Hazard Management and Smart Infrastructure in Central-Java, Indonesia

The Possibilities and Disadvantages of Smart Infrastructure in the Battle against Hazards and Rapid Urbanization

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Preface

This bachelor thesis is written in the context of the Geography, Planning and Environment bachelor at the Radboud University in Nijmegen. During this bachelor I have had several lectures on the 'Global South' in which this developing part of the world was the main subject of discussion. I was immediately intrigued by this subject of development, and more in particular, the role of Smart City and Hazard Management Systems, in Indonesia. When the opportunity came to do a bachelor thesis research on Indonesia, I immediately chose this subject for this research. As Indonesia is known for several kinds of major (natural) hazards on a regular basis like earthquakes, tsunamis and volcanic activity and the lower level of development compared to the Netherlands.

This research was originally planned to be conducted in Yogyakarta, this in cooperation with the Universitas Gadjah Mada University (UGM) in Yogyakarta. Unfortunately, the Coronavirus (COVID-19) pandemic forced me to conduct this research 100% 'online'. Even though I had to face the challenges caused by the pandemic, I still believe that this thesis represents the knowledge I have gathered in my years as a bachelor student well. This research connects perfectly to the knowledge I have gathered and the interest I have in physical geography, development and the 'Global South'. The city of Yogyakarta matched these interests as a city with a high development rate. A high development rate in a city in the 'Global South' usually comes with inequality, environmental problems and in Indonesia with a greater danger of being exposed by (natural) hazards.

While writing this thesis I had extensive contact with associate professor Rini Rachmawati, based with Geography at the Universitas Gadjah Mada University who helped me before and during the Coronavirus (COVID-19) pandemic, and whom I would like to take this opportunity to extend my appreciation to. Furthermore, I want to thank Sem van der Linden and Martijn Vriezen. As co-students also looking at smart cities issues in Yogyakarta they helped me finding new insight on my subject and research as well as by helping arrange interviews. I also want to thank Dr. Ary Samsura, for helping me to get in touch with various non-UGM professionals and contacts, as well as Dr. Wisnu Pradoto who used his network to help me find more interviewees. At last I would like to thank my supervisor Dr. Lothar Smith for the new insights he gave me on my thesis, the helpful Skype-meetings and feedback.

Nijmegen, June 2020

Jelle van Bethraij

Summary

Yogyakarta and Central-Java are two of Indonesia's most affected regions by natural hazards and disasters. Earthquakes, tsunamis and volcanic activity are several disasters that inhabitants of these regions have to deal with on a monthly or even weekly basis. With ongoing climate change, these disasters become more frequent and violent. Hazard Management (Mitigation) Systems are installed in every part of Central-Java and Yogyakarta to deal with these disasters. Alongside this, rapid, unplanned urbanization is challenging Central-Java and Yogyakarta with yet another problem.

A different development in the regions of Central-Java and Yogyakarta is that these regions start developing 'Smart Cities' to create an innovative city with certain information- and communication technologies. This is done to improve quality of life, efficiency of city operations as well as to increase the competitive level of the city. The cities are trying to catch up to the western world as cities grow and become more prosperous. This growth (economically and in size) has a downside as well. Cities in the Central-Java and Yogyakarta regions are expanding unplanned and rapidly which challenges local governments and its vulnerable inhabitants significantly.

A potential cooperation between the Smart Cities and Hazard Management (Mitigation) Systems is a possible solution to tackle urbanization problems and protect the vulnerable inhabitants of a city from certain disasters. Looking through the eyes of Pierre Bourdieu and his Habitus and Capital theory, it does not matter where you live and how you live, everyone creates their own Capitals and Habitus. The goal of this research is to provide insight and create deeper understanding of how smart infrastructure can be implemented to support a safer environment in the battle against several hazards on the island of Java, even in a time of the Coronavirus (COVID-19) pandemic. Based on this research goal, the following research question was constructed: *How can the concept of Smart City help to empower more vulnerable populations in the Central-Java region in dealing with safety and development issues through natural hazards?*

The results of this research can provide a valuable insight on how these two concepts of 'Smart Cities' and 'Hazard Management (Mitigation) Systems' can work together (or perhaps be built around each other to tackle the aforementioned problems. All this, to create a viable platform for every part of urban society to live in a disaster mitigated environment. In this case, it means limiting economic losses and death tolls during and after disasters. Furthermore, the cooperation between Smart Cities and Hazard Management (Mitigation) Systems can facilitate cities develop and give individuals the chance to develop themselves.

To acquire the necessary data a vast literature study was done to prepare for the online ‘fieldwork’. During the ‘fieldwork’, in-depth interviews were conducted with locals alongside interviews with professionals from the Central-Java and Yogyakarta regions. The data that was gathered from both stages of the research quickly showed that natural hazards affect daily life in the regions of Yogyakarta and Central-Java significantly. Some questions about natural hazards were even answered with some hesitation as these natural disasters have a traumatizing effect on Indonesians.

With regards to the Smart City concept, the special region of Yogyakarta (DIY) has begun building their own Smart City. As of now the goal of the DIY-project still is to create an efficient and effective public service network but also to improve local economic development and reduce the gap between local and provincial governments and the local community. Plans for this gap reduction were presented shortly before the Coronavirus (COVID-19) pandemic and involved local and provincial governments to carry out poverty alleviation pilots through this Smart City project by data sharing. The future of this project is uncertain at the moment of the Coronavirus (COVID-19) pandemic.

Although the effect of the Coronavirus (COVID-19) is significant on the funding of the ‘Smart City’ concept, the implementation of it around Hazard Management Systems can already be started. Fast data transmission and analyzation for Hazard Management Systems is something that could improve daily life for inhabitants of Central-Java and Yogyakarta. Its ultimate goals is that the Smart City concept can reach all parts of urban society, which has to be worked on.

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1. Introduction

Java, the most populous island of Indonesia is home to Indonesia's Capital, Jakarta, the economic engine of Indonesia as well as several major hazards and disasters. 'The Global South' is a term that also defines Java well; as a newly industrialized region that is upcoming between its complexities and post-colonial appearance (Miraftab, 2009). As Java (and Indonesia itself) is relatively young compared to other (western) regions. Java is located near the collision zone of three tectonic plates, situated between two big continents and within two major oceans known as the 'Pacific Ring of Fire'. This causes several volcanic eruptions, earthquakes and tsunamis. A big problem for Java and Indonesia in general, as Indonesia is one of the fastest growing economies and developing countries in the world (Marfai, King, Singh, Mardiatno, Sartohadi, Hadmoko & Dewi, 2008). Therefore, Indonesian and Java governments are in a difficult situation, caught between development and safety which should go hand in hand, but is difficult for a developing country (Andreastuti, Alloway & Smith, 2000). With small funds, choices have to be made between, for instance safety and development. A possible solution for these hazards is a better Hazard Management System on Java. A system which warns people for hazards, which has the resources to contain biological hazards and even stop several other hazards (Marfai *et. al.*, 2008; White *et. al.*, 2001). To facilitate this system, Java could make good use of smart infrastructure to facilitate both the Hazard Management System and the Smart City concept. Especially in the tumultuous region of central-Java where several major fault lines and volcanoes are located. These fault lines and volcanoes create several physical dangers. Furthermore, this region has been hit with other, non-visual, hazards such as the recent Coronavirus (COVID-19) outbreak.

'(…) when disasters occur, traditional systems of sharing (warnings) are no longer in place while the substitute systems of organized relief and welfare are still poorly developed' (White et. al., 2001).

Smart infrastructure is a concept in which intelligent energy systems, building technology, industry and other technological advanced systems are used to create a simpler, easier and ultimately a more efficient city infrastructure system (Mehmood, See, Katib & Chlamtac, 2019; Al-Hader & Rodzi, 2009). Smart infrastructure, in essence, is data and technology that are most important as assets to create a high (energy) efficient city and to create economic growth (or even add to the growth there already is) (Balakrishna, 2012). Several international companies like Siemens and IBM are willing to work with government institutions to create such a Smart City and its infrastructure as described above. For Java, an economic flourishing island located between Bali and Sumatra, this is a very interesting concept in their

transition from industry island to a clean, technological, developed and attractive island (Rusadi, Nurhayati, Tallo & Setiawan, 2016). By facilitating the Smart City infrastructure, cities in central-Java could become a hotspot for young talent, as a good infrastructure is vital for a good Smart City concept.

> *'(…) in context of smart cities, anything physical, electrical and digital that is the backbone of the Smart City can be considered as its infrastructure' (Mohanty, Choppali & Kougianos, 2016).*

Java is home to several fast-growing cities. This is because of massive growing tourism and an even faster growing tertiary sector for instance (Isdarmanto, 2015; Rochman, Ashton & Wiharjo, 2017). This sector provides goods and services to 'mainland' Indonesia as economic growth increases yearly. Because of this growth, Java is looking for new, fresh and smart students as well as well-developed people. On the contrary, Indonesia has a Transmigration Program (Transmigrasi) to move landless people from densely populated areas, like Java, to other parts of Indonesia. To make the island more attractive for the smarter and more well-developed people, they have begun to make their island into a hub for growing smart cities (Nurnawati & Ermawati, 2018). These plans are still very young and in their developing phase as proposals have just been made last December 2019 and are awaiting further plans of a possible capital move to Kalimantan. For instance, Yogyakarta (located in south-Java) has been deemed the 'Future of Urban Development' by the Times of Indonesia (Times Indonesia, 2019). A condition for bringing in new talent, students and tourists is a safer environment with a better Hazard Management System.

