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Towards Smart and Resilient City: A Conceptual Model

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Abstract. This paper aims to compare five smart city models selected based on a number of specific criteria. Following the comparison and assessment performed, we draw conclusions and further linkages identifying the components and characters found in resilient cities. The purpose of this analysis is to produce a new approach and concept: the “smart and resilient city.” Through in-depth literature study, this paper analyzes five conceptual smart city models deemed to have a background, point of view, and benchmark towards software group, as they focus on welfare, inclusion, social equality, and competitiveness. Analyzing the strategies, methods, and techniques of five smart city models, this paper concludes that there has been no inclusion of resilience concepts in the assessment, especially in the context of natural disasters. Basically, the models are also interrelated and there are some things that overlap. As a recommendation, there is a model that tries to combine the components and character of smart city and resilient city into one entity that is embedded as a whole in a conceptual picture towards the new concept, the “smart and resilient city”. The concept of smart city and resilient city go hand in hand with each other and thus are interrelated. Therefore, it is imperative to study that concept deeper, in this case primarily in the context of disaster.

1. Introduction

The rapid development of the smart city concept, has led to the concept being widely used in various fields. However, this is also offset by the many criticisms that emerge about smart city from various researches. Some researchers say that the concept of smart city is still abstract, bias, unclear, and without consistent interpretation ([1]; [2]; [3]; [4]; [5]; [6]; [7]). Some mentions that there has been no mutually agreed, multi-dimensional, universal definition of smart city, and that the problems smart cities attempt to solve are not relevant existing problems ([4]; [8]).

The discussion about smart city concept has developed greatly as of late, seen from the dramatic increase of the number of research on it. Based on the latest data from Colding and Barthel, (2017) [9], publications on the concept of smart city has increased sharply in the last decade (from 2006 to 2016) (Figure 1).

Publications on smart city has also spread on various aspects. One of the most prominent discussions is the concept of the smart city that focuses on information communication and technology (ICT) when in fact other fields are covered by the discussion, for instance social issues, environment, energy,



business, and so on. The increased number of research yields an increase of resulting publications containing various conceptual models.

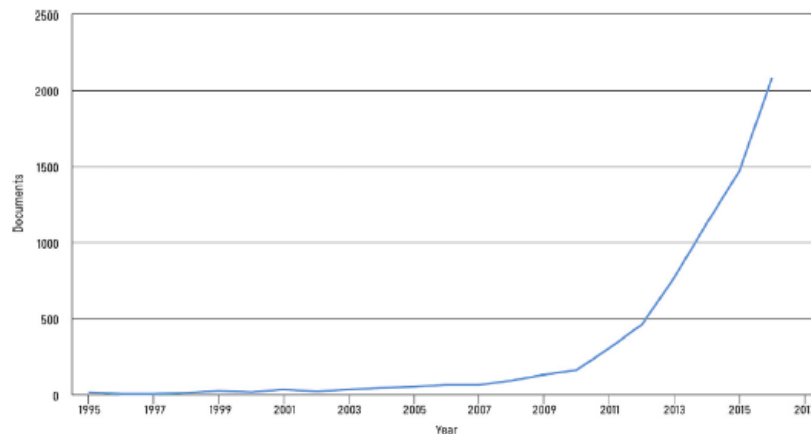


Figure 1. Number of publications on “smart cities” based on SCOPUS database [9].

Anthopoulos, et al. (2015) [10], classified these different models based on their factors and ideas, for instance, by relating them to sustainability, resilient, global city performance, local government effectiveness, urban competitiveness, and good urban governance. This comparison is made to draw a wide perspective on benchmarking method in order to measure smart city on different perspectives and clarify each different perspective in which issues are focused on and assessed in. Those perspectives are the society, government, economy, mobility, environment, and life [10].

This article will compare and analyze smart cities perspectives through in-depth literature study. We will select the models by exploring, through Google Scholar, articles about smart city concepts written in 2010-2015. From those articles, we identified five models that we subsequently analyze further and compare between each other. Unlike the model comparison done by Anthopoulos et al., (2015) which uses different perspectives in comparing models, this article specifically focuses on articles providing the fundamental concept of smart city.

The five models are: 1) Europe smart city model by Giffinger and Gudrun (2010); 2) The basic component of smart city model by Nam and Pardo (2011); 3) Smart city initiatives framework by Chourabi et al., (2012); 4) the basic element of smart city model by Dameri (2014); and 5) relationship component and characteristic smart city model by Manville, et al., (2014).

The aim of this article is to compare existing models in smart city concept for further analysis, followed by linking the conclusion of the analysis with elements and characters found in resilient cities. The expected outcome of this paper is to introduce a new approach combining concepts of smart and resilient city. Resilience is an important factor as we are facing rapidly changing natural and social conditions, which require cities to be more resilient. This resilience concept in the context of a city refers to the city’s ability to absorb, adapt, and respond to any changes in urban system. Therefore, a resilient city is able to withstand the impact of shocks, hazards, and pressures through adaptability or transformation to ensure the long term sustainability, basic functions, characteristics and the structure of a city [11].

Resilience has become an important element in establishing smart city because resilience is a key factor in creating a better quality of life, sustainable urban development, and improving environmental condition. Therefore, this paper will analyze and evaluate existing smart city models in order to clearly identify elements of resilience so as to create a new, and highly-applicable, model of smart and resilient city.

