quality. Similarly, studies related to the same authors in various articles from the journals were removed. The selection result that remained after the exclusion of studies based on the full-text selection in all stages is shown in Figure 2.

The primary study was selected using the inclusion and exclusion protocol for choosing a relevant article, as shown in Table 3.

Table 3 Criteria selection

Criteria	Keyword Term
Inclusion	Studies in theoretical in academic literature and empirical study in the case in the real-world Studies discussing factors or indicators or models or framework or architectures or case implementations in the area of smart city fields The inclusion criteria of paper type are both the journal and conference. Only the journal or conference versions will be included
Exclusion	Double publications of the same study, only the newest and most complete data one will be included, and the paper languages must be in English.

2.4 Data extraction

The data extraction process was used to collect data that contribute to addressing the research questions. For each of the 40 chosen articles, the data extraction form was finished (Step 2) and collected from the main articles to answer the Research Questions (RQ1 to RQ6). The process defined through the inclusion of the exclusion criteria and analysis was introduced in Table 3. Seven properties were used to answer the research questions, as shown in Table 4.

Table 4 Criteria of review with PICOC

ID	Properties
RQ1	Data extraction of topics trends in smart city fields
RQ2	Data extraction of Smart City architectures
RQ3	Data extraction of Smart City components
RQ4	Data extraction of Smart City frameworks or Model
RQ5	Data extraction of Smart City Challenges
RQ6	Data extraction of initial Model for Indonesia

2.5 Study quality assessment, data synthesis, and validity

The study quality assessment (Step 3) in Figure 2 and data extraction can be used to guide the interpretation of synthesis findings and to determine the related conclusions. Data synthesis was carried out to gather evidence from the articles, which was chosen to answer research questions. The data extraction technique in this review uses a mixed-methods approach which includes quantitative and qualitative methods. Strategies used to synthesize the extracted data related to various types of research questions (RQ) were searched. Generally, this research used the narrative synthesis method with data consistently tabulated using the RQ process. Furthermore, several infographic tools, including tables, pie charts, and bar charts, are also used to enhance smart city models' distribution.

In addition, the paper validation methods used expert judgment to select paper or primary studies in accordance with pre-established research plans based on research questions [12]. For the validation of the proposed model of smart city initiatives in Indonesia, this research used a questionnaire prepared to determine the agreement of smart city indicators. The respondents in this study come from the demand side, such as the community (citizens) that have already received government services of the cities. Finally, the authors proposed an initial model for Indonesia and validated it using triangulation sources, such as theoretical or systematic review, expert judgment and survey questioners.

3. Results and discussion

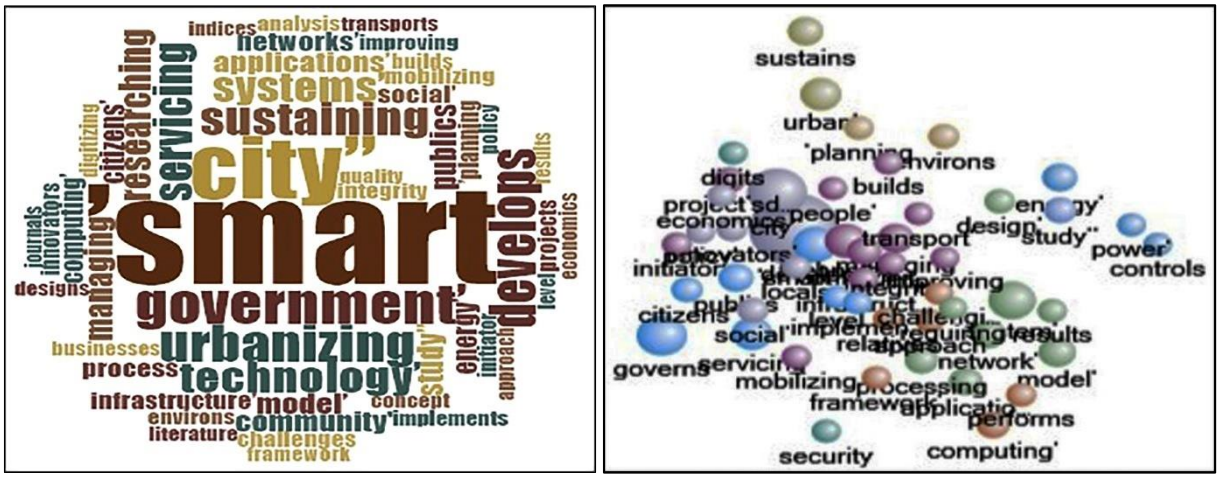
The results of the study are outlined in the following points and used to answer the research question that has been previously designed.