> *'Smart City concept redefines the urban planning and development of the existing and new cities. It drives on economic, social and environmental sustainability of a city and attracts citizens, professionals and corporations to build sustainable livings' (Mehmood, et. al., 2019).*

Combining the three subjects above leads us to the general subject of this research. The possibilities of improving safety on Java with improvements to the Hazard Management System with smart infrastructure. As well as facilitating the development in this way with the safer environment. As well as facilitating the Smart City with smart infrastructure as an incidental extra in developing central-Java. Some examples of how smart infrastructure can be used in Hazard Management Systems is data analyses of volcanic movements or fault line movement (Al-Hader & Rodzi, 2009). This data can then be used, via data processing systems through which citizens in the cities of Central-Java can be warned. This new processing system is a recent progression integrated in warning systems (Sorensen, 2000). With smart infrastructure this data processing can be even quicker and more precisely.

1.1 Objective and Questions

The objective of this research is to provide insight and create further understanding of how smart infrastructure can be implemented to support a safer environment in the battle against several hazards on the island of Java. The objective is to create an insight in the recent and less recent hazards Java has been faced with. With this insight the right adaption of smart infrastructure can be applied to the situation to improve hazard warning systems on the island. This would lead to less damage caused by hazards and even the containment of hazards that could support growth in the developing parts of the island. Furthermore, the possibility that the smart infrastructure that facilitates the Hazard Management System could also facilitate a Smart City, will be researched. All this, to create a safer and more development efficient climate on the island of Java in which safety and economic development are assured.

To research this, the following research question has been made as well as several other sub questions, to facilitate this research and to acquire data.

1.2 Research question:

How can the concept of Smart City help to empower more vulnerable populations in the Central-Java region in dealing with safety and development issues through natural hazards?

By answering the main question, an insight will be created on how smart infrastructure can achieve the main goal of creating a safer environment in central-Java by facilitating better Hazard Management Systems. This is done by looking at the recent history of Hazard Management Systems, hazards, disasters and the way this affects the development in central-Java. As well as looking at recent urbanization phenomenon's in the region. Furthermore, it creates a view on how it effects daily life in this region. To answer this main question four sub-questions help uncover four key dimensions of this question, to gain sufficient data in answering the main research question.

1.3 Sub questions:

1. Which hazards are present in the central-Java region and to which extent do they influence daily life in growing urban areas?
2. What is the state of current Hazard Management Systems and Smart City in Central-Java?
3. To which extent have the Hazard Management Systems and Smart City a ripple through effect on all parts of society?
4. To which extent does daily life improve in Central-Java with a better Hazard Management System and which side effects could it have?

By selecting these four sub questions the four most important topics with regards to the main research question get answered. These four topics are: Hazards, Hazard Management Systems, Smart City and Ripple Through Effect (Daily Life). By choosing for these topics I include the 'Instigator' of the ongoing problems in Central-Java, the Hazards. Furthermore, the two main topics of this research, Smart City and Hazard Management Systems are included. At last, the topic of Ripple Through Effect is included to show the possible effects of the aforementioned topics on urban society and daily life. These topics will be further elaborated on in the Theoretical Framework part of this research.

1.4 Scientific Relevance

The scientific relevance of this research is the possibility to add to the recent studies done on disasters, hazards and hazard management in central-Java. Furthermore, the smart infrastructure and Smart City concept are still in their conceptual infancy. By connecting the two elements, a new scientific insight on Hazard Management Systems in rural areas in Central-Java combined with smart infrastructure, can be created.

Hazard Management Systems are multidimensional and therefore makes it is relevant to look at how it should be implemented in central-Java. Furthermore, the central-Java region lends itself for a scientific research, as historically and in more recent years, hazards and disasters have been present. Connecting to the recent hazards and disasters, like the recent Merapi volcano outburst and the Coronavirus (COVID-19) outbreak, this subject is relevant. The Merapi volcano outburst and the Coronavirus (COVID-19) outbreak have not been researched very much yet as they are very recent. Connecting to the densely populated city of Yogyakarta, this unknown virus is perhaps as dangerous as a fire or earthquake.

While most research about hazard management is focused on improving old systems and not smart infrastructure-based systems alike (White *et. al.*, 2001; Fuchs *et. al.*, 2017). This research will focus on new insights with smart infrastructure and more recent hazards and disaster for a broader research frame.

1.5 Societal Relevance

This research is conducted with the goal to contribute to limiting economic losses and deaths by improving hazard management. These losses could be economic, but more importantly they could also be social (lives for instance) and material losses (White *et. al.*, 2001). These losses have increased dramatically in recent years, even though research and knowledge about hazards and disasters have increased (Jakarta Post, 2019).

Thereby, this research can contribute to more knowledge for central-Java governments and the Indonesian government about the effects these hazards have on urban society and how to deal with them.

All this, to decrease economic losses and death tolls in the event of a hazard. For society, this means a safer environment which in itself means a more efficient way of living and more effectiveness in work. These social gains for people in Central-Java account for every part of society, when a Hazard Management System and its infrastructure ripple through to every part of society. No part of society should be left behind in knowing when an earthquake or flood is coming.

1.6 Thesis Outline

In Chapter 2, the theoretical framework of this research is elaborated on. This is done by explaining the issue at hand in Central-Java and Yogyakarta at the moment, alongside elaborating on the main concepts of this research such as Smart City and Hazard Management Systems. As well as the theory of Pierre Bourdieu on different forms of Capital and Habitus. The conceptual model is also presented in this part of the research. After that chapter 3 begins with the methodology of this research. In this chapter, the certain choices that I made are elaborated on and explained. Furthermore, in this chapter, the informant selection is presented as well as information about the location of this research. The results of this research are presented in chapter 4. This is done in four different paragraphs, as every main topic of this research gets its own part in this chapter. After presenting the results, chapter 5 includes the conclusion of this research. At first, the sub questions are answered and eventually a conclusion of the main research question is presented. In the following chapters 6 and 7 there is a recommendation for policy makers and scientist and discussion respectively. At the end of this research a bibliography and appendix can be found too.

2. Theoretical Framework: The Smart Core of this Research

Hazard Management Systems seem to be a straight forward concept of warning and protecting people of hazards. Nevertheless, the underlying assumptions and choices on how they are demarcated and designed, are very complex and different, depending on which hazard they are used for. Further elaboration on what it exactly contains and how it can be applied to smart infrastructure is necessary as a clear definition is important for this research. Before the Hazard Management Systems can be explained, the problem that Central-Java is facing will be elaborated with regards to hazards, development and urbanization. Furthermore, smart infrastructure and the Smart City concept are both very broad terms and consist of multiple layers that have not been in use for a long time. Therefore, these terms need to be conceptualized and elaborated on in a clear way, to create a clear definition for both of these terms. I will discuss multiple definitions of Hazard Management Systems, as well as smart infrastructure and Smart City from external literature. As well as state a clear definition for this current research. Moreover, the theory of Pierre Bourdieu will be explained and applied to this research to have a different look on, for instance, Capital and Habitus. Pierre Bourdieu was a French sociologist and thinker who created the concepts of Habitus and three forms of Capital. Bourdieu aimed to transcend typical dichotomies like passive and active as well as theory and practice (Inglis & Thorpe, 2018). The three key concepts can be linked to this research and the subject of Hazard Management Systems and smart infrastructure, as well as how it effects people's daily life, in this case their Habitus and Capital.

2.1 The Issue at Hand

Before we look into any technological systems and immediate answers we have to look at the ongoing issues in Central-Java. This is important as McFarlane and Söderström (2017) and Hollands (2015) tell us that the 'real' Smart City needs to start with the city itself and its attendant social problems. Rather than looking immediately to smart technology for answers. These social problems are created because of the near exponential growth of cities in Central-Java because of urbanization (Washburn Sindhu, Balaouras, Dines, Hayes & Nelson, 2009). This rapid urbanization creates an urban system which is much greater than several Hazard Management Systems. This usually creates a dangerous living environment for the poorer parts of society (Respondent 1, personal communication, May 14th 2020).

2.2 Hazard Management Systems

At first, I will start elaborating on the subject of Hazard Management Systems. Firstly, we need to know what a hazard exactly is. A hazard is an occurrence of a natural, biological, technological, social or complex phenomenon that causes physical, economic, social and/or structural (property) harm to people, animals and larger systems (economies, networks and ecosystems) (White *et. al.*, 2001; Anthopoulos & Vakali, 2012). Several examples of these hazards are; natural: earthquake; biological: disease (Corona or COVID-19, for instance); technological: industrial accidents; social: terrorism; complex: desertification. When a hazardous situation becomes a real phenomenon and there is damage (in any form). It is called a disaster (Anthopoulos & Vakali, 2012). Naturally, governments of all sorts want to minimize the damage caused by such a disaster or even (if possible) stop the occurrence of the phenomenon. This is done by using Hazard Management Systems in several forms such as Hazard Mitigation, Hazard Management and Hazard Prevention.

With the knowledge of what a hazard or disaster actually is, we move on to the system itself. A Hazard Management System is a system in which data, on for instance water levels or movement in the earth, is measured and transmitted to datacenters (Ochola *et. al.*, 2002). This data collection is part of the forecasting of disasters. When data measurements rise above a certain level, in case of water levels to an extent that there is a flood risk, the centralized point (datacenter) transmits a warning to all parts of society. This is done by means from messages on telephones, to vehicle manual warnings, depending on the degree of technological development (Sorensen, 2000). Zooming in on central-Java, most of the cities are relatively well equipped (for Indonesian measures) with warning systems. Rural areas in Indonesia, like farmers working the fertile land on the foot of one of Java's many volcanoes, are less equipped with those systems (Cobar *et. al.*, 2016).