The first part of this paper will introduce the concept and background of a smart and resilient city. The second part will dissect the analysis method: a literature study on the approaches, research strategy, method, and techniques used in five smart city models. The third part of this study will narrate the whole understanding on three concepts – smart city, resilient city, and the combination of the two – and assess the five selected models based on smart city and resilient city characteristics. From the assessment above it can be concluded that these models are interrelated and have some elements that overlap. These models also have not incorporated the concept and elements of resilience intentionally in the discussion and consideration when forming the model, especially in the context of natural disasters. Finally, the paper will talk about conclusion and recommendation about the importance on having resilience elements in smart city concept in order to form a new concept, the smart and resilient city concept. This new concept is realized through a model in which there are 25 characters that are integrated and embedded within the scope of smart and resilient city concept. To achieve a complete concept, the characters must not be separated and should always be attached. This model is still a recommendation, therefore more in-depth research is required for exploration and model testing.

2. Research Approach

This chapter will elaborate on analytical approaches used in determining the selected smart city model, what strategy will be used and how will the method and technique use in comparison and discussion be done. The research approach has five tiers, each one increasing in specificity: 1) approach; 2) strategy; 3) method; 4) technique; and 5) the outcome model. This is done in order to view the model comprehensively, so the discussion will be more objective and structured.

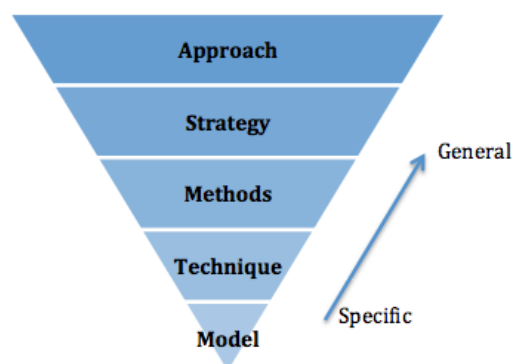


Figure 2. Research approach in analyzing model.

2.1. Approach

The approach is a very general state used to benchmark the use in forming a model. In smart city concept, there are 2 main approaches: hard infrastructure and soft infrastructure [12]. The hard infrastructure approach focuses on the use of technology and ICT managing urban infrastructure such as transportation, clean water management, sewage, electrical, waste, energy, security service, etc. The soft infrastructure approaches focus more on the community, inclusion, community social capacity development, and human resources, education quality improvement, society participation, social innovation, social equity etc.

Out of more than two thousand publications [9], most of the existing researches are in computer science and engineering, followed by researches in social sciences, mathematics, and various other fields. Looking from the data, it is obvious that researches on computer science and engineering still dominate existing publications, compared to studies, for instance, in social sciences. Hence, publications and researches in social science should be encouraged to increase the number and broaden the studies.

This paper will centralize its research on soft infrastructure, with hard infrastructure as supporting element.

Some of the existing definitions or understanding on smart city which focus on software approach, had many times stated about the importance of having such role as the utilization of information and communications technology, the awareness and smartness of society, welfare, participation, effectiveness, and competitiveness in implementing smart city, all of which has the aim to achieve a higher quality of life and improve the quality of the environment [13]. Out of five selected smart city models, all generally use approaches focusing on soft infrastructure and hard infrastructure as support. Thus, to delve more on the soft infrastructure approach, it is crucial to be familiar with its strength and weakness.

Table 1. Strength and weakness of soft infrastructure on smart city concept approach ([12]; [14]; [15]; [16]; [17]).

Strength	Weakness
<ul style="list-style-type: none"> - Improve human resources. - Community empowerment. - Intelligence and theory invention. - Social capital improvement. - Social and digital inclusion sustainability. - Possess an equal portion of belonging sense and responsibility to their city. - Humanity approach in representative technology. - Enhance skills and user's interest. - Respect individual along with their diversity. 	<ul style="list-style-type: none"> - Unequal access of society participation. - Limited community involvement. - The great availability on data and information does not ensure the improvement of knowledge and integrity of society. - Cyberspace is not mainly and purely a public space.

2.2. Strategy

Strategy is the next discussion after the analysis approach. General strategy will be those related to ideas, planning, and activity performed. In this article, strategies to be undertaken in discussing each smart city conceptual model will at least refer to some strategic elements, which are [18]: 1) identification on specification and result qualification, also targets to be achieved; 2) main approaches and considerations taken in achieving the objectives; 3) steps taken from the start to the end; 4) confirmation on benchmark and criteria.

Strategy is important in conducting research, moreover when it is supported by the development in procedural and contextual analysis so that it will create a wider and more convincing development [19]. The four elements of strategy mentioned above will be prominent in discussing and analysing strategy of each smart city conceptual model.

Description:

I = Identify the specifications and qualifications of the results, as well as the targets to be achieved.

II = Main approaches and considerations taken in achieving the objectives.

III = Steps taken from start to finish.

IV = Setting benchmarks and criteria.

Table 2. Research strategies analysis on each model.

