Smart City: Utilization of IT resources to encounter natural disaster

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Abstract. This study proposes a framework for the utilization of IT resources in the face of natural disasters with the concept of Smart City in urban areas, which often face the earthquake, particularly in the city of North Sumatra and Aceh. Smart City is a city that integrates social development, capital, civic participation, and transportation with the use of information technology to support the preservation of natural resources and improved quality of life. Changes in the climate and environment have an impact on the occurrence of natural disasters, which tend to increase in recent decades, thus providing socio-economic impacts for the community. This study suggests a new approach that combines the Geographic Information System (GIS) and Mobile IT-based Android in the form of Geospatial information to encounter disaster. Resources and IT Infrastructure in implementing the Smart Mobility with Mobile service can make urban areas as a Smart City. This study describes the urban growth using the Smart City concept and considers how a GIS and Mobile Systems can increase Disaster Management, which consists of Preparedness, mitigation, response, and recovery for recovery from natural disasters.

1. Introduction
Indonesia is an area prone to earthquake and tsunami disaster. This is due to its geographical position which lies in the geological configuration of the three tectonic plates in the world: the Australian Plate in the South, the Euro-Asia Plate in the West and the Pacific Ocean Plate in the East, which can lead to a number of disasters as can be seen in Figure 1. These plates always move and collide, producing an active motion that will produce seismic activity. This position has also caused a large number of natural disasters, earthquakes, tsunamis, and volcanic eruptions in Indonesia [1].

Figure 1. Geographical Position of Indonesia.
Climate change experienced by the world population derives originally from natural processes and human activities. Climate change is due to the economic problems [2]. The activities of detecting natural disasters are part of disaster management [3]. A natural disaster has become a serious problem in urban areas around the world because of the deterioration of ecological factors which tends to intensify the
effects of heat and global warming [4]. Smart City is created with the objective is to be able to handle or reduce unforeseen natural disasters through high efficiency handling [5]. Mauritius [6] explains Smart City has six characteristics as shown in Figure 2.

![Figure 2. Smart City Model.](image)

Theoretically, there are four stages established for Disaster Management Operations, i.e., mitigation, preparedness, response and recovery [7]. Yavar et al. [8] provide a major phase in disaster management with several dimensions and factors as can be seen in Figure 3.

![Figure 3. Stages of Disaster Management.](image)

Figure 3 shows that to handle disaster requires technological resources in assisting disaster management in every city. Mao et al. [9] describe technological resources which are divided into three, namely, IT infrastructure Resources, IT Human Resources, and IT Relationship Resources. Smart City is a city that integrates social development, capital, civic participation, and transportation with the use of information technology to support the preservation of natural resources and improved quality of life [10]. Smart City system planning can be defined as the use of sensor tools so that the resulting data can be used as a support during decision-making generated by government authorities. The efficiency of Smart City can be done by providing data related to air temperature, rain discharge, humidity, pressure, wind speed, and high water level [11]. This study discusses the utilization of technology resources to Smart City to face disaster so that it can assist in how to manage the disaster effectively.

2. Related Works

A smart city can be defined as "A city that meets challenges through the strategic implementation of ICT resources, networks, and services to provide services to citizens or manage infrastructure" [12]. Serhani et al. [13] propose service discovery and reservation engineering for Mobile Ad Hoc Network (MANET) designed to support disaster recovery and military environmental operations. Smart City's innovation begins with the metabolism of urban thinking, produces intelligent citizenship, strengthens human capital, develops the collectivity of people's intelligence, facilitates the needs of the population, and benefits derive from individuals [14]. The further developments emerge from the availability of new technologies, cities adopting urban solutions, communications, and intelligent information technology organizations that develop and provide solutions for technology [15]. Development and growth in urban populations can exacerbate risk and increase the frequency of natural
disasters caused by climate change [16]. The increasing factor of human settlements, demanding greater preparedness for natural disasters such as hurricanes and storms, earthquakes, tsunamis, floods, droughts, and forest fires [17]. Emergency disaster simulations are essential to minimize harm, damage and build resilience [18]. In addition, information security for Smart City related to personal privacy or individual autonomy such as secret copyright, patent or trade needs to be increased where the information is used to control systems from the power grid for medical care when a disaster takes place is very important [19]. Policy integration is always at the regional and national levels and not at the local level. Regions may often be a more relevant scale to address and manage climate change issues [20].