3.1 Research trends in smart city field

Figure 2 (in stage 1) shows that the initial searching and selections from the scientific databases, 80.803 documents were found based on the Scopus index. The searching paper is carried out based on the string on keyword, title and abstract. Smart Cities are an essential research topic in the interdisciplinary theory domain [1, 13]. Furthermore, the selected primary studies' analysis revealed that current smart cities research focuses on two general topic outlines, namely: conceptual or theoretical and empirical or case studies in the real-world.

Figure 3 shows the thematic analysis using NVivo tools for the past 13 years (2007-2020) as follows, (a) visualization of the word cloud and cluster analysis of primary studies found in searches with the keyword string specified in steps 1. Figure 3(b) shows that most keywords with stemmed words are "Smart OR Smartness," "City OR Cities," "Governs OR Governance OR Government," "System," "Develops OR Developed." Furthermore, Figure 3 visualizes the closeness between themes such as the words "Smart" with "City," "Urbanizing" with "Sustaining," "Govern" with "Citizens" and "Public," "Technology" with "Development" and "Models."

The content analysis is used to determine the trends in smart cities fields over the last thirteen years (2007-2020). This literature review was carried out to determine whether smart cities are primarily scientific perspective, built on conceptual grounds, or arise from concrete implementation in urban areas, and the relationship between conceptual and case studies in the real world [13]. Furthermore, this study also aims to investigate whether smart cities are bottom-up or top-down phenomena. For comparison, the case of Amsterdam Digital City, which is one of the best practices in Europe, has become a bottom-up phenomenon that grows from the Internet free of charge by citizens to share their opinions before local votes [14]. Further lesson learn from Amsterdam Smart City emerged like a top-down project that took the lead role to implement some smart initiatives in urban areas. Understanding the origins of city development, both theoretical and empirical, helps readers to understand better the phenomenon of Smart Cities or Digital City [11].



(a) (b)

Figure 3 (a) Visualization of the word cloud and (b) Cluster analysis of primary studies

3.*2 Smart city architectures*

Due to the ambiguous definition of smart cities, their architecture is diverse without unified criteria. This led to the storage of many smart city architectures in the digital library that focuses on multi-dimensions, such as technology, people or human interaction, and organization. These studies provide a list of popular architectures to help provide better views of smart cities' foundation factors [4, 15]. From the literature review, conclusions on three general forms of smart city architecture structure, namely a layered form with multi-tier structure, modular forms structure, and a combination of layered and modular, were proposed. The layered form is the most popular system architecture, and its components, according to [4], are as shows in Figure 4.

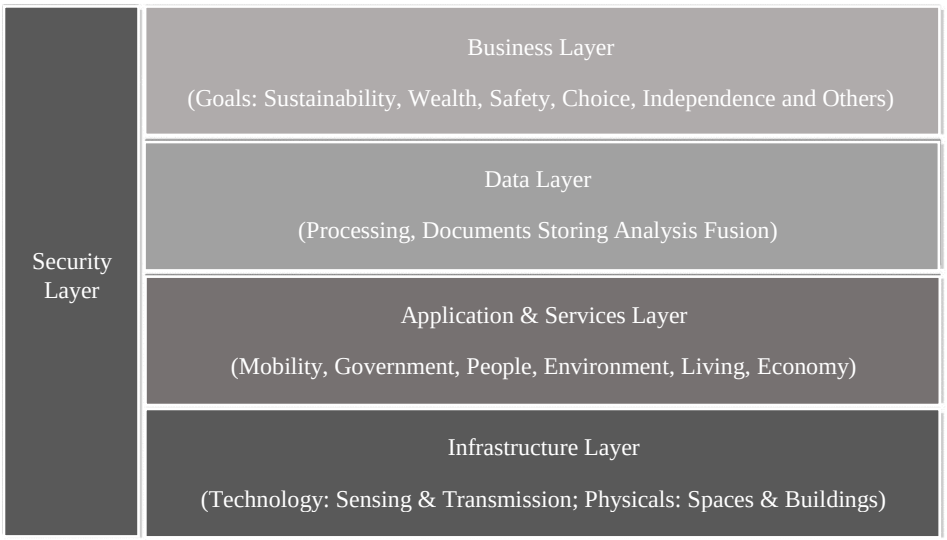


Figure 4 Common layered style architecture of smart city

Based on previous work from [4, 10, 11] and after a thorough analysis of some existing architectural models, the bottom-up architecture showed the majority architectural model of the proposed work. This Architectural model consists of four layers, namely the infrastructure layer, the application and service layer, the data layer, and the business layer. Security issues such as sensitive data protection are the main problem of every smart city. Therefore, it needs to be included in every layer. Data series from devices are the main areas of the infrastructure layer, which is at the basis of the architecture. The infrastructure layer moves data, while the applications/services and data layer processes and store valuable information used to provide services offered by various destinations in the business.