Elements of Strategy	Europe smart city model, by Giffinger and Gudrun (2010) [20].
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I	<ul style="list-style-type: none"> - Ranking a Smart city is done through a different approach. This approach is used as an effective instrument in identifying the weaknesses and strengths of cities in improving city competitiveness through relevant strategic efforts. - A smart city is a city with good performance in six characteristics, built on a combination of intelligent support, a decision of community activity in self-determination, independence, and awareness.
II	<ul style="list-style-type: none"> - Smart city ranking approach not only provides city ranking data, but also the types of characteristics used as the basis of discussion in the strategic plan. Six characteristics in this conceptual model are: smart economy, smart people, smart environment, smart mobility, smart living, and smart governance.
III	<ul style="list-style-type: none"> - Transparency in ranking from selected groups of cities. - Elaborate and illustrate the specific characteristics and profile of each city. - Develop existing benchmarks among selected cities. - Identify strengths and weaknesses for strategic discussions and policy advice.
IV	<ul style="list-style-type: none"> - Using 6 characteristics that characterizes the city with smart city concept. - Using 31 relevant factors that reflect an important aspect of each characteristic, then each factor is empirically defined through 74 indicators used to operationalize and incorporate relevant factors.
Strategy elements	The basic component of smart city model by Nam and Pardo (2011) [8].
I	<ul style="list-style-type: none"> - The conceptual model is based on three multidimensional components, namely: technology, society, and institutions. These components become the basic factor in creating a smart city concept. - A city will be smart when there is investment in human/ social capital and information technology infrastructure that can improve the quality of life and promote sustainable growth through participatory governance. This is an embodiment of the relationship of the above three factors.
II	<ul style="list-style-type: none"> - Besides technology, social factors are important factor in the smart city concept, therefore it takes a socio-technical view in the context of smart city. - In creating a smart city initiative requires a thorough understanding of the complexity and the interrelationships between social factors and technical factors of service and the physical environment in a city.
III	<ul style="list-style-type: none"> - Identify the current conditions of cities that have already begun to apply the smart city concept successfully, discuss the meaning and definition of the smart city concept, and find a variety of concepts that are similar or have similarities.
IV	<ul style="list-style-type: none"> - The strategic principles are aligned with the three main dimensions (technology, people, and institutions), namely: integration of infrastructure and services through technology media, social learning to strengthen human infrastructure, and governance for institutional and citizen engagement.
Strategy elements	Smart city initiatives framework by Chourabi et al., (2012) [2].
I	<ul style="list-style-type: none"> - Using a conceptual framework to understand the smart city concept as a whole.

	<ul style="list-style-type: none"> - Identify eight very important factors of smart city: management and organization, technology, governance, policy context, people and community, economy, built infrastructure, and natural environment.
	Continued...
Strategy elements	Smart city initiatives framework by Chourabi et al., (2012) [2].
II	<ul style="list-style-type: none"> - Creating a conceptual framework that can be used to characterize how to create the vision and design of smart city initiatives. - This vision is realized through shared services, and through the direction given to the challenges that the city faces.
III	<ul style="list-style-type: none"> - Develop an integrative framework to explain relationships and influence between factors and smart city initiatives. - Each factor is spelled out through the derivation of factors, the dimensions, and the challenges it faces.
IV	<ul style="list-style-type: none"> - This conceptual model provides direction and agenda for the researcher in the smart city field and provides an overview of practical implications for government professionals.
Strategy elements	The basic element of smart city model by Dameri (2014) [21].
I	<ul style="list-style-type: none"> - The desire to create a broader vision of the existing smart city phenomenon. - Developing a conceptual model from the previous theory of Nam and Pardo (2011) and smart city dimensions by Giffingger and Gudrun (2010), became a conceptual model of smart city consisting of four core components: land, infrastructure, society, and government.
II	<ul style="list-style-type: none"> - Compare the studies and considerations on how to form a smart city. - How to design a smart strategy and how to measure a smart action really can shape public value for society and create a better quality of life in urban space.
III	<ul style="list-style-type: none"> - Searching for the growing of smart city ideas, then defines the meaning of smart city from existing literatures. - How existing initiatives can improve intelligence and can achieve the ultimate goal of the smart concept. - Measure the intelligence and creation of public value through clear and measurable objectives and processes.
IV	<ul style="list-style-type: none"> - In an effort to create a city with a better concept of smart city, then a city must improve the "smartness" of each component of the city. - Benchmarks used are, effectiveness, environmental balance, and innovation.
Strategy elements	Relationship component and characteristic smart city model by Manville, et al., (2014) [22].
I	<ul style="list-style-type: none"> - The goal is to generate strategies and design of smart city initiatives. - Smart city as a city that can solve public problems through ICT-based solutions based on multi-stakeholder cooperation and city-based partnerships. These solutions are developed and refined through smart city initiatives, either as separate projects or as a network of overlapping activities.
II	<ul style="list-style-type: none"> - Mapping cities with the concept of smart city in Europe. - Making connections between characteristics and components in the smart city concept.

III	<ul style="list-style-type: none"> - Model the relationship between smart city project, smart city initiatives, and smart city concept. - Defining smart city based on the existing literature and redefine it in accordance with the goals and objectives to be achieved. - Defining the characteristics of smart city. - Seeing the relationship between the characteristics and components of smart city in certain cases. - Identifying smart city for mapping study. - Conducting smart city mapping in Europe.
	Strategy elements
IV	Relationship component and characteristic smart city model by Manville, et al., (2014) [22].
	<ul style="list-style-type: none"> - In smart city strategies and initiatives, at least one characteristic must be included as either the objective or the mode of operation, namely: Smart Governance, Smart People, Smart Living, Smart Mobility, Smart Economy and Smart Environment. - This characteristic will be a goal for stakeholders that participating in smart city initiatives. For example: to solve environmental problems.