The number of agencies responsible for reducing the occurrence of disasters and improving the effectiveness of disaster management, including the Ministry of the Environment (providing guidelines on non-national rules and regulations); Regional councils (responsible for policy frameworks or regional watersheds); Territorial authority (City and parliament are responsible for land use and certain decisions); Civil defense emergency management group (Disaster preparedness and response); and the lifeline of the engineering group (Infrastructure Management). Cooperation between agencies is very important in the flow line and the national holistic approach to disaster planning [21]. The municipal authorities have established disaster management plans, created early warning systems, emergency response mechanisms, capacity building, disaster, climate change, mitigation, evacuation plans, early system recovery and coordination of government agencies [22]. Lack of information in the event of a disaster can lead to slow access, ineffective and negligent post-disaster recovery [18]. The results show that GIS applications still place a secondary focus on data preparation and exploration of disastrous impacts [23].

3. Method and Framework

The approach used in this research is a combination of Geographic Information System (GIS) and mobile IT [16] in the form of geospatial information as Resource IT affecting Smart Mobility which is part of Smart City. Geospatial information is geospatial data that has been processed and can be used to facilitate planning, decision-making, and activities relevant to the detection of natural disaster sites [24]. The Research Framework explaining the relationship of IT resource, Smart City, and disaster can be seen in Figure 4.

Figure 4. IT Resource Framework in Smart City Disaster Management.

Perboli et al. [25] describe a Smart City is an Intelligent city where new technologies are implemented to provide a more efficient, secure, and sustainable day-to-day activities and services. Urban populations around the world have been depressed due to social problems and political instability, urbanization, and migration [26] in which the greater frequency of natural disasters. Lifestyle threatens the greater impact of natural disasters and citizens should consider opportunities through science and technology. The most important thing to the government is to develop a regional project as a natural disaster mitigation intervention [27] For example, the provision of land and open buildings where rapid evacuation can accommodate many people.
In the context of current research, the terms 'smart', 'Digital', and 'innovative' are often used to describe Smart city. As emphasized by [28], it is a challenge to separate the term as they are often defined using certain other term assumptions, or have been used interchangeably. Different definitions could be related to certain concepts - some of those definitions have been highlighted in Table 1. [29] have addressed better explanations of the concept.

| Related to the Concept | The exact definition of every concept                                                                 | Keywords                                                                 |
|------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|
| Infrastructure         | A Smart City connects physical infrastructure, IT infrastructure, social infrastructure, and business infrastructure to capitalize on the city's collective intelligence [26]                         | Infrastructure, intelligence                                              |
| Knowledge              | Smart city is a region with a high capacity to learn and innovate, a built-in creativity of their populations, their institutions for knowledge creation, and their digital infrastructure for communication and knowledge management [30] | Learning, innovation, knowledge                                           |
| Community              | A Smart City is a city that is prepared to provide the conditions that provide people in it to live healthy and happy in challenging global conditions that have an impact on environmental, economic, and social change [31] | A happy society, Overcome challenges                                    |
| Sustainability        | A Smart City is when human investment in social capital, ICT-based modern transportation, communications infrastructure, fuel, and economic growth are directed to sustainability and high quality of life through wise management of natural resources and participatory governance [32] | Sustainable economic growth, social capital                              |

4. Results and Discussion

Smart City planning provides support for collective action in the evacuation of natural disasters. Mobile-GIS provides real-time visualization of spatial risks and resources and analyzes evacuation routes to safe area [33]. The smart city-based planning of eco-friendly technologies is basically planning a collaboration involving various agencies in the planning process, for example through integration, information dissemination and environmental space interactions within the city [34]. Smart City as a whole can contribute to enhancing the mitigation of natural disasters that can help in situations where policy makers in planning methods can propose cooperative and effective technologies [35]. A key challenge in Smart City development is the analysis of real data to create action. If it exceeds a predetermined limit then warnings or warning signals are transmitted to the public via social media [11]. Mitigation strategies are identified and implemented in an effort to prevent or minimize damage to social, economic, and ecological systems [36]. The perception of hazards is in accordance with the factors of age, education, and income determined, but it depends on a number of factors such as the intensity and frequency of occurrence, the extent of damage to the population and its assets, experience, traditions and the way natural phenomena are recognized [37]. Natural disasters around the world have an impact on the safety and well-being of the urban economy community largely due to global warming and climate change. It is necessary to develop techniques for assessing the impact of natural disasters in a comprehensive and systematic manner allowing for additional incidents for disaster events [38]. Sensor systems can generate large data disaster data, people, environments, and so on from smartphone devices that have great potential to transform urban communities [39]. The system is built to predict population mobility or evacuation in affected cities and can inform future disaster management strategies [39]. However, the disadvantage of this system is that if there is an error from the Global Positioning System (GPS) transmitter.