The shape of the smart city architectures is validated by experts in the fields of academic and industry. Another form of generic architectures is shown in Figure 5. This form describes architectures modularly by focusing on the smart city aspect, namely business, security, applications/services, data, and infrastructure modules. Furthermore, it is subdivided into small modules that are downgraded into some of the surrounding elements from each aspect or element. Except for the multi-tier architecture model, a modular structure which is a comprehensive process is executable and need to consider both the city model and the architecture view. A smart city with soft infrastructures, such as data, information, people, and applications, is simple, easy to interconnect and extensible among devices [16]. In contrast, it is a complex infrastructure and physical environment with many limitations in the modular definition. Except for the architectural models previously reviewed, several works to design modular smart city architecture suggest a structure consisting of the components, as shown in Figure 5.

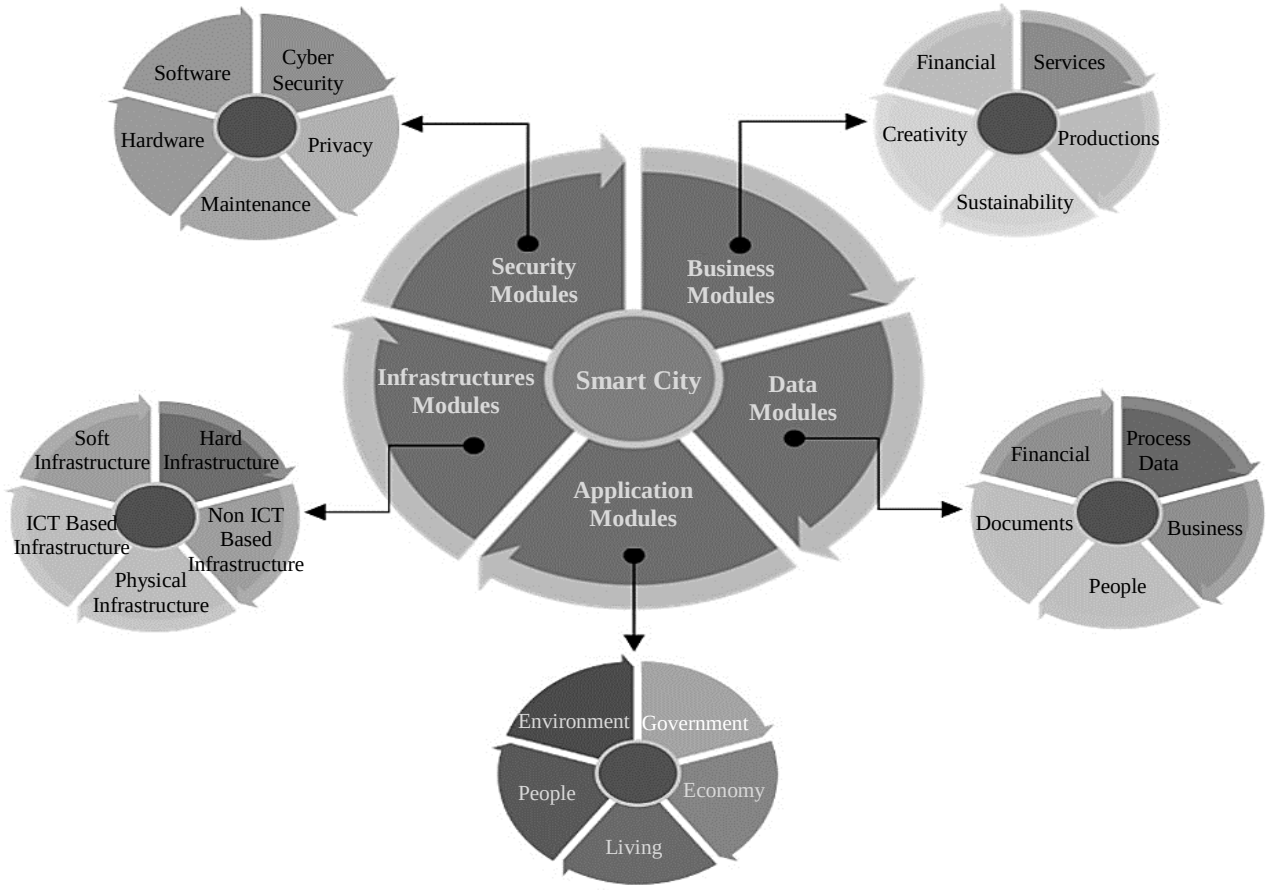


Figure 5 Common modular style architecture of the smart city

The systematic reviews from the list of primary studies are shown in Table 5. Furthermore, the data extracted and used to answer RQ3 from this study are listed by protocol review of primary studies stages to generate thirteen common smart cities dimensions/components, namely Smart government or governance and eGovernment or Public Services, Smart Planning or Design, Smart Economy and e-commerce/business, Smart Infrastructure and Building, Smart Living or Home, Smart Mobility or Transportations, Smart people/citizen and communities, Smart Technologies, Smart Healthcare, Smart Energy and Grids, Smart Surveillance or Security and Public Safety as well as Smart Environment and Natural Resource.

