Promoting smart city research for engineering students

Fachrul Kurniawan†, Supeno M.S. Nugroho‡ & Mochamad Hariadi‡

Sepuluh Nopember Institute of Technology, Surabaya, Indonesia†‡
Maulana Malik Ibrahim State Islamic University, Malang, Indonesia†

ABSTRACT: There has been increase in the development of smart city-based systems in cities throughout the world. However, there is a diversity of cities and problems, and so cities are not all the same. There has not been research to support a city in implementing smart city concepts. Therefore, research on the smart city concept is needed and should be categorised based on the level of education, such as Bachelor, Master and doctoral level. This research is intended to help understand smart city-based development. It aims to produce a human resources development design that can support the city with implementation research contributing to the smart city development. Presented in this article is a mind map on the division of smart city research based on the level of higher education.

INTRODUCTION

As cities develop, complicated problems increasingly are encountered. One of the ways to solve these problems is by implementing a smart city to optimise the decisions [1-4]. The concept of the smart city has six main features [5]:

1) smart government,
2) smart health,
3) smart mobility,
4) smart energy,
5) smart telecommunication, and
6) smart education.

The main problem for smart city implementation is which feature to implement first to solve the city's problems [6]. The intention in almost all cities in the world is to implement smart city systems to address the complex and complicated problems being faced in these cities. Rapid population growth as a result of urbanisation is a major issue that must be faced, because of the potential negative effects on the development of a city [7].

A city is an area of socio-economic activity that may be the centre of government. In a developing country, such as Indonesia, a city does not necessarily have a wide range of infrastructure to support smart city systems [8]. This is different from developed countries, where the infrastructure is in place, so that problems can be addressed properly. The cities in the world are distinguished based on their country group; namely, whether the city is in a developed or developing country. This difference in infrastructure makes implementing smart city systems different for cities in the developed versus developing world.

Research on smart cities usually focuses on cities in developed countries, and the implementation of the six main features by using design modelling, e.g. how to set hotspot (Wi-Fi) areas throughout a city, so the connectivity for electronic devices is always available; how to make a smart health system, so that medical records are available at all hospitals in that city [9][10].

However, a lack of adequate smart city research can be inferred from the research published in international journals. This shows that smart city research is a fertile and largely original field for investigation. By focusing on the design model of the smart city, research could lead a multitude of findings on how to implement smart city systems to address city problems [2]. City problems cover many areas, especially engineering, which has implications for engineering students. It is important to understand that the research results clearly can help a city to solve problems in their development [11][12].

INDONESIA - A DEVELOPING COUNTRY

As stated above, cities in the world are categorised based on whether they are in a developed or developing country. The problems encountered by cities in developing countries are more complicated compared to cities in developed countries. This is due to the relative strengths of their economies and human resources [3][13]. The high rate of urbanisation leads to cities becoming the biggest problem in developing countries [14]. Moreover, the data related to problems in the cities are not recorded well and correctly, thus hindering good solutions to the problems.

Indonesia belongs to the group of developing countries. Its cities do not have the infrastructure to support a smart city system. This is different from the developed countries, where the city infrastructure has been prepared to support the trouble-free implementation of smart city systems [6][15][16].

There are not many smart city developments in Indonesia. There is a lack of information regarding cities evolving into smart cities in Indonesia. There is little research in higher education institutions regarding smart city systems. The insufficient infrastructure to support smart cities in every city throughout Indonesia contrasts with cities in the developed countries [3][17]. As a developing country, Indonesia needs many approaches to develop the advanced technology needed for smart cities. Not all leaders in cities throughout Indonesia realise this, and thus sometimes development is stalled, because of lack of leadership [6][18].

The development of smart city systems needs consistency and commitment. In Indonesia the six main features of smart city are adapted from smart cities in Europe and developed countries (see Figure 1).

Note:

1. Smart government
2. Smart energy
3. Smart building
4. Smart mobility
5. Smart infrastructure
6. Smart technology
7. Smart health
8. Smart people

Figure 1: The smart city in Indonesia.

THE SMART CITY AS A RESEARCH TOPIC

The smart city concept aims to overcome various problems of a city to produce a city ecosystem, which is green, interconnected and integrated to serve public needs. A smart city development gives the city a stronger character and can be used to evaluate city planning. The smart city development can be used for synchronisation and optimisation of economic investment, and communications networks, and has a strategic value in benchmarking the city against other cities [11].