2.3. Methods

In each study, the method is intended as a form of concrete and practical activities undertaken to achieve the research objectives. The methods used in the existing models generally use the method of desk study and literature review method. This method is done by summarizing and analyzing the results of previous studies that present comprehensive and balanced facts and theories. The results of the study will generally be summarized through data integration and then expected to generate new theories or concepts in a deeper and more thorough understanding level [23]. The following descriptions and explanations of the methods used in each model.

Table 3. Description of the methods in each model.

No	Model	Methods
1.	Europe smart city model.	<ul style="list-style-type: none"> - Field research, interviews, and mostly use desk research. - Analysis using primary and secondary data. - Weight factors and indicators are generally used in their influence for the purpose of ranking. The method used is a mix qualitative and quantitative. Qualitatively in determining the characteristics, indicators, and factors, and quantitatively calculate the weighting for the urban ranking. - City rankings were made with the aim of comparing characteristics and to identify the strengths and weaknesses of a city in a comparative way.
2.	The basic component of smart city model.	<ul style="list-style-type: none"> - Using qualitative methods through desk study. The study was conducted using a literature study, the previous study of smart city and the projects that have been undertaken.
3.	Smart city initiatives framework.	<ul style="list-style-type: none"> - Using qualitative methods through the study of literature from various disciplinary fields.
4.	The basic element of smart city model.	<ul style="list-style-type: none"> - Using qualitative methods through in-depth analysis of the various literatures. Furthermore, using the five basic frameworks in the literature searching process by Vom Brocke et al, namely: the definition of scope;

		conceptualizing topics; literature search; literature analysis and synthesis; and research agenda.
5.	Relationship component and characteristic smart city model.	<ul style="list-style-type: none"> - Conventional approach with the strong emphasis on desk study method. - Using in-depth analysis.

2.4. Technique

Technique is how a researcher implements a specific method. Research techniques usually consist of how the data obtained, how the data is processed and how the procedure performed. The following explanation of research techniques used in each model.

Table 4. Description of research techniques used in each model.

No	Model	Description of the technique used.
1.	Europe smart city model.	<ul style="list-style-type: none"> - Selects the cities, identifies the indicators and data sources, and standardizes and aggregates data. - Using cities of medium size or second city in the scale of European cities. Town with population 100.000-500.000 population.
2.	The basic component of smart city model.	<ul style="list-style-type: none"> - The conceptual framework is obtained through literature studies with the technique of defining smart city through the meaning of intelligence in urban contexts, exploring new definitions, and understanding smart city as a broad concept. - Then, observe the key components of smart city and discuss the strategic principles that can create success in smart city initiatives.
3.	Smart city initiatives framework.	<ul style="list-style-type: none"> - Explores the literature from various fields such as e-government, information science, urban studies, and public administration. It further identifies key trends, identifies and discusses challenges, success factors, and the impact of initiatives to create smart cities.
4.	The basic element of smart city model.	<ul style="list-style-type: none"> - Using in-depth analysis techniques through various literatures. Redefine the research methods used for the purpose of identification and organization of the articles to be used for the literature review analysis. - Then test the collected data to answer specific questions through timing analysis, terminology, typology, and geographical analysis.
5.	Relationship component and characteristic smart city model.	<ul style="list-style-type: none"> - Using in-depth analysis to provide an actual, accurate, and objective picture of the patterns and trends that occur, and gain an understanding of the factors that contribute to the success of smart city initiatives as the basic of smart city.

3. Discussions and Findings

Based on analysis and discussion in the previous chapter, it can be concluded from the five models, each model is related and has some similarities with another. This is due to several studies in more recent years citing several items from previous researchers. Furthermore, the discussion in this chapter will be divided into three sub chapters, namely: the smart city concept, the resilient city concept, and combination of the two.

3.1. *The Smart City Concept*

As discussed earlier, the smart city concept has grown rapidly and extensively to various fields. Therefore, the understanding and meaning of smart city that emerged also expanded and varied. Based on the previous discussion on the five smart city models, it can be concluded that the smart city concept that used towards resilience is the smart city concept with soft infrastructure approach.

There are several meanings and concepts of smart city in an approach that focus on soft infrastructure (such as participation, inclusion, and citizen intelligence), among others: 1) The main purpose of smart city concept is to improve sustainability with the help of technology [24]; 2) Smart city is a concept that can run a city well through its perspective on the economy, society, government, mobility, environment, and life, it's built using an intelligent combination of support and independent community activity, and society awareness [25]; 3) The concept of smart city uses the role of information and communication technology (ICT) to achieve prosperity, effectiveness, and competitiveness. [12]; 4) Smart city is built on the political understanding of technology, it takes a process approach to manage the city, and focus on economic benefits and other public values [7]; 5) The concept of smart city actually does not match with the character of a city which is difficult to be predicted, informal, and can lead to the emerge of social inequality [26].