3.3 Smart cities components and challenges

Although there is no consensus on a smart city's precise definition, some critical components have been defined through several systematic reviews. The smart city' components include smart government or governance and eGovernment or Public Services, Smart Planning or Design, Smart Economy and e-commerce/business, Smart Infrastructure and Building, Smart Living or Home, Smart Mobility or Transportations, Smart people/citizen and communities, Smart Technologies, Smart Healthcare, Smart Energy and Grids, Smart Surveillance or Security and Public Safety, Smart Environment and Natural Resource. These thirteen components or factors are relevant to the traditional regional and neoclassical theories of urban growth and smart city development. These components are based on theories of regional competitiveness, mobility and ICT, economics, natural resources, human and social capital, quality of life, and participation of citizens in the governance of cities. The results and findings for the smart city initiative obtained after the extraction of 471 papers in scientific databases are mapped to common components/dimensions.

Table 5 The smart city's components/dimensions and its challenges

Components/Dimensions	Challenges	Papers Source
Smart Government/ Governance/e-Government and e-Services	• Low urban institutional capacities • The gap between government and governed • Unbalanced geographical development • The deficit in social services • Need for new governance models • Lack of Governance Frameworks and Regulatory Safeguards	[17-23]
Smart Planning/Design	• Lack of city Planning • Lack of city strategy and roadmap • Lack of planning support system • Lack of smart cities national references model	[6, 13, 14, 16, 24-26]

Table 5 (continued) The smart city's components/dimensions and its challenges

Components/Dimensions	Challenges	Papers Source
Smart Economy and eCommerce/Business	• High infrastructures deficit • Budget Constraints and Financing Issues • Specific problems of urban youth • Limited urban-based industries • Unbalanced geographical development	[19, 22, 23, 27, 28]
Smart Infrastructure and Building	• Lack of ICT infrastructure and Internet access • Lack Infrastructure integrations • Lack of infrastructure funding • Lack of Investment in Basic Infrastructure	[18, 20, 23, 27-29]
Smart Living and Home	• Urban violence and insecurity • The deficit of social services • Threats to cultural identity • Urban poverty and inequality	[18, 30-33]
Smart Transportations or Mobility	• Lack of public transport • Pollution issues and Traffic congestion/ City traffic • Multimodal transport system • High infrastructures deficit	[18, 32-35]
Smart People/Citizens and Communities	• Lack of citizen behaviour • Social polarization • Global urbanization • Lack of Skilled Human Capital • Lack of Inclusivity • Lack of Citizen Participation • Knowledge Deficit among the Citizens	[22, 23, 36]
Smart Technologies	• Lack of multi-source and multi-temporal data • Lack of real-time decision mechanism • Lack of security and privacy issues • Lack of standards and interoperability issues. • Lack of IoT and Big Data management • Integrating Big and Fast/Streaming data analytics	[35, 37, 38]
Smart Healthcare and Hospital	• Big data in the healthcare context • Lack of mitigations pandemic and citizen healthcare • Lack of healthcare support system for massive treatment	[1, 4, 39, 40]
Smart Energy and Grid	• Lack of Standardization • Lack of Power and energy efficiency • Lack of investment • High energy consumption	[19, 37, 38, 40, 41]
Smart Surveillance/ Security and Public Safety	• Lack of security and privacy • Lack of public safety • Lack of public surveillance systems • Big issues and challenges in Blockchain	[1, 3, 42-45]
Smart Education and Human Capital	• Learning, education, and teleworking issues • Lack of knowledge-based society • Lack of social literacy	[1, 23, 42]
Smart Environment/Natural Resources	• Scarcity of resources • Water scarcity • Climate change effects • Pollution • Rapid growth and Urban sprawl • Waste Management • Carbon Footprint	[4, 13, 22, 30, 46, 47]

Table 5 showed the smart city common components or dimensions and its challenges based on a systematic review from primary studies. Almost all articles discuss smart city components commonly to only six components. However, adding several common more components or dimensions or factors in other studies. Therefore, the components to be completed based on the reference were included.

The Smart city implementation process carried out in this research faced challenges throughout the planning, designing, implementation, and operation phases. Some of the associated challenges are design and operations costs, the interconnection between devices, data collection and analysis processes, data security, and sustainability [5]. Table 5 shows a few main concerns associated with designing realistic smart city components investigations based on a systematic review. Technological solutions in smart cities require to be understood as a guide to realize goals and overcome the obstacles. The main objective of the SC project is to solve the city's problems to improve sustainability and the quality of life of its citizens [5, 29, 48]. From a governance perspective, projects need to be framed in a multi-stakeholder, city-based partnership to provide holistic, efficient, and practical solutions.