Hazard Management Systems are vital for Central-Java as Java is generally located in the 'Pacific Ring of Fire' where several active volcanoes are located as well as the constant presence of earthquakes and tsunamis. In 2010 the Merapi volcano erupted and killed 350 people (Pallister *et. al.*, 2013). As Pallister *et. al.* (2013) describes the eruption forecasting as not sufficient (hence the deaths). The systems have improved since 2010 but they are not comparable to western systems. Therefore, the Merapi volcano is part of this research in how the hazard management near it can be improved.

Moving on from a natural hazard to a more recent biological hazard that will be used for this research, the recent Coronavirus (COVID-19) outbreak. In an unorthodox situation like this outbreak, the small Hazard Management Systems in Indonesia and central-Java were activated shortly after the outbreak.

Compared to the Netherlands, Indonesia (including central-Java) had a lot less infections, 33.076 versus 48.109 (on June 9th 2020) (John Hopkins University, 2020).

The last subject of hazards we will focus on in this research is the natural hazard of earthquakes. As mentioned before central-Java is located in the Pacific Ring of Fire along fault lines. Therefore, earthquakes are very common in the region. Although they are less deadly than volcano eruptions, they cause more material damage (Pallister *et. al.*, 2013).

2.3 Smart City

Now I will start elaborating on the Smart City concept. Because the definition of smart infrastructure involves the concept of Smart City. This is because the Smart City is the wider concept which smart infrastructure is just a part of. A Smart City is a city which is becoming 'smarter' in the sense that its local government institutions, local businesses, its communities and inhabitants become more involved with technology and associated data to help overcome the challenges of urbanization and associated hazards (Washburn *et. al.*, 2009). Adding to the definition of the Smart City connected to Washburn *et. al.* (2009) is that the Smart City involves a diverse range of concepts like: information, technology, business innovation, sustainability and (technological) innovation (Hollands, 2008). This wide variety of concepts causes the Smart City to be a difficult to 'label' concept. Although the Smart City is a real policy instrument and not an ideology, it is difficult to label. This is because it is still in development and being applied to myriad contexts and locations. Nam and Pardo (2011) define the Smart City as a fuzzy concept that can be used in ways that are not always consistent. The label 'Smart City' for them is not more than a template that can hardly be put onto a city in a way it is put onto another city. It is a template that is not in the category of 'one-size-fits-all'. A theory that was also brought out by Hollands (2008). A theory in which the Smart City enables people to be autonomous and not constrained by anything, as well as space for human agency and governance instead of fixed norms, rules and freedom.

In this research the Smart City is regarded as a combination of a city that is difficult to connect to the label 'one-size-fits-all' but also as a city that is becoming 'smarter' as the use of technology, data and sustainability solutions keep growing to overcome rapid urbanization problems (Washburn *et. al.*, 2009; Nam & Pardo, 2011). Therefore it is a concept of urban development based on the utilization of human, collective and technological capital for the improvement of prosperity, development and sustainability in cities around the world (Angelidou, 2014). For Indonesia perhaps, it is an even broader concept in growing their capital in the 'Global South'. I will elaborate more on the forms of Capital in a later stage.

The exact definition used by Java governments is not completely clear, although the Smart System Research Group of UGM University defines it as following:

'An innovative city that utilizes information and communication technology and other technologies to improve the quality of life, efficiency of city operations and services as well as the competitive level of a city. All this, while supporting the needs of current and future generations related to economic, social and environmental aspects build around the 5 pillars of Smart Environment, Smart Living, Smart People, Smart Economy and Smart Governance (Smart System Research Group, 2020).

Java governments do state about the obstacles of the Smart City and its different factors. In this, services, ICT, Smart City planning and development are also named as parts of the Smart City (Achmad, Nugroho & Djunaedi, 2018). As every local government has its own set of powers and obligations, it is difficult to form a singular Central-Java definition for the Smart City concept. Therefore UGM University created the Smart System Research Group. As mentioned before, this Smart City concept can contribute to improvement of hazard management in the region of central-Java. Furthermore, the Smart City needs to be protected against hazards, as people gather in cities and could get more exposed to several biological, natural and technological (White *et. al.*, 2001).

2.4 Smart Infrastructure

With a clearer definition of the Smart City concept we move on the basis of the Smart City: its infrastructure. In recent years more and more literature about the Smart City and its smart (sustainable) infrastructure have emerged. This enables us to define a clear definition of the smart infrastructure. As mentioned in the Smart City definition, the Smart City becomes 'smarter' through the use of technology, data and sustainable solutions (Washburn *et. al.*, 2009). Smart infrastructure is easier to define than the Smart City concept as it generally refers to constructible and physical objects or technologies supporting the Smart City and its technology and data. These physical, constructible objects and technologies form the framework of the Smart City in its goal to reach a sustainable, well urbanized and safe city (Al-Hader & Rodzi, 2009). Sensors, large data analytics and stable power networks are examples of smart infrastructure that provide the basis for everyday life and enable the flow of goods, information and services within a city. On the other hand, it keeps cities safe from earthquakes and other hazards. (Ogie, Perez & Dignum, 2017; Rice, Mechitov, Sim, Nagayama, Jang, Kim & Fujino, 2010). Other examples of smart infrastructure are electricity grids, communication webs, distribution networks and transport infrastructure (Ogie et al., 2017).

The importance of this smart infrastructure has grown massively over the last decades as the demand of infrastructural assets is growing constantly. As well as power and data consumption, as productivity demands have risen (Ogie *et. al.*, 2017).

Therefore, research about what smart infrastructure really is has increased over the recent years as well. Whereas Al-Hader & Rodzi (2009) define it as a framework and architecture for only a few smart cities like Dubai, Kochi and Singapore. Although the definition could have changed very much since its further development from 2009. These regions are, compared to central-Java, less influenced by hazards (excluding the recent Coronavirus (COVID-19) outbreak). By combining the more recent literature, we get the definition used for this current research for smart infrastructure. Smart infrastructure is a systems that provides the basis for everyday life that creates the framework for a Smart City. Tis can be used by its citizens in a sustainable and safe way (Ogie et al., 2017; Mehmood et al., 2019).

Not only could smart infrastructure be the basis for everyday life in a Smart City, it could also be the protection of the Smart City. When applied in a correct manner, smart infrastructure can protect the city in the form of Hazard Management Systems (Anthopoulos & Vakali, 2012). In this research, the definition of smart infrastructure is important as a main factor as well as its carrying factor for hazard management in a Smart City construction. As mentioned before, the smart infrastructure is the servant and protector of the overarching subject, the Smart City concept and the smart infrastructure itself.

2.5 Habitus

Habitus is described by Bourdieu (1990) as ‘a system of practice-generating schemes which expresses systematically the necessity and freedom inherent in the collective conditions of life of a certain group of people’. It is the way of thinking, feeling, acting and experiencing the characteristic way for members of a certain group of people (Inglis & Thorpe, 2018). It could be seen as a constancy or a fixed internalized system which can also be seen as ‘natural’. Although Habitus is a concept that cannot be equated with a particular space it does predisposes with particular spatial preferences (Bourdieu, 1990). Because of this ‘natural’ fixed internalized system, with particular spatial preferences, Bourdieu’s Habitus can be applied to this research. For this research, a change of hazard warning systems creates a feeling of safety for inhabitants of central-Java. A persons Habitus can therefore change quickly in this transition, if their living area, for instance a city, gets safer. A change of Habitus can be seen as a Ripple Through Effect that the Smart City or Hazard Management System can have. The effect caused by a change in any of these concepts ‘ripples through’ like a wave from governmental part all the way down to the poorest and most vulnerable parts of society. Another Ripple Through Effect is a possible change in for instance, labor possibilities, if a change is made to these systems.

2.6 Forms of Capital

Capital is described by Bourdieu (1986) as a resource (cultural, social or economic) which has to be accumulated by an individual to have power and/or influence in a field (sphere). These resources can be obtained in three different parts of an society/environment. The three types of Capital can be applied to this research and will be elaborated on according to Bourdieu (1986) and Inglis & Thorpe (2018).

Cultural Capital can exist in three forms: the embodied state (long lasting dispositions of the mind and body). In the objectified state as cultural goods (paintings, books, dictionaries etc.) and at last in the institutionalized state. This state must be set apart, says Bourdieu (1996) as it is solely seen in the case of educational qualifications and therefore is too objectified. Connected to this research, cultural Capital is the knowledge about hazards, which will arguably grow when the Hazard Management Systems improve.

Social Capital is a form of Capital that expresses itself in the form of network and relation resources. It is described by Bourdieu (1996) as the mutual acquaintance and recognition of a durable network or institutionalized relationship. To be a member of a group is the most important resource one can have in the form of social Capital (Inglis & Thorpe, 2018). The safety of people will be talked over from generation to generation. Social Capital will grow when people learn from each other's mistakes and experiences from the past. Also in a way of improving hazard management and society in general, and through smart infrastructure.