After concept approach, the research strategy in smart city concept also an important thing to be considered. From the analysis conducted on the model research strategy, it can be concluded that the five smart city models can be grouped into two main groups, namely: 1) group of models that describes dimension and main component in smart city concept; and 2) group of models narrating the process toward the smart city and generates measurements in the form of city rankings (table 5). Each model group is important, because these two groups are supporting the creation of models in applying smart city concept. Prior to the process of measuring the level of smart city, it is necessary to identify the dimensions, components, and important factors in shaping the concept of smart city.

It can be concluded that generally these models use a qualitative approach in research, with the method of in-depth analysis into desk research and literature review. Techniques used to obtain data, data processing, and processing procedures also vary. General data is obtained using literature documents, interviews and surveys. Data processing and procedures employs the identification of previous smart city, finding new definitions, identifying indicators and standardization, identifying smart city components, identifying trends and patterns, identifying existing challenges, identifying factors success, using literature with multiple perspectives (such as information science, government, public administration), and using various analyses (such as timing analysis, typology, terminology, geography).

Based on the meaning of each character, we assessed five smart city model from existing documents. From this assessment we will see which model represents the most smart city concept.

After concept approach, we look at the research strategy in smart city concept. We conclude that the five smart city models can be classified into two groups: 1) group of models that describes dimension and main component in smart city concept; and 2) group of models narrating the process toward the smart city and generates measurements in the form of city rankings (table 5). Each model group is important, because these two groups are supporting the creation of models in applying smart city concept. Prior to the process of measuring the level of smart city, it is necessary to identify the dimensions, components, and important factors in shaping the concept of smart city.

It can be concluded that generally these models use a qualitative approach in research with the method of desk research and literature review through in-depth analysis. Techniques used to obtain data, process data, and process procedures also vary. In obtaining general data using literature documents, interviews and surveys. In the processing data and procedures, here are some of the main techniques: identifying the previous smart city and then finding new definitions, identifying indicators and standardization, identifying smart city components, identifying trends and patterns, identifying existing challenges, identifying factors success, using literature with multiple perspectives (such as information science, government, public administration), and using various methods of analysis (such as timing analysis, typology, terminology, geography).

Based on the meaning of each character, an assessment was conducted to five smart city model based on existing documents. The Assessment is done by seeing whether from each element of the character becomes one of discussions or considerations in discussing and forming a smart city model. From this assessment we will see which model represents the most smart city concept (tabel 6).

Table 5. Grouping of models.

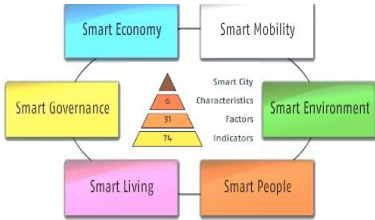
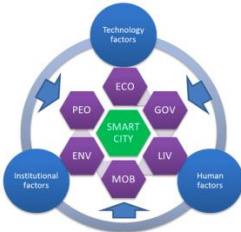
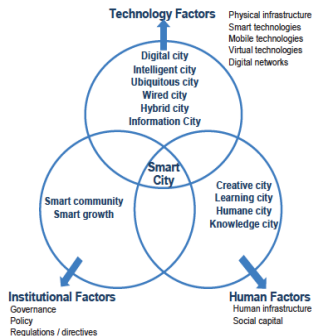
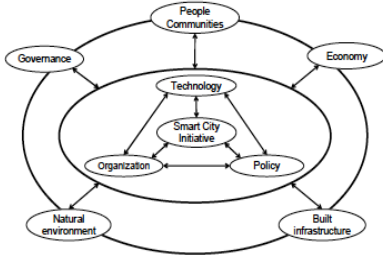
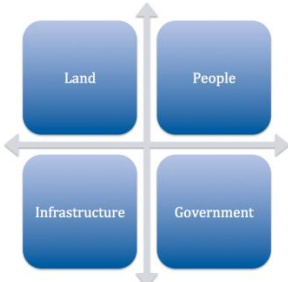
No.	Model	Image/ illustration	Category
1.	Europe smart city model.		The process towards smart city and city ranking measurement.
2.	Relationship component and characteristic smart city model.		
3.	The basic component of smart city model.		Dimensions and main components in the smart city concept.
4.	Smart city initiatives framework.		
5.	The basic element of smart city model.		

Table 6. Assessment of models based on the character of smart city concept.

No.	Traits of a smart city	Europe smart city model	Basic component model	Smart city initiatives framework	Basic element model	Relation of component & characteristics
1.	Efficiency	1	1	1	1	1
2.	Flexibility	1	1	1	0	1
3.	Adaptability	1	1	0	0	1
4.	Networking capacity	1	1	1	1	1
5.	Learning capacity	1	1	1	1	1
6.	Diversity	1	1	1	0	1
7.	Innovation capacity	1	1	1	1	1
8.	Creativity	1	1	0	0	1
9.	Participation	1	1	1	1	1
10.	Awareness	1	1	1	1	1
11.	Collaboration	0	1	1	1	1
12.	Fairness and social inclusion	1	1	0	1	1
13.	Monitoring capacity	0	1	1	1	1
14.	Reliability	0	0	0	0	1
15.	Anticipation	0	0	0	0	0
		11	13	10	9	14

Based on the results of the assessment above on the five models, it can be concluded that, “the model relation of component and characteristic” is a model that strongly represents the characters in the smart city concept. The second model that has the closest character of the smart city concept is “the basic component model”. Both models seem to represent their respective groups. The model by Manville represents the group “process towards smart city and city rank measurement”, and the model by Nam and Pardo represents the group of “key dimensions and components in the smart city concept”.