3.4 The pilot project smart cities in Indonesia

Some pilot project smart cities in Indonesia initiated several years ago started in Bandung [33]. The proposed aspects of smart city indicator include a smart government with the data command centre, an environment such as a park for singles, and a big mosque that serves as the Islamic centre and a cultural icon and tourist attraction. Furthermore, [49] used GSCM (Garuda Smart City Model) to measure ten smart cities in Indonesia and concluded that they are not already smart. However, this model does not identify the smart cities based on their uniqueness or characteristics, such as the unique nature of the archipelagos and its culture like Bali city, also known as a "smart city."

According to several international standards bodies such as International Telecommunications Union (ITU) or International Standards Organization (ISO), the smart cities' initiatives in Indonesia is still at the initial level [33, 48, 49], SC is measured using technological (ICT-based) and non-technology (natural resources aspect, human aspect, and institutional aspect) devices [33, 36]. A city with its own tourism charm (smart tourism) is a smart city based on the indicators or its characteristics. The smart cities research in Indonesia in the future is used to identify numerous advantages of each city for its citizens' competitive advantages.

Several other studies, such as in Yogyakarta, use smart city readiness to determine its framework [48]. The method connected technology enabler with city responsibilities and used the validation method in groups of doctoral students and e-government research groups. In general, smart city enabler technology project related to analytics is moderate, at 50%. This shows that the evaluation of smart city projects is only partially realized in Yogyakarta. Table 5 showed the relationship between the components of a smart city and its challenges.

3.5 An initial model for Indonesia

Based on the discovery process of the systemic literature review conducted on 471 Paper and the analysis used in 40 primary studies, the authors initiated thirteen components used to create smart cities initial model in Indonesia, the list of primary studies as shown in Table 6 in Appendix.

The model used in this study was validated using questionnaire agreement and expert judgment. Furthermore, the agreement test was carried out by an online questionnaire distributed among academician/lecturer group all over Indonesia. Data were obtained from 66 people spread in various cities in Indonesia. The demographics of respondents is shows in Figure 6.