Economic Capital is all the productive property a person has. It refers to money and material Capital that can be used to produce goods and services (Inglis & Thorpe, 2018). Economic Capital is the most important Capital as the other forms of Capital can be derived from economic Capital. Bourdieu (1996) sees economic Capital as a conversion factor, a factor that can transform into social Capital for instance if it is spent in the meaning of exchange. Therefore it also is the basis of the strategy to ensure there is a form of reproduction of Capital. Economic Capital is arguably the most important Capital for a hazard warning system, and also the most difficult to obtain for a country like Indonesia and region like central-Java.

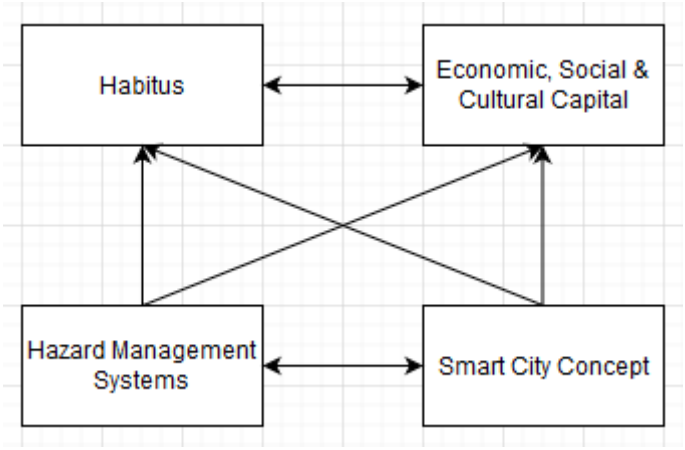
Applying the three sorts of Capital to this research, we can see that having differences in the amount of Capital a person has, means that they will act differently in certain situations. For instance, a person with a relatively high amount of economic Capital in central-Java can be more easily included in the use of a Hazard Management System. More money means that a person can have a cellphone with internet connection or can be connected to a smart and sustainable power source. This inevitably means that this also works the other way around. Low economic Capital could mean exclusion (winners keep winning and losers keep losing) (Bourdieu, 1993).

Social Capital comes back in this research as a connective field (sphere) factor. Staying connected to people around you and being a part of a group in the community to not get excluded in a hazardous situation. In central-Java, especially on fertile grounds around the Merapi volcano, people live near each other and social Capital is very important.

Cultural Capital can be applied to this research in the form of knowledge of the residents of central-Java about hazards, history of these hazards and the smart infrastructure supporting Hazard Management Systems. It can furthermore be seen as the exchange of knowledge between people in a field (sphere) connecting to the social Capital.

Bourdieu's theories Capital and Habitus can be applied on this research in many forms as presented above. The interconnectivity between the different theories is large, which indicates that in this research as well as in the theory of Bourdieu, there is a lot of connections between different actors, communities (fields and spheres) and the way people act and behave. This concept can not only be connected to Indonesia or central-Java, but also to other parts of the world.

2.7 Conceptual Model



This is the conceptual model underpinning this research. In this research, the main subject is if smart infrastructure can influence and improve Hazard Management Systems. Furthermore, this research is on the empowerment of more vulnerable populations in Central-Java. With a change in Hazard Management Systems, dialy life and Habitus will change in any way possible. Connecting to economic, social and cultural Capital, the amount of availabilty of these Capitals connecets to the way your daily life is, as well as how a Hazard Management System works. In essence like the research question: *How can the concept of Smart City help to empower more vulnerable populations in the Central-Java region in dealing with safety and development issues through natural hazards?*

3. Methodology

The methodological framework for this research is used to illustrate the methods that are used to gather information and analyze the gathered information. For this methodological framework, several forms of literature have been used to make choices regarding the different ways of data collection and analyzing. The choices will be justified in this chapter as well.

3.1 Research Strategy

This qualitative research aims to find structures and reasoning through the intricate fabric composed of minute threads, many colors, different textures and various blends of materials (Creswell & Poth, 2016). The research will be conducted following qualitative methods in order to answer the main research question. The reason for the choice of qualitative is because this research is about exploring the dimensions of Smart City, Hazard Management Systems and the different reasons certain choices are made. As well as how people deal with being included or excluded from, for instance, the concept of Smart City. Moreover, the research is a generalized research as not every actor in this case can be interviewed (also because our travel restrictions during Coronavirus (COVID-19) lockdown). Furthermore, secondary data and other literature cannot all be checked or used in the research due to the vast amount of secondary data. This qualitative research is conducted by primary data (research with various urban actors in Indonesia) and secondary data (literature analysis), a form of data triangulation to increase the reliability of this research's data.

In their book 'Designing a research project', Verschuren and Doorewaard (2007) describe five different strategies of research: survey, case study, grounded theory approach, desk research and experiment. For this research, the case study with semi-structured interviews is chosen for data gathering. I have chosen the case study because of its in-depth analysis of one bounded cases. This bounded case usually has an issue or social impact connected to it (Verschuren & Doorewaard, 2007). In this research, this case is Hazard Management Systems which could potentially be improved by smart infrastructure. The semi-structured interview method was chosen to identify motives, opinions and gather information from different actors. By semi-structuring the interviews, the questions are more general and can be partially altered during an interview. This enables the interviewer to ask more actor-specific questions and get more detailed answers. It also enables the interviewee to express himself more and tell his own story before diving deep into the questions. Beforehand, a clear interview overview is needed for these interviews to inform and prepare the interviewee (interview guide). The interviews will unfortunately not be conducted in Indonesia due to the recent Coronavirus (COVID-19) outbreak which limited our traveling opportunities. All the interviews will now be conducted via Skype or e-mail.

3.2 Informant Selection

Date	Interviewee	Subject
1. May 3rd	Mr. R. Primanto. Head of Communication and Information Provinical Board of Yogyakarta	The Special region of Yogyakarta and Smart City.
2. May 6th	Prof. dr. E. van der Krabben. Planning. Chair: Real Estate	Smart City and Natural Hazard Management in Practice.
3. May 6th	Respondent 1. (Stated: wants to be anonymous after interview was conducted) Researcher on Smart Urbanism and City development. Private research center.	Smart City concept in Central-Java and Indonesia in general. Also little Natural Hazard Management information.
4. May 7th	Leah. Inhabitant of Banjuwangi (East-Java).	Natural Hazards and Natural Hazard Systems and locals in Indonesia. Also general knowledge on Smart City Concept
5. June 7th	Yuana. Inhabitant of Bandung (West-Java)	Natural Hazards and Natural Hazard Systems and locals in Indonesia. Also general knowledge on Smart City Concept.
6. June 9th	Dr. Wisnu Pradoto. Vice Director Research Collaboration, Head of Cooperation management Board Diponegoro University and Lecturer in Urban and Regional planning (Universitas Diponegoro Semarang).	Natural Hazard Management and Smart City concept in urban planning for Indonesia.
7. June 10th	Dr. Doddy Aditya Iskandar. UGM, University of Louisville and Cincinnati. Urban and Regional Economics and Planning researcher.	The Smart City in Yogyakarta Special Region and its connection with the Coronavirus (COVID-19) and Hazards.

The individuals who have been interviewed for this research are listed above. The choice for these informants will be clarified now. A wide variety of respondents were needed for this research as Smart City specialists, Hazard Management Specialists and locals are all of importance to this research. The respondents had to meet the condition of being able to videocall or email and speak fluent English for it to work out. Alongside this, a different look on several subjects is important to this research. Therefore, Indonesians, but also Dutch professionals have been interviewed to give several different insights on some subjects. The importance of this became clear when Dr. Pradoto (personal communication, 9th of June 2020) advised me to focus on the different implementations of the Dutch and Indonesian 'Smart City Builders'. Furthermore, 2 inhabitants of Java, Leah and Yuana, who have both studied at the Radboud University, were interviewed to gain access to information from locals. The interview with Dr. Doddy Aditya Iskandar was conducted via Email and not via a face to face interview. Finally, Dr. Aditya Iskandar's information was significant because of his vast knowledge of the Smart City concept in the special DIY-region of Yogyakarta. A interview guide was sent to Dr. Aditya Iskandar to inform him on the essence of this research so his information could match the needed information of this research. This was done because email exchanging is very time consuming.

3.3 Location

This research mainly focuses on the Central-Java and Yogyakarta provinces located on the island of Java, Indonesia. As this research is in cooperation with the Universitas Gadjah Mada University of Yogyakarta, interviewees from the region are easier to get in contact with. Furthermore, this region is heavily involved in the development of Hazard Management Systems as well as the Smart City concept. Both because of their location in the 'Pacific Ring of Fire' and because of their growth, economically and in their globalization degree. Alongside this, Yogyakarta special region (DIY) and its Universitas Gadjah Mada University are working hard on their own form of Smart City just like other cities within the region.

3.4 Research Questions and Data

In this part of my research I link the research question and its sub questions to how the data is gathered and which data links with which question. This, to get a clear view on the different sides of the questions and to create an overview of how they are going to be researched. The sub questions are vital for answering the main research question, as they form the basis of data and information. With each sub question, several research literature forms will be added, as well as the research strategy for the sub question.

To reiterate, the main research question is: ***How can the concept of Smart City help to empower more vulnerable populations in the Central-Java region in dealing with safety and development issues through natural hazards?***

Sub question 1: *Which hazards are present in the central-Java region and to which extent do they influence daily life?*

This question will be answered through extensive literature research (secondary data) connected to hazard presence and management. Present literature and research are based around hazards and disasters which can be used for this research. To see how it influences daily life of central-Java's the use of literature is limited but present. With the semi structured interviews conducted with Indonesians, the influence of Java's themselves will become clear. Existing and already used literature on this sub question includes the following authors: Andreastuti *et. al.*, (2000), Cobar *et. al.*, (2016), Fuchs *et. al.*, (2017), Marfai *et. al.*, (2008), Ochola et. a., (2002), Pallister *et. al.*, (2013) and White *et. al.*, (2001). Furthermore, Yuana (Personal communication, June 7th 2020) and Leah (Personal communication, May 7th 2020) answered several questions about this subject.