3.2. Resilient City Concept

The explosive pressure of the population is one of the major problems in the world. The human population is growing rapidly: we are expected to reach 7.4 billion in 2015 and is expected to reach about 8.3 billion people by 2030, and 8.9 billion by 2050 [27]. Urban populations are generally a major challenge, cities in the world must be able to cope with such diverse pressures as urbanization, climate change, air pollution, water crisis, increased risk of natural disasters, and so on. To face this, the city is required to solve the problem, it can learn to adapt in facing the challenges ahead in an uncertainty era by building the concept of resilience.

The concept of resilience was originally developed by C.S. Holing in 1973 in ecology, developed in the field of disaster science ([28]; [29]), planning [30], social psychology by Walsh in 1998 [31], resilience studies in socio-ecology ([32]; [33]), and resilience concepts leading to social studies ([34]; [35]; [36]). The meaning of resilience in the city context refers to the ability to get, adapt, and respond to the changes in the urban system. A resilient city is a city that is able to detain or absorb the impact of the disasters, shocks and pressures through adaptation or transformation, in order to ensure long-term sustainability, basic functions, characteristics, and urban structures [11].

In the field of planning, the concept of resilience is developed in various sub-areas, such as: 1) The context of catastrophic disasters, terrorism, energy crisis, and climate change ([37]; [38]); 2) the context of socio-ecological resilience with communicative planning [39]; and 3) the context of collaborative planning for governance in addressing resilience [40]. In the context of disaster and other contexts that are still related, some researchers interpret the concept of resilience as follows:

- Resilient city is a system of physical networks (artificial and natural components) and human communities (social and institutional components) that can survive and continue to be sustainable under conditions with extreme and unique pressures. Physical system is a network of muscle and community network that is like the brain of a city, without any resilience of these two systems, then a city will be very vulnerable to disaster. [37].
- Resilience has three main features that must be owned, namely: persistence, adaptability, transformability [41].
- Resilient city will reflect the capacity of the city through individuals, communities, institutions, companies, and systems to survive, adapt and develop. It does not matter with any kind of heavy pressure or any strong shock they have experienced. [42].
- Resilience refers to the capacity of individuals, households, population groups or systems to anticipate, absorb, recover from the dangers and impacts of climate change, other shock effects, long-term stress and potential long-term prospects. Resilience is not fixed, but it is a dynamic set of conditions and processes [43].
- Resilient city has a vision to enhance the city's ability to respond to various pressure factors (climate, environment, energy and economy), with the ultimate goal of ensuring a higher quality of life and sustainable urban development. [44].
- Resilience is the capacity of the social or ecological system and its component parts to overcome dangerous and pressure shocks, in a timely and efficient manner, in responding, adapting, and changing the ways that restore, nurture, and even enhance important functions, structures, and identity while maintaining capacity for growth and change. [45].

The resilience of a city in the face of disasters can be built through strategies and key factors: building cross-sectoral leadership for disasters, adding the possibility of greater earthquake risks to building codes, increasing resilience through communities, and taking into account the importance of equilibrium natural resources under certain conditions. [42]. Another resilience strategy is proposed by Wilkinson (2012) [46] by creating four strategies: assumption of changes and uncertainty about the arrival of disasters, maintaining conditions of recovery and repair after a disaster, a combination of different types of knowledge is needed to create learning, and creating opportunities for self-organization.

In strengthening the analysis and discussion on the existing model, the next analysis will identify characters of resilient cities in the five models. These characters are spelled out through three main factors in resilience [47]: persistence, adaptability, and transformability. Further described and interpreted one by one from the side of resilient city by Papa, et al. (2015) [44] in detail. There are a number of different characters and similar characters between smart city and resilient city.

Generally, these five models have not deliberately used the perspective of resilience or incorporated the elements of resilience in the discussion of the formation of smart city concept models. However, since there are some elements in the concept of smart city that are also contained in the concept of resilience, on the other hand, the assessment of the resilience elements in the five smart city models will be done through the identification of the character of the concept of resilient city.

As mentioned earlier, the assessment will be done by looking at whether each character of the resilient city character is considered informing a smart city model. From this assessment, it will be found which model represents the most or use elements of the resilient city character.

Table 7. Assessment of models based on the character of resilient city concept.