Smart city research provides many opportunities as a research topic in higher education institutions in Indonesia [19][20]. This research must reflect the vast area of the country and the four types of city; namely, small town, middle city, big city and metropolitan city. The research will be the basis of the implementation of smart city systems in the various city types. Figure 2 shows the research roadmap for the smart city concept as the research topic.

The research roadmap for smart cities is shown in Figure 2, focusing on the main smart city features.

The main features are centred on the problems of cities around the world. The smart city concept covers six features; these are smart health, smart education, smart mobility, smart energy, smart governmental (smart economy, smart people, smart environment, smart living), and smart telecommunication. The aim of the research would be to assist the smart city implementation in cities of developing countries, such as Indonesia, and to set a standard pattern for implementation of smart city features.

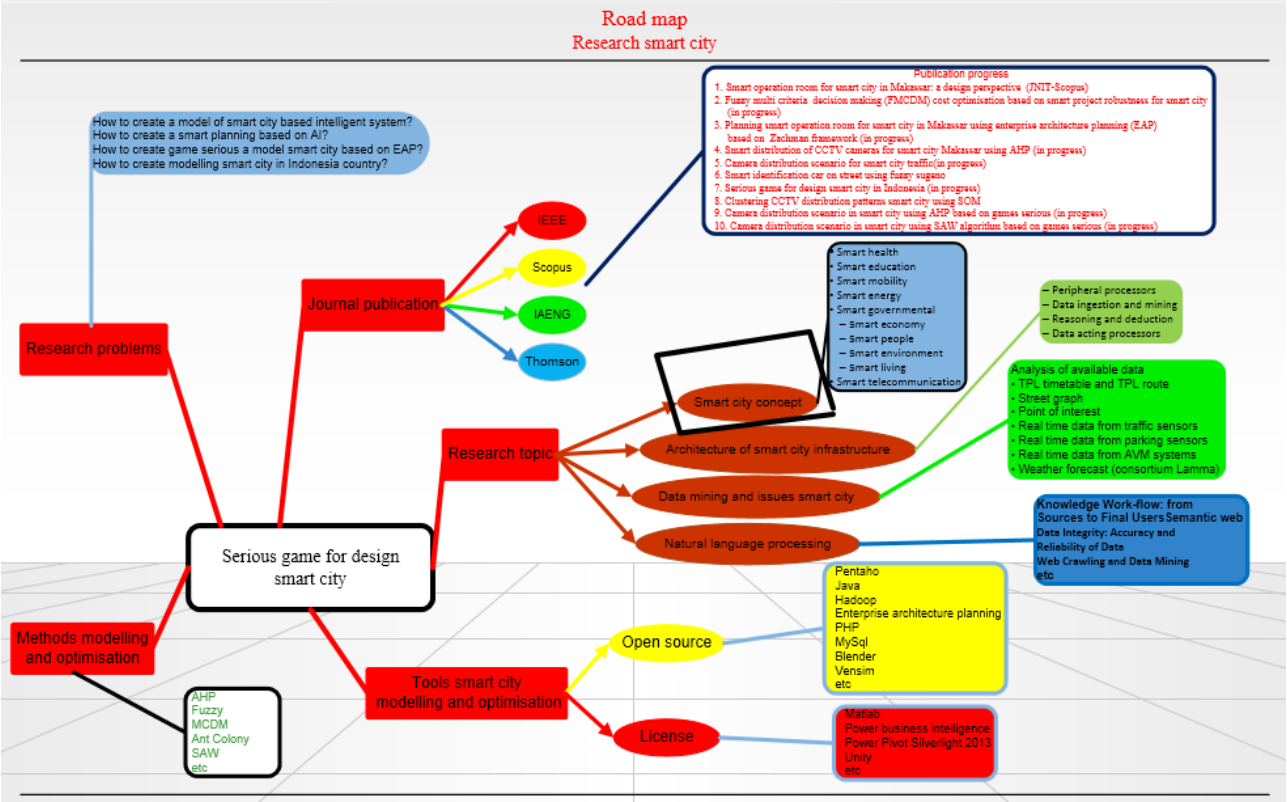

Figure 2: Research roadmap for smart cities.