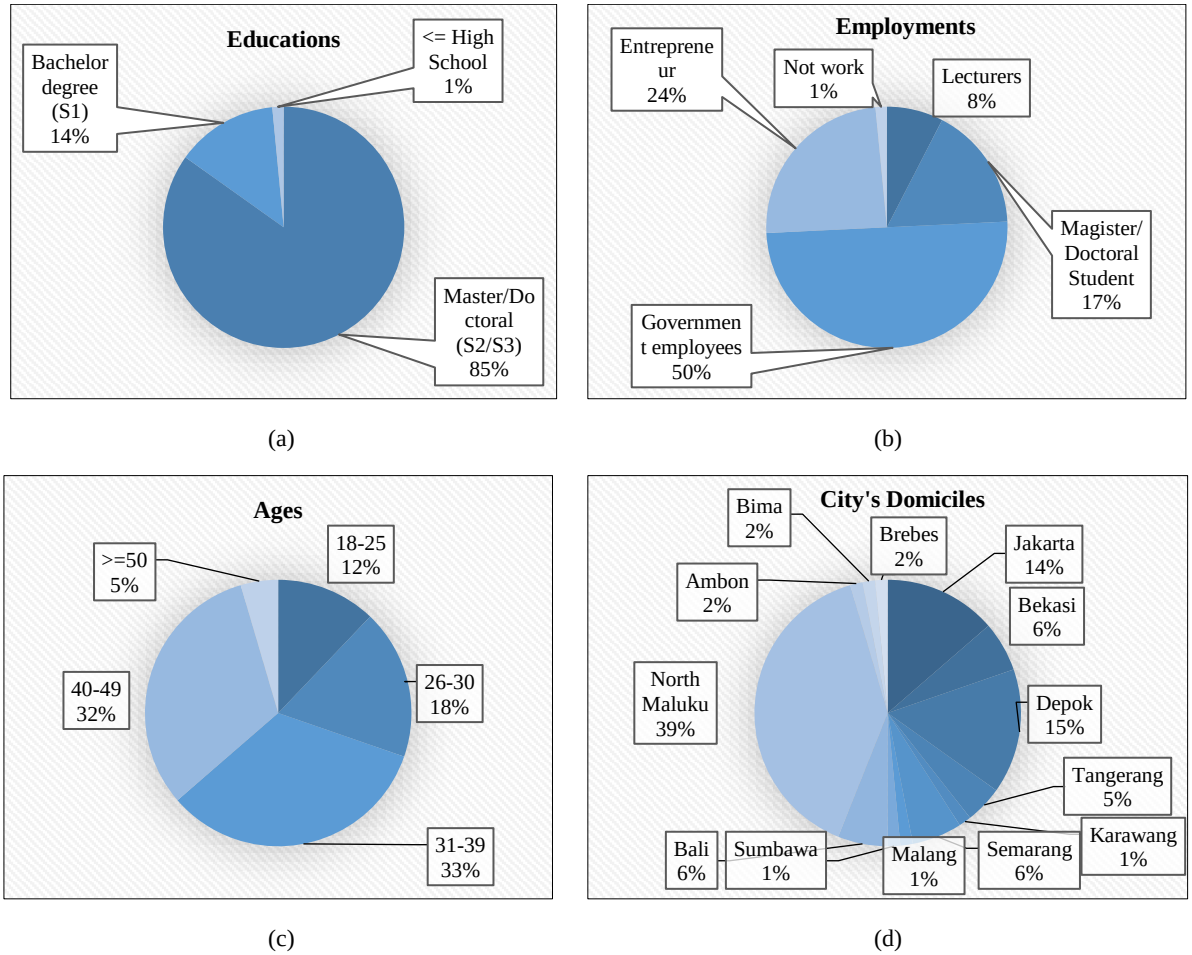


Figure 6 (a)-(d) The Demographics of respondents from the various city in Indonesia

The demographics of respondents are shown in Figure 6. It consists of 50% government employees, 24% of entrepreneurs, 17% of students and 1% of not working. The data domicile is mostly from North Maluku provincial (39%), Depok City (15%), Jakarta City (14%), Semarang City (6%), Bali City (6%), Bekasi City (6%), Tanggerang City (5%), Ambon City (2%), Bima City (2%), Brebes district (2%), Sumbawa, Malang City, and Karawang district each at 1%. The educational data is a graduate of S2 or Master/Doctoral while age is productive age at 18-49 years (95%).

Figure 7 shown that the model used to describe the unity of integrated systems among smart cities' components is based on a literature finding. Furthermore, a proposed idea of a smart city initial model in Indonesia is known as "Smart Nusantara." It is the digital archipelagos model because it philosophizes the uniqueness and diversity of the Republic of Indonesia's unitary state, also known as Negara Kesatuan Republik Indonesia (NKRI).

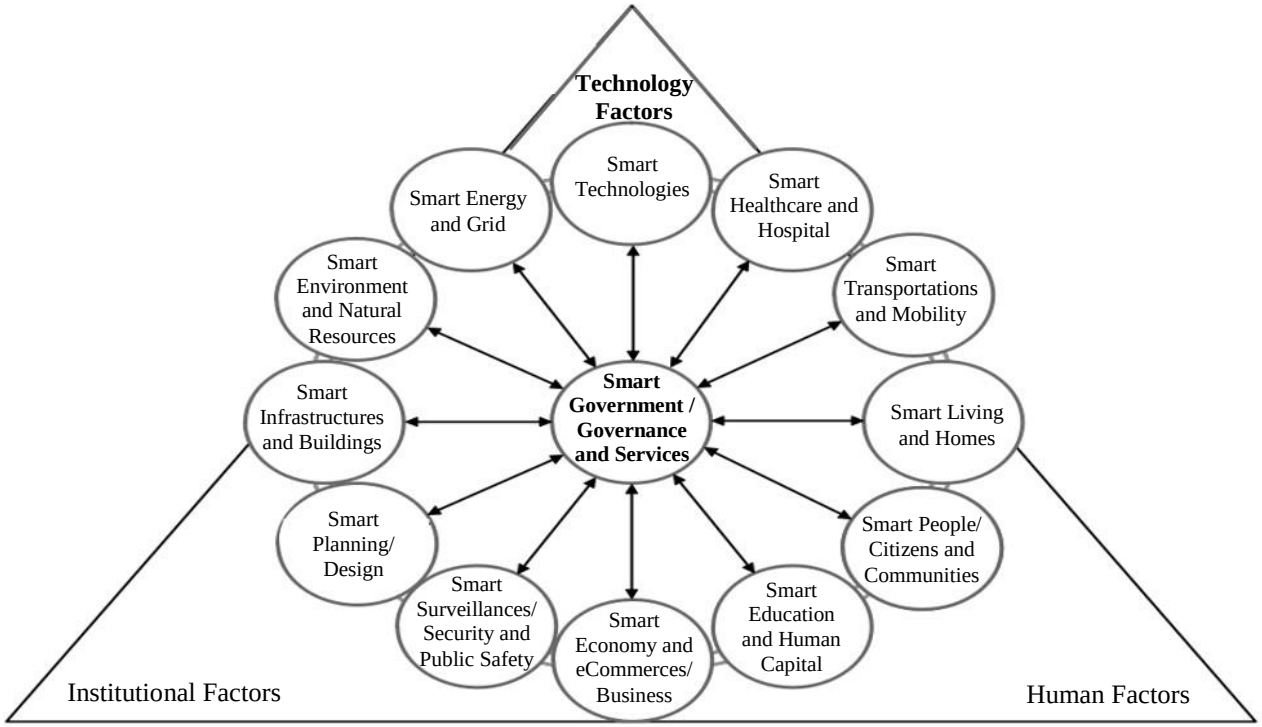


Figure 7 An initial model of a smart city for Indonesia: Smart City Nusantara (Semar)