No.	Traits of a resilient city	Europe smart city model	Basic component model	Smart city initiatives framework	Basic element model	Relation of component & characteristics
1.	Efficiency	1	0	0	1	1
2.	Flexibility	0	0	0	0	0
3.	Adaptability	1	0	1	0	1
4.	Networking capacity	0	1	0	1	1
5.	Connectivity	0	1	0	1	1
6.	Learning capacity	0	1	0	0	1
7.	Diversity	0	1	0	0	1
8.	Innovation capacity	1	1	1	1	1
9.	Creativity	0	0	0	0	0
10.	Participation	0	1	1	0	1
11.	Awareness	1	0	0	1	1
12.	Knowledge	0	1	0	1	1
13.	Collaboration	0	1	1	1	1
14.	Persistence	1	1	0	1	1
15.	Resistance	0	1	1	1	1
16.	Modularity	0	0	0	0	1
17.	Redundancy	0	0	0	0	1
18.	Memory	0	0	0	0	0
19.	Robustness	0	1	0	0	1
20.	Resourcefulness	0	1	1	1	1
21.	Transformability	1	1	1	1	1
		5	11	7	8	17

Based on the assessment above (table 7), it can be concluded that out of the 21 characters resilient city, “the model relation of component and characteristic” is a model that strongly represents the characters in the resilient city concept. The second model that most has character of the resilient city concept is “the basic component model”. Just like the results of smart city character analysis, both models seem to represent their respective groups. The model by Manville represents the group "process towards smart city and city rank measurement", and the model by Nam and Pardo represents the group of "key dimensions and components in the smart city concept".

3.3. Smart and Resilient City Concept

The vision of the smart city concept and the resilient city concept is in line and aligned, it's aimed to create a higher quality of life, sustainable urban development, and improving the quality of the

environment that is judged to be declining ([44]; [3]; [16]; [17]). Some perspective approaches to the concept of smart city also use urban sustainability and resilience factors, with the aim of indicating an effort to both directions [10]. Resilience is an important element that must enter into the complexity of a city, therefore a city must be built with its capacity toughness. The Capacity consists of multicomponent, namely process and interaction that put it above the physical boundary of the city. It's Important for a city to be resilient when it is said as a smart city [48]. Therefore, the concept of resilience is one of the important factors in smart city planning.

One of the meaning of smart city concept based on resilience are: the concept of the city that utilizes the role of information communication and technology (ICT) in raising awareness, intelligence, welfare, and citizen participation, when facing pressure, shocks and hazards, in order to survive, adapt, tough and transform, so that later can lead to quality of life and environment , which is better and sustainable in the face of an uncertain future [13].

The concept of smart city and resilient city have transformed and changed over time. This occurs in the different approaches, characters, and focus of each concept. From three main groups of smart city and resilient city concepts, the closest approach to this discussion is a mix of software and hardware-focused groups and groups that focus on adaptive capacity, transformation skills, learning and innovation.

The discussion of the concept of smart city that leads to the concept of resilience concept, is marked by the start of studies that link between the concept of smart city and resilience. The relationship between theory and concept of smart city and resilience has been done by Baron (2012) [49], which sees the importance of resilience from the perspective of business praxis, urban studies, and territoriality, through literature studies and empirical studies. The existence of theoretical relationship between the smart city concept and city resilience is expected to be the starting point for further research and reflection that concentrate on city development strategies that want to achieve intelligence and toughness.

Papa et al. (2015) [44], also looked at the synergies and inconsistencies between the smart city concept and resilience through the identification of key characteristics of the smart city and resilient city urban systems, then compiling them into a conceptual model in case of mitigation and adaptation in the context of confronting change climate. This model is expected to serve as a guide for planners and decision-makers in building smarter and more resilient cities, and to increase capacity responses from complex urban systems in facing the climate change.

In addition, Viitanen and Kingston [50] criticized smart cities using the perspective of green growth to achieve resilience, which is used by big companies through public and private partnerships. The municipal system became a digital marketplace where consumer-citizen participation increased by accident and increased hegemony of global technology companies. This makes the city less resilient in facing future social and climate risks.

Some of the studies discussed above are studies that connect the concept of smart city and resilience in the context of soft infrastructure. From these studies, no studies have specifically linked the smart city concept and resilience in the context of disaster with a soft infrastructure approach.

The closest model is the resilience study made by Desouza and Flanery (2013) and Papa et al. (2015). They set up city resilience benchmarks through a design, planning, and management approach to perfecting city resilience, including dynamic process and cultural evaluation within a city. Next, they compile the resilience framework of a city by dividing the two components of the city, namely: resources and processes (physically); and communities, institutions, and activities (socially). This model describes the city as a complex adaptive system and then divides it into components and elements of analysis, making it easier to achieve its goal of becoming a more resilient city through the design, planning and management of urban systems. Existing physical and social processes are understood as spatial and temporal interactions across networks to improve what is beneficial and reduce something harmful. There are four kinds of stresses in this model: natural stressors such as earthquake, tsunami, hurricane, etc.; economic stressors such as reduced employment opportunities, rising poverty levels, decreasing business investment, monetary crisis, etc.; technological stressors such as failure and error complex technical network system; and finally, human stressors such as terrorism, war, crime, riot, etc.

In this study, there are two pressures that become important points and affect the smart and resilient city concept, namely natural pressure and technological pressure. Natural disasters are one of the types of pressure that fall within the natural stress group, which will be related to disaster resilience. Technological pressures arise due to the increasing complexity of existing technical network systems in cities with smart systems, such as smart cities, will create interconnected network systems, so vulnerable to failures caused by errors that can spread through the system.

4. Conclusions and Recommendations

4.1. Conclusions

This study looks at the concept of smart city as a whole and towards resilience city through one part of many fields on resilience concept, that is the disaster field. One side of disaster, especially natural disaster, is expected to fill the gap in bridging the importance of resilience element in smart city concept.