Sub question 2: *What is the state of current Hazard Management Systems and Smart City in central-Java?*

This question will be answered partially through semi structured interviews with professors and experts from the industry. Furthermore, a thorough literature study which includes everything about Hazard Management Systems and its possible smart infrastructure influence was conducted. Hazard Management Systems and smart infrastructure in general are described by the following authors: Achmad *et. al.*, (2018), Al-Hader & Rodzi (2009), Balakrishna (2012), Hollands (2008), Marvin *et. al.*, (2015), Mehmood *et. al.*, (2019), Nam & Pardo (2011), Ogie *et. al.*, (2017), Andreastuti *et. al.*, (2000), Cobar *et. al.*, (2016), Fuchs *et. al.*, (2017), Marfai *et. al.*, (2008), Ochola et. a., (2002), Pallister *et. al.*, (2013) White *et. al.*, (2001). and Washburn *et. al.*, (2009). Respondent 1 (Personal Communication, May 6th 2020), Van der Krabben (Personal Communication, May 6th 2020) and Primanto (Personal Communication, May 3rd 2020) also gave answers to questions related to this subject.

Sub question 3: *To which extent have the Hazard Management Systems and Smart City a ripple through effect on all parts of society?*

This question will be answered partially by semi structured interviews with Indonesians and central-Javan's, with questions about the current situation and questions about a possible prospective situation, as well as professors involved in this subject. Furthermore, data has been gathered by doing a thorough literature study on hazard management in general and its ripple through effect. This literature study can get a view on side effects in finished an researched projects. Literature about this sub question is described by the following authors: Andreastuti *et. al.*, (2000), Cobar *et. al.*, (2016), Fuchs *et. al.*, (2017), Marfai *et. al.*, (2008), Ochola et. a., (2002), Pallister *et. al.*, (2013) and White *et. al.*, (2001). Furthermore, Yuana (Personal communication, June 7th 2020) and Leah

(Personal communication, May 7th 2020) answered several questions about this subject as well as Respondent 1 (Personal Communication, May 6th 2020) and Primanto (Personal Communication, May 3rd 2020).

Sub question 4: *To which extent does daily life improve in central-Java with a better Hazard Management System and which side effects could it have?*

This last sub question will be answered by the interviews with Indonesian locals, professionals on the Hazard Management Systems and secondary data. Online conversations with Indonesian locals are vital for this question. The secondary data from several Indonesian newspapers delivers the opinion of locals to a wider platform. Therefore, literature about this sub question is described by the following respondents and newspapers: The Jakarta Post. This is augmented with an Interview with local respondents Yuana (Personal communication, June 7th 2020) and Leah (Personal communication, May 7th 2020).

3.5 Data Analysis

For this qualitative research, a significant amount of verbal, linguistic, subjective and translated data has been obtained. Data was obtained through the semi structured interviews. To gather real data out of this, the interviews have to be summarized as it is otherwise useless for the analysis. Furthermore, a more thorough literature study will be used in the data analyzing phase of the research as well as an analysis of the summarized data. After the data analysis, the only thing left to do is answering the main question using the gathered data and the answered sub questions. This will be done in chapter 4 of this research where all the results will be set out on the basis of the summarized data. After that, a conclusion will be formed on the results of the data.

3.6 Methodology Reflection

This research was originally planned to be conducted in Yogyakarta, as mentioned before, in cooperation with the Universitas Gadjah Mada (UGM). Unfortunately, the Coronavirus (COVID-19) pandemic forced me to conduct this research online. Therefore, in the original proposal of this research, I had planned to do observations in Yogyakarta, as well as in-depth interviews with locals while being in Yogyakarta. Furthermore, contact with UGM was less frequent and extensive due to the difference in time zone and less productive email contact (instead of face to face contact). Finding local respondents from a distance was difficult. Luckily I found two students who studied at the Radboud University who are from the island of Java to help me out. Although this pandemic caused several difficulties, I have been able to conduct my research according to this aforementioned methodology.

4. Results: 4 Topics of the Research

In this part of the research, the results of the analyzed interviews will be discussed. This will be done per sub question that was brought up before. The discussed topics during the interviews were: Hazards, Smart City, Hazard Management Systems and the improvement of daily life for the Indonesian society if Hazard Management Systems get upgraded with help of the Smart City concept and its additional Ripple Through Effect. The different topics will be discussed individually (connected to sub questions) by using the analyzed interviews as well as secondary data.

4.1 Hazards

Indonesia has a total of 34 provinces of which 24 are classed as provinces located in the 'Pacific Ring of Fire' or in close proximity to this ring. These provinces are especially vulnerable to natural hazards. Of those 24 provinces, 12 of them (including Yogyakarta and Central-Java) are classed as the 12 most vulnerable provinces of Indonesia. These most vulnerable provinces are characterized by the regular presence of physical, economic, social and structural (property) harm to people, animals and larger systems (economies, networks and ecosystems) (White *et. al.,* 2001; Anthopoulos & Vakali, 2012). Throughout Indonesia economic damages were estimated at around 4.1 billion US Dollars (Jakarta Post, 2019). In the Yogyakarta province the reason is because of the regular presence of tsunamis, tornadoes, earthquakes and volcanic eruptions of the Merapi Volcano. For the Central-Java province, this is because of the regular presence of tsunamis, volcanic eruptions from several volcanoes, earthquakes, landslides, flooding and land subsidence. Hazards and disasters are a near weekly issue for the inhabitants of Java, something that traumatizes some of them. The disasters that have impacted Indonesians the most are: the eruption of the Merapi in 2010 (Volcanic Hazard); the 2004 Indian ocean earthquake which led to a tsunami that killed over 150.000 people in the South-East Asia Pacific area and the 2006 Yogyakarta earthquake. When asked about these hazards, most Indonesians hesitate at first to answer. A hesitation like this implies that there is a significant amount of fear with regards to the natural hazards, which could be reduced by warning systems. Dr. Pradoto answered that disasters are very likely to happen in these vulnerable areas and they have to be dealt with high standards and protocols (personal communication, 9th of June 2020). These hazards and their accompanying disasters get taken very seriously by every part of society as their occurrence grows due to climate change.

In 2019 (from January 1st to December 15th) there were a total of 3622 natural disasters on Indonesian soil according to the National Disaster Mitigation Agency (BNPB). According to the BNPB, any form of movement in the earth is qualified as an earthquake, or even a small

landslide is classified as a natural hazard. Therefore, the amount of natural disasters in Indonesia (measured by the BNPB) is difficult to compare to other countries with different standards. This aforementioned 3622 natural hazards in 2019 is 6.6 percent higher than in 2018, which saw 3397 natural hazard incidents (Jakarta Post, 2019). This growth could be connected to the ongoing climate changes which leads to greater extremes in the weather. For 2019, disasters were arranged in 2 different categories: 1. Hydrometeorological and 2. Human or Seismic disasters. 90% of the disasters that occurred in 2019 were of the hydrometeorological kind and included: tornadoes, floods, land and forest fires, floods and landslides. The other 10% of these disasters: the Human or Seismic disasters included earthquakes, volcanic eruptions and human inflicted forest fires. For reference, BNPB spokesman Agus Wibowo added that the largest number of these disasters occurred in West Java, Central-Java, Aceh and South Sulawesi. Although in Java is where most of these disasters struck. The difference in areas impacted by the disasters becomes clear from various interviews:

Yuana (personal communication, 7th of June 2020) and Leah (personal communication, 7th of May 2020):
'Yes I have only encountered a few small, harmless earthquakes before (in Bandung, West-Java)'. This is in vast contrast with the presented numbers above and with Leah's quote: 'If it rains hard, we are always afraid that a flood would happen and some stuff will be broken due to water coming inside the house or worse when a tsunami comes by (in more western located Banyuwnagi)'.

Hazards are therefore also treated differently throughout different parts of Java. Although the aforementioned number of disasters grew in 2019, the amount of casualties decreased from 4231 (including missing) people in 2018 to 583 people in 2019 (Jakarta Post, 2019). According to the BNPB, the higher casualty number in 2018 was caused by stronger and more present earthquakes, tsunamis and soil liquefaction.

Staying in recent history, but moving on from the natural hazards and disasters to the Coronavirus pandemic (COVID-19). This because Indonesia, just as every other country in the world, was struck by the pandemic, which can be seen as a biological hazard that has put the country in a state of lockdown. Dr. Pradoto (personal communication, 9th of June 2020) described the situation in Indonesia as following. Indonesia has suffered massively, just like any other country in the world, although the amount of confirmed cases is lower than in most 'western' or 'Global North' countries. Dr. Pradoto describes this as a very lucky case for Indonesia as it could have been much worse. Something Indonesia probably could not economically recover from.

This is also the reason that Indonesia is currently opening up again; to restart the economy, so that large and small companies will stay in service and not more people will lose their jobs. The BNPB declared the outbreak as a 'particular state of disaster emergency' in the beginning of this year and downgraded this to 'a non-emergency emergency' (Jakarta Post, 2020). This downgrade meant that the lockdown got scaled down. This plan is called the 'new normal' and was introduced by the Indonesian Health Ministry. Following this downscaling of the lockdown, there have been significant spikes in COVID-19 cases as the 'new normal' began. This new spike has frightened Indonesians as they prepare to begin their lives again, but also fear for a new, much stricter lockdown in a couple of weeks from the big new case spike on May 6th (Jakarta Post, 2020).