According to [20], three pillars illustrated as a large triangle are key factors of a smart city, namely human (People), technology (ICT), and institutional (Government). All smart city components are binding and directed in the same national goals, which have led by the central government. Based on the literature review and empirical study validated by an online survey in Indonesia, the authors proposed a smart government component as a Key Component [50-51]. Smart government is the central and key enabler because institutions/organizations, country/government, are the largest resource owner in this country, both in terms of funding, human resources, and regulatory authority. It is a key component of smart cities in Insdonesia because it has all the necessary resources and acts as a driving factor used to make the city and community municipality efficient.

Identification and validation of Smart Nusantara were carried out using the online agreement questionnaire of 66 respondents from a smart city research group in various regions in Indonesia, with the respondent's demographic, shown in Figure 6. The percentage of the smart government/governance agreement acts as the key component of smart cities implementations and the initiation of the proposed model. The summary result of the agreement obtained is shows in Figure 8, with the agreement result used to illustrate expert judgment to finalize the initial model.

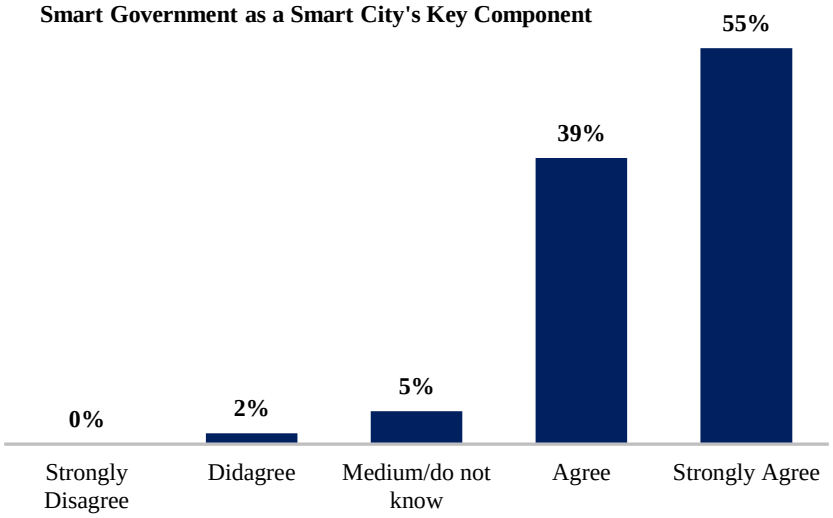


Figure 8 Resume of respondent's agreement of smart government as a key component

The data analysis shows that it is urgent to validate the proposed model's approval due to research limitations. Figure 8 shows that the smart government/governance and its services are approved as a Key Component of cities in Indonesia with 55%, 39%, and 5% in the strongly agreed, agree and medium categories. The total agreement is 98%, and the remaining that fail to agree is only 2%. Figure 9 shows that as much as 100% of respondents' citizens' agreed to use the smart city's thirteen components as a component in Indonesia. The summary of the questionnaire agreement of an initial model for Indonesia, named "Nusantara Smart City Model (NSCM)", is shown in Figure 7.

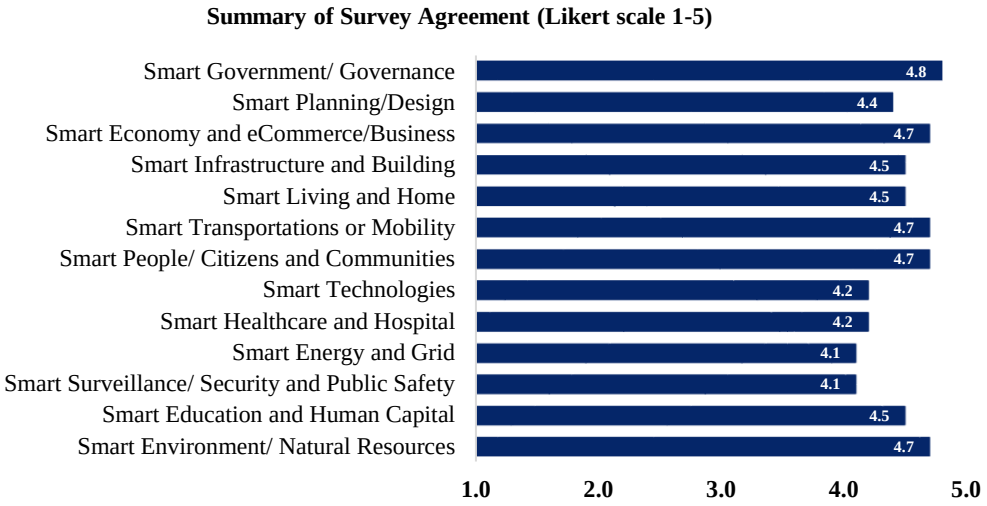


Figure 9 The Summary of survey agreement of smart cities component in Indonesia

Figure 9 shows that 90% of the respondents agreed to use smart cities' components as an initial model in Indonesia. This number indicates that the model can be used for the next research assessment stage in cities in Indonesia.