5. Conclusion

A good Smart City can be carried out using the IT Resource owned by the City Government in the face of disaster. The use of resource IT consisting of Resource Infrastructure, Human Resource, and Relationship Resource can help mitigation and preparedness of natural disasters occurring in big cities. The benefits of building Smart City not only to provide benefits to government authorities but also can help people to guard against disasters and manage efficiently to achieve goals. Smartphone devices
have great potential in transforming urban society through social media consumed by the public who can convey information relevant to spatial characteristics such as geographic information and location social territory. In natural disasters, seismic waves taking to spread away from the epicenter could serve as an early warning system for large-scale incidents. Systems will be built to predict population mobility or evacuation in affected cities can inform future disaster management strategies.

References

[1] Diposaptono, S and Budiman. 2008. Live Familiar with The Earthquake and Tsunami (Bogor: Buku Ilmiah Populer)

[2] Gravitiani, E and Antriyantri E. 2016 Willingness to Pay for Climate Change Mitigation: Application on Big Cities in Central Java, Indonesia. Procedia-Social and Behavioral Sciences, 227, 417-423

[3] Goswami S, Chakraborty S, Ghosh S and Chakrabarti A. 2016. Ain Shams Engineering Journal

[4] Yamashita, S., Watanabe, R. and Shimatani, Y. 2015 Smart Adaptation to Flooding in Urban Areas. Procedia Engineering, 118, 1096-1103

[5] Rumbach A. 2015. Decentralization and Small Cities: Towards More Effective Urban Disaster Governance. Habitat International, 52, 1-8

[6] Mauritius. 2015. Environmental Guideline for Smart Cities (Mauritius: Ministry of Environment, Sustainable Development and Beach Management)

[7] McLoughlin, D. 1985. Emergency Management: A Challenge for Public Administration. Public Administration Review, 45, 165-172

[8] Yavar B, Bagherizadeh M T and Mirtaheri M. 2008. The Lesson Learnt from Tehran Snow Disaster Management Proceedings of the Disaster Risk Reduction Conference, Disaster Management Institute of Southern Africa (DMISA)

[9] Mao H, Liu S, Zhang J and Deng Z. 2016. International Journal of Information Management, 36, 1062-1074

[10] Walvarens N. 2015. Qualitative Indicators for Smart City Business Models: The Case of Mobile Services and Applications. Telecommunications Policy, 39, 218-240.

[11] Rathore M M, Paul A, Ahmad A and Rho S. 2016. Urban Planning and Building Smart Cities Based On The Internet of Things using Big Data. Analytics Computer Networks, 101, 63-80

[12] Lovehagen N and Bondesson A. 2013. Evaluating Sustainability of Using ICT Solutions in Smart Cities-Methology Requirements. Proceedings of First International Conference on Information and Communication Technologies for Sustainability, 175-182

[13] Serhani M A and Gadallah Y. 2010. A Service Discovery Protocol for Emergency Response Operations Using Mobile AdHoc Networks. Proceedings of Sixth Advanced International Conference on Telecommunications, 280-285

[14] Battarra R, Gargiulo C, Pappalardo G, Boiano D A and Smerald J. 2016. Planning in The Era of Information and Communication Technologies. Discussing the “ label : Smart ” in South-European cities with environmental and socio-economic challenges. Cities 59, 1-7

[15] Paroutis S, Bennett M and Heracleous L. 2013. Technological Forecasting & Social Change A Strategic View on Smart City Technology: The Case of IBM Smarter Cities During a Recession. Technological Forecasting & Social Change, 1-11