The Coronavirus (COVID-19) pandemic is not the only recent hazard that the island of Java has to deal with. Recent climate changes has resulted in weather-related hazards to be more intense and unpredictable and has affected sea level rising. Both hazards have had significant impacts on Java as Hazard Management Systems have to be adapted to these new standards.

4.2 Smart City

Dr. Doddy Aditya Iskandar (personal communication, May 6th 2020) explains that Yogyakarta has a different institutional setting and arrangement compared to other parts and provinces of Java. This is because the Indonesian central government has granted Yogyakarta a special status as Special Region of Yogyakarta (Daerah Istimewa Yogyakarta) in Bahasa, abbreviated as DIY. 'Jakarta' granted more independence to its local governments to explore their own needs, in this case their needs for a Smart City (Respondent 1, personal communication, May 6th 2020). This special status allows the government of Yogyakarta or the DIY to exercise their power in five different regions with the DIY. This means that activities such as the development of specific programs and projects like the Smart City are carried out independently from other regions or the central government. Three of the five regions who are in this DIY have already developed their own version of the a Smart City. These regions are Bantul, Sleman Regency District and the Yogyakarta municipality. The urge to make a Smart City (or smart region in the case of Bantul and Sleman) was high, as the local government was already working with a system created around local office management information systems. This is a support system to carry out primary tasks as well as collect and spread data. This smart way of coordinating between working units, programs and projects in the local government were hard to achieve with a support base such as the Smart City. The initial plan of this Smart City Concept was to create an efficient and effective way of work inside local governments. This initial plan has been upgraded in 2017-2018 with intent to not only make local governments work efficiently and effectively.

As well as public services and life in general. This 2017-2018 plan upgrade saw the DIY Smart City project being upgraded from a local level project to a provincial level project, thus receiving more funds to accomplish the goals of the DIY Smart City goals (Primanto, personal communication, May 3rd 2020).

As of now, the goal of the DIY-project still is to create an efficient and effective public service network and to improve local economic development. As well as to reduce the gap between local and provincial governments and the local community. Plans for this gap reduction were presented shortly before the Coronavirus (COVID-19) pandemic and involved local and provincial governments to carry out poverty alleviation pilots through this Smart City project by data sharing. The future of this project is uncertain at the moment, as Dr. Doddy Aditya Iskandar told me. The reason being that most government funding is now going towards Coronavirus (COVID-19) for 'first aid' help. This is because the provincial government, which partially funded the Smart City project, is in charge of handling the Coronavirus (COVID-19) pandemic in the DIY-region. Yet, a part of the Smart City is actually also used to tackle this pandemic as the governments are now establishing a system of web informing people on the pandemic, alongside updating and reminding people of the status of numbers (confirmed contraction and fatalities). With regards to the already scarce funds that local governments have in their quest to become more sustainable, this is a rigorous problem. Although most regions and cities in Indonesia want to become smart and sustainable, they simply do not have sufficient funds and other resources for this. This is why these cities and regions are backed up with an ASEAN-Australian Smart Cities' trust fund managed by the Asian Development Bank (ADB) as well as funds from the World Bank and the Swiss Government. The Jakarta Post (2019) posted a research about this fund and Respondent 1 reported that this trust fund contains 13.4 million Dollars.

At this moment, the aforementioned project of alleviating poverty and introducing people into the Smart City world is cancelled for now because of the Coronavirus (COVID-19) outbreak. This was a DIY-project that could be useful to many, usually poorer and older parts of the communities located in the DIY-region. This was mentioned in several interviews, for instance, Dr. Pradoto (personal communication, June 9th 2020) told me that the goal is to bridge this gap and get everyone involved. In practice this is very difficult to do so because of the lacking infrastructure (electricity and Wi-Fi) in smaller and more rural parts of Indonesia. There is also not always full willingness and knowledge about these systems here. When asked about the Smart City concept in general Yuana told me that she knows only little facts about a Smart City Concept that is very far away from completion. Leah even told me that she does not really know what a Smart City is. This shows the vast contrast between how people on a governmental (professional) level experience the Smart City and how inhabitants of Java experience it, especially in this phase of Smart City building.

Some cities are just less active in the process of the Smart City Concept or unfortunately leave some parts of society out of it as Prof. Van der Krabben has seen in Indonesia.

4.3 Hazard Management Systems

In the interview with Dr. Pradoto and the extensive secondary (literature) data research, it became clear that it is not only about hazard management, but also about hazard mitigation. This term 'mitigation' is used because of the very frequent presence of hazards in Java. Governments and organizations know that they cannot stop the disasters from happening, therefore they can mitigate the disaster so its effects will be hampered. Alongside, the term 'mitigation', the word 'management' is also used in Hazard Management (Mitigation) Systems. In essence Hazard Management Systems and Hazard Mitigation Systems have the same meaning: it is a system with high standards that reduces the amount of disaster-related risks, deaths and reduce economic losses (Jakarta Post, 2019; Pradoto, personal communication, 2020).

Since the 2004 Indian Ocean earthquake and tsunami, Indonesia has invested significantly to reduce the likelihood of a similar disaster. For instance, 25 countries in the Asia Pacific region have created a transnational Indian Ocean Tsunami Early Warning and Mitigation System to detect earthquakes, tsunami's and issue alerts on time. This transnational system has yielded clear results as millions of people have been evacuated through the Asia Pacific region during more recent tsunami's, typhoons and cyclones (Jakarta Post, 2019). This Indian Ocean Tsunami Early Warning and Mitigation System is also in full effect on the island of Java. The Indonesian government invests money in this project to keep the island safe from all the aforementioned disasters. As Java contributes from this System, they also have their own Hazard Management (Mitigation) Systems on the island. Dr. Pradoto (personal communication, June 9th 2020) explained that spatial institutions and local governments develop and manage the Systems. This is done on a national and regional level. They manage the Systems naturally, with high standards as disasters are very common. For instance, the 2004 disaster and the ongoing climate changes.

As mentioned before, Hazard Management Systems have been upgraded and invested in significantly since the 2004 earthquake and tsunami. In essence, the Systems have stayed the same with regards to their function. They have been upgraded with certain technological and infrastructural improvements. For instance, as Yuana and Leah told me, there are still simple ways of directing people to higher areas in tsunamis with signs. Furthermore, warning systems take the form of loud alarms that can be heard throughout the city. Moreover, warnings are also provided via television and radio.

Local and national governments still use these relatively old forms of communication to reach all parts of society. The only new introduction to the System has been the introduction of hazard training teams Dr. Van der Krabben talked about. These teams train local communities on what to do before and during a natural disaster. Systems will stay the same in the next years, but will be upgraded to keep them up to date. This will be done with a 90 million dollar infrastructure investment boost (Jakarta Post, 2019). This investment is done to ensure that Java stays safe against natural hazards. Furthermore, the investment in infrastructure is needed to meet global economic and population growth. This investment therefore is only in the infrastructure of the systems. There will be no change to the design of the systems. In essence, the system will be expanded in the infrastructural way. Quite adversely to these investments is the fact that Indonesia's tsunami warning buoys fell out of service in 2012. Which let to no data from direct tsunami measuring systems. They now rely on detection of seismic activity detection systems to see if a tsunami is coming.

The first and most essential way on how a Hazard Management (Mitigation) System works is that it warns communities, governments and all other parts of society when a natural hazard is bound to happen or happening. This is done by a combination of forecasting and monitoring. For instance, earthquake hazard mitigation systems can forecast an earthquake seconds before any seismic waves happen (Kanamori, Hauksson & Heaton, 1997). Another brought up example is the earlier mentioned tsunami buoy system that was in place before 2012. These buoys, who were activated after a seismic activity, had been present in the ocean to measure if a tsunami would come. The same would be done when there was a volcanic eruption in the ocean. The importance of this buoy tsunami warning system became clear in 2018 when Indonesia was struck by tsunami's twice in 4 months. These tsunami's were caused by volcanic activities and because of the failure of this system. The warnings came too late. What becomes clear from these systems is that they collect data according to their function (earthquake, tsunami, volcanic or typhoon related data). This data is collected and managed by spatial institutions throughout Java as Dr. Pradoto told me. Naturally, when the data is divergent, a warning will be transmitted from the warning system to the spatial institutions who deal with this warning.

After the warning is transmitted from the System to institution, the second function of a Hazard Warning (Mitigation) System comes into play. If a warning is very urgent, the Javan spatial institutions immediately start their protocols of warning every part of the island by using the aforementioned means such as warning alarms and messages on radio's but also through smartphones and social media. If it is a forecasted warning, the institution will have a look at the data and start consulting with governments etc. on what protocols to use and what to do as Dr. Pradoto told. When a natural hazard is declared and ongoing, the fixed infrastructure of the Hazard Management (Mitigation) Systems comes to use.

This can take the shape of the signs used by the locals to navigate them to higher ground in a tsunami or landslide or the alarm systems that are used in natural hazards as told by Leah and Yuana. The most important of this is the Social and Cultural Capital of people. They have been trained for the event of a disaster happening, therefore they could also use their communicative skills to bring over memories and tips on what to do during certain hazards. The systems only work to their full effect if the people of Java also work as efficient as possible. When this mutual corporation is in full effect both parties help in the overall decrease in disaster-related deaths on Java island (Jakarta Post, 2019).