This study's results are based on triangulation resource; there are systematic review finding used Kitchenham methods [12], expert judgment and survey agreement with questionnaires. It also proposed an initial model for the smart city, which is empirically confirmed by citizen surveys and expert judgment validation. This study is in line with other popular research, such as that conducted by [51-53], which uses the same methods: systematic review approach, experiment, and empirical confirmation that resulted in the framework for smart city initiatives.

4. Conclusions and future work

In conclusion, the investigation results carried out to answer the research questions that have been previously designed from RQ1 to RQ6. RQ1 is designed to identify the research trend of the smart cities field. The study revealed that the current smart city research in literature review focuses on two general topic outlines, namely academic/theoretical and empirical/case studies. Studies related to the smart city are divided into two because the topic is an interdisciplinary field from various sciences. This research also identified three general forms of the structure of smart city architecture, namely a layered form with multi-tier structure, modular and a combination of layered and modular architectures in the smart cities research field provide answer to RQ2.

RQ3 and RQ4 are components and challenges of the research initiatives. The study showed that the thirteen components of the smart city area are smart government/governance and services, smart planning/design, smart economy and e-Commerce/e-business, smart infrastructure and building, smart living and home, smart transportations and mobility, smart people/citizens and communities, smart technologies, smart healthcare and hospital, smart surveillance/security and public safety, smart energy and grid, smart education and human capital, smart environment, and natural resources. The authors carried out further discussion on the challenges of smart city initiatives in each component of the smart city-builder from the thirteen components. The results concerning RQ6 are challenges that act as solutions to the varying challenges in each component. Therefore, in summary, the smart city rises due to its holistic view and used to form urban environmental management and implementation strategies.

Finally, smart cities' biggest challenge is associated with the right strategies to implement the associated concepts into reality using pilot projects as best practices. After that, the red thread was used to determine the biggest challenge on the government's strategies as the main driving component of the implementation of smart cities in Indonesia. This study proposes Smart Nusantara as the initial Model of Smart Cities in Indonesia, which validated the components or dimensions of smart cities in online questionnaire surveys from smart city research group in various cities in Indonesia and expert assessment to final validation. Further studies are needed to propose a successful smart government model as a key dimension for smart city implementation.

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7. Appendix

Table 6 Common smart city's component/dimensions extraction from primary studies

Reference & Years	Smart Government/Governance	Smart Planning/Design	Smart Economy and eCommerce/eBusiness	Smart Infrastructure and Building	Smart Living and Home	Smart Transportations or Mobility	Smart People/ Citizens and Communities	Smart Technologies	Smart Healthcare and Hospital	Smart Energy and Grid	Smart Surveillance /Security and Public Safety	Smart Education and Human Capital	Smart Environment /Natural Resources
[53] 2007	√		√		√	√	√						√
[27] 2008	√		√				√	√				√	
[32] 2010	√			√				√					√
[36] 2011	√					√	√	√	√	√	√	√	√
[54] 2011	√		√			√	√					√	√
[51] 2012	√		√	√			√						√
[55] 2012	√		√		√		√						√
[56] 2012	√		√		√		√						√
[57] 2013	√			√			√						√
[41] 2014	√		√	√	√	√	√			√			√
[58] 2014	√						√	√					
[46] 2014	√		√	√		√		√					√
[34] 2015	√			√		√			√		√	√	
[42] 2015	√					√	√		√	√		√	√
[43] 2015	√		√	√		√	√	√					√
[44] 2015	√		√	√	√	√	√		√		√		√
[59] 2015	√		√	√	√	√	√					√	√
[60] 2016	√		√	√			√	√					√
[35] 2016	√		√		√	√	√			√			√
[61] 2016	√		√		√	√	√						√
[2] 2016	√		√		√	√	√						√
[1] 2017	√			√		√		√	√	√	√		
[62] 2017	√		√		√	√			√		√	√	
[63] 2017	√	√	√	√	√		√	√					
[19] 2017	√		√	√			√						√
[20] 2017	√		√	√	√	√	√						√
[14] 2018	√	√	√					√					
[4] 2018	√			√	√	√	√		√	√			√
[64] 2018				√	√	√		√	√	√	√		
[65] 2019	√		√	√			√				√		√
[66] 2019	√	√	√	√		√		√					√
[67] 2019s	√		√			√	√	√					√
[23] 2020	√	√	√	√			√	√					√
[68] 2020	√		√		√	√	√						√
[69] 2020	√		√			√	√	√	√	√	√		