The increased population of cities requires a great number of well-organised good services compared to, say, a village. By using technology, the problems that emerge from urbanisation can be adjusted for and solved.

The putative research can be divided into education levels, i.e. Bachelor level, Master level and doctoral level. The smart city research needs to be classified, so that each education level makes a tangible contribution to the city and would involve a clear relationship between the world of education and city government. This would foster a better and more developed city in providing service and protection to its public. The classification of smart city research into topics is shown in Table 1.

Table 1: Smart city research by education level.

Smart city research / Smart city research	Bachelor thesis (application)	Master thesis (compare)	PhD thesis (concept)
Smart health	Monitoring	Supplement	Health modelling
Smart education	Facilitate	Model teaching	Pedagogy concept
Smart mobility	Simple service	Maximal services	Mobility
Smart energy	Easy to get	Efficiency	Optimisation
Smart governmental (smart economy, smart people, smart environment, smart living)	Accountable	More protective	New prospering citizens
Smart telecommunication	Available	Equally	Speed and accuracy

Based on Table 1, the research at Bachelor level belongs to the implementation stage and focuses on helping directly in developing smart city systems, adjusted for organisations in the city. The research at Master level concerns the evaluation of the implemented system, to provide feedback to perfect the system. Evaluating a system that will be implemented or has been implemented will result in updates or corrections to the smart city features. Doctoral research focuses on evaluating features implemented in a city, and to examine problems that have emerged. This enables new models to be developed or even to set new parameters for smart city development.

There are six fields for the smart city implementation carried out in European countries (Table 1). In the health area, the research at Bachelor level focuses on how to make an application to monitor the health of people by using a technology network. The application needs to be evaluated to improve efficiency and accuracy. The evaluation will be

carried out by Master students for their research. If there is any change in the lifestyle of people in the city, one of the issues that must be studied is health. Thus, the focus on analysing and modelling (setting the parameters) is the job of doctoral students. Figure 3 shows research activity by education level.