The third way a Hazard Management (Mitigation) System works is to create more awareness among society and to fund the Hazard Systems. Local and national authorities have started integrating disaster and climate change risks into private and public sector investment decisions. This is where a Hazard Management System 'starts' and gets funded from; when it is integrated in development plans by connecting upcoming disasters and climate risk forecasts in plans for development. By doing this, a Hazard Management System becomes a concept that cannot be ignored by corporations, for instance in their decision making. As mentioned by the respondents in the interviews, only the presence and awareness of a Hazard Management System influences Indonesians to be aware of the potential disasters. Furthermore, the Systems will be respected and listened to better when they are needed the most.

One of the biggest challenges that governments and institutions are facing at the moment is keeping their Hazard Management (Mitigation) Systems on par with the rapid, unplanned urbanization of cities in Central-Java and Yogyakarta, where usually poorer and more vulnerable communities live. A secondary problem to this rapid, unplanned urbanization is that most of the cities with a rapid, unplanned urbanization are located in low-lying coastal areas, with increased exposure to certain natural hazards (Jakarta Post, 2019). As Prof. Van der Krabben and Dr. Pradoto indicated, there are protocols for all cities and all parts of the city for hazards, including the outer expanding regions. This could be problematic if not handled correctly. There are different protocols even, as well as investments for low-lying cities that attract a significant amount of tourist (via tourist attractions etc.). The focus here lies on a safe city for more tourism, which will eventually lead to more income for people who live in a tourist city and for Indonesia (Java) itself (Jakarta Post, 2019). Although these protocols are being used, urbanization rapidly catches up to these protocols. Sometimes protocols are even ignored by the usually poorer parts of society. For example, when the Merapi volcano erupted in 2010, the area of land around the volcano was deemed as unsafe to live on. Even though this was announced by the local governments, people still went back to those unsafe areas, for land (labor) and social purposes (Van der Krabben, personal communication, May 6th 2020).

Local and national governments are working on all kinds of Hazard Management (Mitigation) projects to ensure low-lying cities are protected, tourists are protected and people in the exposed areas are protected. A target which is difficult to achieve in a country hit by so many hazards annually.

At last, the connection between the earlier explained Smart City Concept and Hazard Management (Mitigation) Systems is an important connection to make as several interviewees saw the potential connection between these two concepts. For instance, Prof. Van der Krabben saw the downsides of Smart City Concept, but also saw its advantages when implemented alongside (or in addition with) the Hazard Management (Mitigation) Systems). Unfortunately, the Smart City concept does not reach all parts of communities as mentioned before. Although it does give certain (usually more privileged) communities that are included in the Smart City concept a way of dealing with information they get about certain disasters. They also get information on how to act and what to do, but the difficult part is what people do with it. The Smart City Concept forms a good data management system for any natural occurrence which can be analyzed to a certain degree. After this analyzation they can determine whether there should be a warning or not. Furthermore, Dr. Pradoto stated that the connection between Smart City and hazards is that the Smart City concept contributes to the Hazard Management Systems as well as that it can be built around the Hazard Management Systems to facilitate it. When the Smart City Concept is built around the Hazard Management Systems, to collect and analyze data through vital infrastructure in a more efficient way, warn people quicker during a natural hazard and ultimately limit of casualties and economic damages.

In recent history, with the Coronavirus (COVID-19) pandemic breakout, Hazard Management (Mitigation) Systems have been used in another way. Indonesia has been in a lockdown just like most other countries on planet earth. They have also been testing people with symptoms of the virus and closed airports and its national borders. The way this virus was approached is different to how hazards are usually approached because of its biological kind that cannot be seen. This made handling (mitigating) this hazard even harder. Currently studies are being conducted on this outbreak, most of them have not been published yet.

4.4 Ripple Through Effect and Effect on Daily Life

Daily Life

In this section I turn to the effects of a working Smart City and potentially improved Hazard Management System for Indonesian society. This will be done with regards to the ripple through effect of the Smart City and Hazard Management (Mitigation) Systems to all parts of Indonesian society and its potential improvement of life of the inhabitants of Central-Java and Yogyakarta.

Daily life on the island of Java (especially in Central-Java and Yogyakarta) is filled with fear for any kind of natural hazard. As mentioned before, every year the most disasters happen to Java compared to any other part of Indonesia. The interviewed inhabitants of Java, Yuana (personal communication, May 7th 2020) and Leah (personal communication, June 7th 2020) both mentioned that they would feel a lot safer when some, if not all of the Hazard Management (Mitigation) Systems, get upgraded. For instance, Leah explained that there are only some guiding signs for when there is a tsunami in her area. If this would be made into an app for instance, that guides her to a certain place when there is a tsunami and tells her what to do, she would definitely feel safer. Yuana answered in the same way as Leah by saying that an upgrade to the Hazard Management (Mitigation) Systems would have a positive effect on her daily life. Even though, her city of Bandung does not get hit that often by natural hazards. This application that Leah was talking about should in this case be the corporation between Hazard Management (Mitigation) Systems and the Smart City. As mentioned before, most informants stated that an upgrade in Wi-Fi and electrical systems is needed for this. An upgrade will definitely lead to a positive effect on the daily lives of people as it gives them a better feeling on their safety.

Another example of this safer feeling in a daily life perspective is mentioned in the Jakarta Post (2019). This example is from the island of Sulawesi (Celebes) but could be useful in the understanding of people in general in Indonesia. When the Palu-Donggala earthquake and tsunami hit the island, many communities did not know what to do when the waves hit their villages, with many casualties as result. Since then, millions of Dollars have been invested in the Hazard Management (Mitigation) Systems alongside trainings for these communities to prepare them for such an event as in 2018. Something that gives the Indonesian a safer feeling in their daily lives. ‘Even though earthquakes and tsunami’s cannot be prevented, much can be done to lessen their impact’ (Jakarta Post, 2019). This sentence perfectly sums up what a significant amount of people go through everyday living in the coastal areas of Java. An upgrade to any Hazard Management (Mitigation) System is therefore indefinitely an upgrade to their feeling of safety. A negative side effect to this decreasing amount of fear for hazards is that people will start to neglect the natural hazards. The feeling of safety with an improved system could lead to a sense of safety that transcends the sense of fear. When disaster strikes them, the effects of this disaster are heavier and more deadly than when this sense of safety is not there.

Ripple Through Effect

When asking Prof. Van der Krabben (personal communication, May 6th 2020) about the ripple through effect of certain Hazard Management Systems he answered that there are certain teams that train different communities on what to do and when to do certain thing while there is a natural hazard coming or when its commencing. This approach is similar to the aforementioned approach after the Palu-Donggala earthquake (Jakarta Post, 2019). In the case of Prof. Van der Krabben, a local remote village community near Yogyakarta was trained in what to do when there is a tsunami and where to flee to. These training teams are part of the aforementioned million-dollar upgrade to Hazard Management (Mitigation) Systems to get all communities and parts of the society involved in awareness on disasters. The Indonesian government has committed to train all parts of society in this manner. These training teams have a secondary ripple through effect as these teams provide people with information on hazards and they also provide labor opportunities for people. Alongside these professional training teams, there are voluntary training teams that inform people on what to do and what the risks are for instance. This is important for some parts of society because it is not clear how dangerous certain hazards are. Even though there is a large ripple through effect on almost all parts of society, the advice and protocols of the government and other organizations gets ignored.

As Prof. Dr. Van der Krabben (Personal Communication, May 6th 2020) told me:
'After the eruption of the Merapi Volcano that erupted ten years ago a lot of people perished. Then they said to communities that some places were too dangerous to live in, but some people did not want to leave the area because of work or social factors'.

The Ripple Through Effect of the Smart City Concept is a different story compared to the Hazard Management (Mitigation) Systems. As mentioned before, most of the respondents stated that some facilities that support the Smart City, like Wi-Fi and electricity, are not available in every community. Therefore, the ripple through effect is not at its maximum capacity as Respondent 1 stated (personal communication, May 6th 2020). The Smart City does have the potential to reach most parts of society, but there will be some people who are left out. For the special region of Yogyakarta specifically (the Daerah Istimewa Yogyakarta), there is a special Smart City concept being developed as Dr. Aditya Iskandar stated (personal communication, June 10th 2020). This special form of Smart City is meant to be implemented by local governments that get encouraged by the Ministry of Communications and Information (Menkominfo). Therefore, these local governments develop the Smart City with intent to make public services as effective as possible although not everyone is reached with this approach.

On the other hand, the Smart City concept has a secondary ripple through effect as it will require a significant amount of labor forces. As mentioned before, the Indonesian Tourism Minister Arief Yahya has said that tourist attractions and tourist destinations will get a very new and developed Hazard Mitigation System (Jakarta Post, 2019). This plan sees the tourist destinations getting an improved system which has the objective to lead to more tourism and a higher place in the Travel and Tourism Competitiveness Index (TTCI) of the World Economic Forum (WEF). This plan has a two way Ripple Through Effect. Firstly, this investment is meant to increase the amount of tourists in Indonesia which could lead to more income for locals and the country itself. On the other hand, the locals are not pleased with this plan because in their opinion everyone and especially the Indonesian and Javan, locals deserve good and up to date Hazard Management (Mitigation) Systems (Jakarta Post, 2019).