Based on the discussion in the previous chapters, it can be concluded that this study more clearly directs the smart city concept to the approach of soft infrastructure and hard infrastructure as a supporter. With the concept of resilient city that leads to disaster resilience group through approach to resilience based on non-equilibrium or social-ecological resilience.

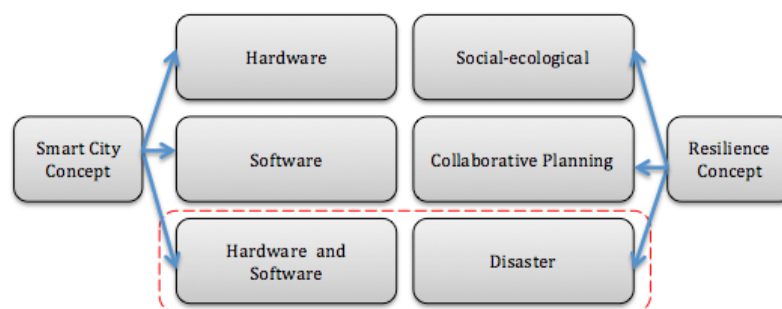


Figure 3. Approach in shaping the smart and resilient city concept.

Out of five smart city models analyzed using approaches: strategies, methods, and techniques, it can be concluded that from the whole model there has been no inclusion of resilience concepts in the discussion, especially in the context of natural disasters. Basically, the models are also interrelated and there are some things that overlap. Based on the assessment of the five models using the characteristics of smart city concept and resilience concept, the results obtained are in the following table.

Table 8. Model rating in smart city concept and resilient city concept.

No.	Model Name	Rank in smart city	Rank in resilient city
1.	Europe smart city model	3	5
2.	Basic component model	2	2
3.	Smart city initiatives framework	4	4
4.	Basic element model	5	3
5.	Relation of component & characteristics	1	1

“The model relation of component and characteristic” is a model that is ranked first and considered to highly represent smart city concept character. This model also ranked first in the assessment on the resilient city character. In the second rank of smart city concept, there is "the basic component model". This model also ranked second based on the assessment of the character of resilient city.

In this case it can be concluded that the concept of smart city and resilient city is a concept that goes hand in hand and has a close relationship and linkage. Therefore, it is important to do a more detailed and in-depth study, in this case primarily in the context of disaster.

4.2. Recommendations

To add value in existing models of smart cities, we need to add components and traits for resilient cities, particularly when it comes to resilience against natural disasters.

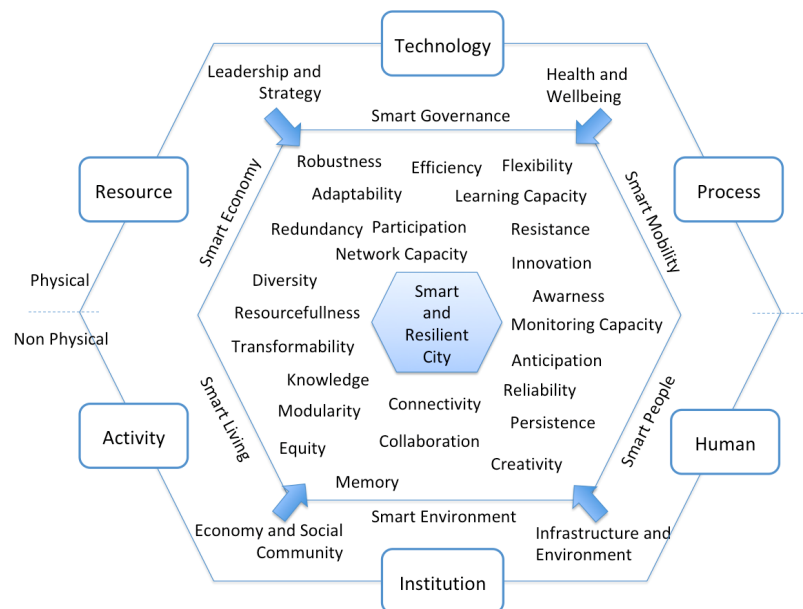


Figure 4. Smart and resilient city model.

In this smart and resilient city model, there are 25 characters that are integrated and embedded within the scope of smart and resilient city concept. To achieve a complete concept, the characters cannot be separated and will always be attached. Manville, et al., (2014) [22] mention that there is at least one characteristic of the six characteristics (smart governance, smart economy, smart environment, smart living, smart mobile and smart people) because it can lead to a multi-dimensional strategy to synergize and support each other. In the new conceptual model, four dimensions by ARUP (2013) [42] are added, and as a whole must be included in shaping the model toward the smart and resilient city concept.

Components of the city are divided into physical and non-physical components, namely: resources, processes, and technologies included into the physical group; people, institutions, and activities entered into non-physical groups. Certainly, with the note that all components of the city are not equivalent to its position. Human component that has the greatest role than other components, because humans that determine the creation, governance, and maintenance of all the components that exist [48]. Minimizing the impact on communities and their efforts to re-emerge from shock is a critical criterion evaluated when measuring the resilience of a city. This model tries to combine the components and character of smart city and resilient city into a new, integrated concept: the "smart and resilient city". This model is still a recommendation that requires more in-depth research, exploration, and model testing.

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