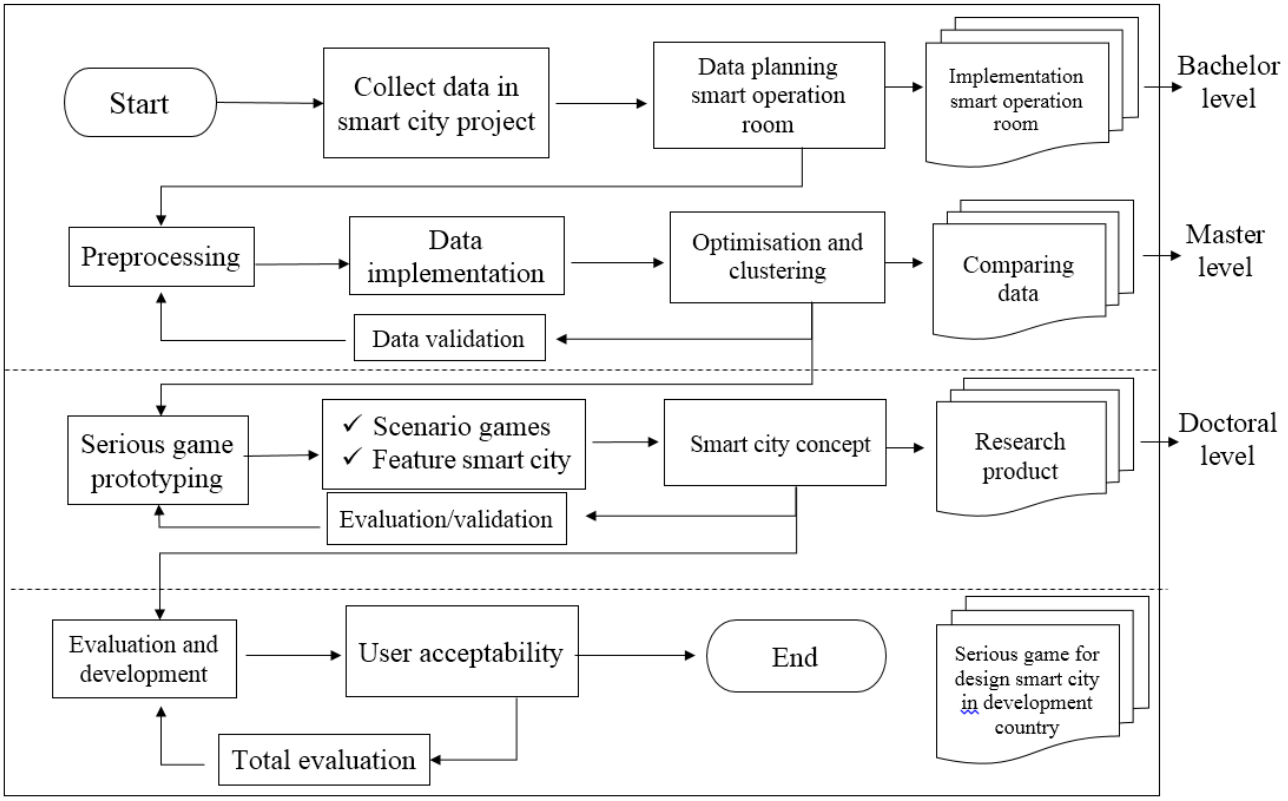

Figure 3: Smart city research by education level.

Figure 3 is an example of a smart city implementation, where the research is divided by education levels. At Bachelor level, the research focuses on the implementation of a smart operation room suitable for the city's business. In addition, there should be research, which is conducted by Master students focusing on how a smart operation room must be built by comparing available smart operation room systems. To establish a smart operation room requires a study beforehand to analyse and model the city problems to determine the main features of the smart city. This is the research domain of doctoral level students. The modelling study requires much intricate data. This modelling is needed before determining the form of the implementation.

In Table 1, the features in each education level are distinguished based on the level of urgency. The important application for smart health is how to monitor health in real time. On the other hand, the smart education feature focuses on teaching to be conducted regardless of the location. Research on smart energy is concerned with customer services and access to energy. Smart mobility focuses on the application supporting the provision of transportation services. Smart government research at Bachelor level is the application to support transparent public services, which is continued at Master level as the comparison of government services. Smart telecommunication research at Bachelor level is the application that supports communication distribution that can be used by citizens at very low cost, regardless of the location.

INDONESIA: ACADEMICS AND SMART CITY RESEARCH

Engineering students have a fundamental role to play in smart city research because their learning is suitable for the smart city-based development model. The main features of the smart city are taught to engineering students, from Bachelor to doctoral level. The research opportunity will be tailored to the city and country. Each city has different types of problem. For example, cities in Indonesia are divided into four city types; namely, small town, middle city, big city, and metropolitan city. This is a challenge for smart city-based development. However, this research is relevant since the scope must be from the broad to the narrow; and, of course, Indonesia is a developing country.

There are many research opportunities for cities in Indonesia. The smart city-based development will connect the small town to the middle city to the big city and finally to the metropolitan city. This research should attract engineering researchers due to the mathematical content and, of course, every location will be different.

There are many cities in Indonesia where the location is near the beach, where the city area includes land, sea and small islands. There are also cities around the mountains, where the location is land and mountainous area. This variety of city

area is a challenge, resulting in many research models. There are about 100 cities in Indonesia in 34 provinces. There are many research opportunities - especially in engineering - from Bachelor to doctoral level, to cover all a city government's businesses in implementing smart city-based development.

CONCLUSIONS

There are several obstacles to smart city research. The biggest obstacle to smart city research is the lack of synergy between the city governments and higher education. A high number of engineering students do not understand smart city systems. One of the main features of the smart city is smart education, which is not well implemented. Hence, it is important to support smart city research. However, there is a research standardisation for smart city research to direct the contributions of engineering students at Bachelor, Master and doctoral level.

The smart city research in Indonesia refers to the European framework divided into six areas; namely, smart health, smart education, smart mobility, smart energy, smart governmental (smart economy, smart people, smart environment, smart living) and smart telecommunications. A suggestion is to engage higher education institutions throughout the country, so as to be more effective in supporting the implementation of the smart city-based developments in all cities. Furthermore, the smart city must connect between one city and other cities and also with the urban area, so as to affect and improve human resources.

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