[16] Forino G, Meding J V, Brewer G and Gajendran T. 2014. Disaster Risk Reduction and Climate Change Adaptation Policy in Australia. Procedia Economics and Finance, 18, 473-482

[17] Steiner, F. 2014. Landscape and Urban Planning Frontiers in Urban Ecological Design and Planning Research. Landscape and Urban Planning, 125, 304-311

[18] Cinnamon J, Jones S K and Adger W N. 2016. GeoForum Evidence and Future Potential of Mobile Phone Data for Disease Disaster Management. GeoForum,75, 253-264

[19] Elmaghraby, A. S. and Losavio, M. M. 2014. Journal of Advanced Research, 5(4), 491-497

[20] Heidrich O, Reckien D, Olazabal M, Foley A, Salvia M, Hurtado S D G, Orru H, Flacke J, Geneletti D, Pietrapertosa F and Hamann J J P. 2016. Journal of Environmental Management, 168, 36-45
[21] Saunders W S A and Kilvington M. 2016. *International Journal of Disaster Risk Reduction* 18, 244-255.
[22] Shaw R, Surjan A and Parvin G A. 2016. Urban Disasters and Approaches to Resilience. *Urban Disaster and Resilience in Asia*, 1-19
[23] Granell C and Ostermann F O. 2016. Computers, Environment and Urban Systems Beyond Data Collection: Objectives and Methods for Research Using VGI and Geo-Social Media for Disaster Management. *CEUS*, 1-13
[24] Sutanta H, Aditya T and Astrini R. 2016. Smart City and Geospatial Information Availability, Current Status in Indonesian Cities. *Procedia-Social and Behavioral Sciences*, 227, 265-269
[25] Perboli G, Marco A D, Perfetti F and Marone M. 2014. A New Taxonomy of Smart City Projects. *Transportation Research Procedia* 3, 470-478
[26] Harrison C G and Williams P R. 2016. Simulation Modelling Practice and Theory A System Approach to Natural Disaster Resilience. *Simulation Modelling Practice Theory*, 1-21
[27] Tironi M and Farias I. 2015. Geoforum Building a Park, Immunising Life: Environmental Management and Radical Asymmetry. *Geoforum*, 66, 167-175
[28] Holands R G. 2008. Will the Real Smart City Please Stand Up? *City*, 12, 303-320
[29] Dattakumar A and Sharma R S. 2016. Smart Cities and Knowledge Societies: Correlation, Causation or Distinct. *Proceedings of IEEE International Conference on Management of Innovation and Technology (ICMIT)*, 193-197
[30] Komminos N. 2006. The Architecture of Intelligent Cities: Integrating Human, Collective, and Artificial Intelligence to Enhance Knowledge and Innovation. *Proceedings of the Second IEEE International Conference on Intelligent Environments*, 13-20
[31] Guan, L. 2012. Smart Steps to A Battery City. *Government News*, 32, 24-27
[32] Caragliu A. 2011. Smart Cities in Europe. *Journal of Urban Technology*, 18, 65-82
[33] Ai F, Comfort L K, Dong Y and Znati T. 2015. A Dynamic Decision Support System Based on Geographical Information and Mobile Social Networks: A Model for Tsunami Risk Mitigation in Padang. *Safety Science*.
[34] Yeo I and Yee J. 2016. Automation in Construction Development for an Automated Modeler of Environment and Energy Geographic Information System (E-GIS) for EcoFriendly City Planning. *Automation in Construction*
[35] Kobayashi T and Ikaruga S. 2015. Development of A Smart City Planning Support Tool Using The Cooperative Method. *Frontiers of Architectural Research*, 4, 277-284
[36] Pine J C. 2011. Enhancing The Resilience of Coastal Communities: Dealing With Immediate and Long-Term Impacts of Natural Hazards. *Treatise on Estuarine and Coastal Science*, 12, 271-281
[37] Nedelea A. 2016. Floods and Public Perception on Their Effect. Case Study: Tecuci Plain (Romania). *Procedia Environmental Sciences*, 32, 190-199
[38] Abaker I, Hashem T, Chang V, Badrul N, Adewole K, Yaqoob I and Chiroma H. 2016. *International Journal of Information Management*, 36, 748-758
[39] Ang L and Phooi K. 2016. Big Sensor Data Applications in Urban Environments. *Big Data Research*, 4, 1-12