5. Conclusion

This research is premised on the idea to explore how more vulnerable populations in Central-Java and DIY Yogyakarta could be empowered with the concept of Smart City. This is done with regards to dealing with safety and development issues through natural hazards. This is done by an extensive literature and interview research conducted through the internet. Following the prior empirical chapter, this chapter will respond to each of the sub questions and thereafter provide a response to the main research question. This conclusion will be provided based on the conducted interviews and literature study.

5.1 Combining all Topics of this Research

In the first section of this conclusion, the first sub question will be answered. The first sub question is: *Which hazards are present in the central-Java region and to which extent do they influence daily life in growing urban areas?*

The regions of Yogyakarta and Central-Java are part of the 12 most hazard vulnerable regions of Indonesia. Tsunamis, tornadoes, earthquakes, volcanic activity flooding, land subsidence and landslides are a nearly weekly occurrence in this region of Indonesia. Not all of these occurring hazards are dangerous and/or deadly, although some of them are. For instance, the 2004 Indian ocean earthquake and tsunami, that killed 150.000 people in total, hit the region hard. Another example is the eruption of the Merapi volcano in 2010, which caused thousands of people to be evacuated. Considering the fact that these hazards are weekly but not always life threatening, does not mean the people in these regions deal with it easily. Daily life is impacted heavily by these hazards as people live with these hazards constantly on their minds. For instance, when it rains significantly, Leah inhabitant of Banyuwangi, is afraid of water damage to her house or even worse, floods or a tsunami. This fear does get relieved with training and practice sessions that teach people what to do and when to do certain things during an ongoing hazard. Daily life for the inhabitants of Yogyakarta and Central-Java in 2020 is characterized by the Coronavirus (COVID-19) pandemic, that sees the country being in a lockdown that is being scaled down as we speak.

The second sub question is: *What is the state of current Hazard Management Systems and Smart City in Central-Java?*

Since the 2004 Indian ocean earthquake and tsunami, the state of Hazard Management Systems in Central-Java and Yogyakarta has been improved significantly. A transnational, 25 Asian Pacific country project was set up for the protection of these countries. The Indian Ocean Tsunami Early Warning and Mitigation System is partially still in effect in the regions of Central-Java and Yogyakarta. An essential part of this system unfortunately is not. The buoys that detect tsunami waves after a seismic or volcanic activity

have not been in use since 2012. An unfortunate given is that in 2018, Indonesia (Java, Sumatra and Sulawesi (Celebes)) was hit by two tsunami's, caused by volcanic activity. Therefore, we could state that the Hazard Management Systems in Central-Java and Yogyakarta have improved significantly since 2004, but are not at their maximum capacity at the moment.

The Smart City Concept is in its beginning phase as funding for large projects like implementing the Smart City is being started. This is done by for instance, the World Bank, the Swiss government and Asian Development Bank (ADB). Zooming in on the DIY, we see that governmental organizations have started using smart programs around their local office management information systems. On the other hand, some interviewed locals are not exactly sure on what this Smart City is exactly, or have not heard from the concept at all.

The third sub question is: *To which extent have the Hazard Management Systems and Smart City a ripple through effect on all parts of society?*

With regards to the Hazard Management Systems, protocols have been made to ensure every person and every part of a city or rural area is protected in the event of a hazard or disaster. Even when a city faces rapid, unplanned urbanization, they should be covered by these protocols. Next to these protocols there are training teams that are part of government or private organizations that train local and more remote communities on what to do in case of a hazard. The Indonesian central government as well as the local governments of Central-Java and Yogyakarta prioritize training these communities to minimize economic damage and minimize the death toll after a hazard. These training sessions cause an increasement in Social and Cultural Capital for the people that get trained. They could transfer this information to others, as well as other generations. A secondary ripple through effect of the Hazard Management Systems is that it creates labor opportunities in the hazard affected regions. Because of the importance of the Hazard Management Systems, its ripple through effect is significantly high.

With regards to the ripple through effect of the Smart City Concept, it is different to the ripple through effect of Hazard Management Systems. The Smart City Concept is seen as a concept with a high amount of potential to reach all parts of society, although it is not that easy in real life to effectuate. Infrastructure in rural and poorer communities is not sufficient enough to be able to connect to the Smart City. Furthermore, elderly people do not have the willingness and knowledge on how to connect to the Smart City in most occasions. Another specific example of the low ripple through effect of the Smart City Concept to all parts of society is the investment in tourist destinations. Locals, usually from rural or poorer communities feel disadvantaged by these governmental decisions.

The fourth sub question is: *To which extent does daily life improve in Central-Java with a better Hazard Management System and which side effects could it have?*

The locals that were interviewed for this research explained that if there would be an upgrade to any kind of Hazard Management System they would, naturally, be delighted by this. Their daily life could improve because of this as their fear for hazards and disasters would become less. Positive side effects for this are potentially, more productivity and less stress as their sense of fear is falling. A negative side effect to this decreasing amount of fear for hazards is that people will start to neglect the natural hazards. The feeling of safety with an improved system could lead to a sense of safety that transcends the sense of fear. When disaster strikes then, the effects of this disaster are heavier and more deadly than when this sense of safety is not there.

5.2 The Possible Cooperation between Smart Cities and Hazard Management Systems

Now that all the sub questions have been answered, I turn to the main research question: *How can the concept of Smart City help to empower more vulnerable populations in the Central-Java region in dealing with safety and development issues through natural hazards?*

When the two concepts of Hazard Management Systems and Smart City are built around each other and complement each other, they are an potential outcome to tackle several problems (Urbanization and Hazards). Fast data transmission and analyzation for Hazard Management Systems is something that could improve daily life for inhabitants of Central-Java and Yogyakarta. Eventually, it could be implemented in the rest of Indonesia. If the Smart City concept can reach all parts of urban society, which has to be worked on, this will lead to an improvement and investment for the more vulnerable parts of urban society. Therefore, their Habitus and forms of Capital will change in a positive way. With regards to rural contexts, the infrastructure that is the support base for a Smart City should be provided to poorer and more rural communities when fully developed. Although this process of expanding and improving the Smart City concept is currently stopped due to the Coronavirus (COVID-19) pandemic, it is essential that this project starts up again after this. Furthermore, it is vital that governments in Central-Java and Yogyakarta as well as in the rest of Indonesia keep investing in Hazard Management Systems, for all parts of urban society. Alongside this, if the governments keep expanding their hazard protocols on their rapid, unplanned urbanizing cities, this will improve the safety of its usually poorer and more vulnerable inhabitants. Therefore, if the Smart City Concept and Hazard Management Systems are combined and complement each other, they could definitely empower the more vulnerable populations in the Central-Java region. Connected to this is that the governments need to keep up their protocol extension to involve rapid, unplanned urbanized areas.

6. Recommendations

The outcome of this research revealed that when the two concepts of Hazard Management Systems and Smart City are built around each other and complement each other, they are an potential outcome to tackle several problems. These problems are the problems central in this research such as: earthquakes, tsunamis, volcanic activity and landslides. The following recommendations have therefore been made to help policy makers and scientist to perfect this cooperation between the Smart City and Hazard Management Systems.

The study revealed that there is a significant amount of funds in both concepts but they have been relocated to ‘first aid’ because of the Coronavirus (COVID-19). When the Coronavirus (COVID-19) pandemic is over, these funds should be relocated back to the Smart City and Hazard Management System projects as they were heading in the right direction. Once these funds are back at the projects, they should keep focusing on involving poorer and more vulnerable people into the projects. When this is done, inclusion will increase and people will feel safer and could become more efficient and developed.

With regards to the special Hazard Management System-funding of tourist destinations, governments have to make a well thought of plan in how they fund these projects. This is done with regards to the Indonesian tourism sector, which is a very important sector for the country and its people. Although this is very important, some people feel left out because of this special funding. The Indonesian and local governments have to be careful that this funding does not shift more to the tourism side after the end of the Coronavirus (COVID-19) pandemic.

For further research about the inclusion of vulnerable people in a developing world with the Smart City concept and Hazard Management Systems, I would recommend looking more into the local stories and perspectives. This can be done by visiting the regions of Central-Java and Yogyakarta once the Coronavirus (COVID-19) pandemic is over, as this seems very important to this research.

At last, looking at the validity and connecting to the further research above, the question that arises is: do the results in this research match the reality given that I have only interviewed several people from different professions and a rather limited amount of locals. A later, more extensive and more ‘hands on’ research that follows this research could show that these results do match the reality.

7. Reflection

In this final part of this research, I evaluate the process of this research by looking at certain research expectations and results as well as the general process itself.

This research, as mentioned before, should have been conducted in and around Yogyakarta, Indonesia from March to May. Although we had high hopes at the beginning of the Coronavirus (COVID-19) pandemic that we could go, we cancelled the trip to Indonesia as countries were shutting down their borders. Furthermore, the Radboud University, UGM University and my supervisor Dr. Smith advised us not to go. This was a big letdown as the results and experiences in Yogyakarta would have been rather different to what it is now. Yet looking back on the Coronavirus (COVID-19) pandemic's peak in this timeframe, I am happy that we did not go as countries shut their borders as the Coronavirus (COVID-19) started spreading fiercely. Not going did mean that we had to restructure and redevelop our research from an 'onsite' research to a research via the internet. This cost me a significant amount of time, which hampered my research time. Furthermore, I had focused on interviewing locals on their experiences with Smart Cities and Hazard Management Systems or hazards in general. This was very difficult to do because of the language barrier, the lack of connectivity in the country and also by the Coronavirus (COVID-19) pandemic. The face to face interviews that I had chosen had to be conducted by someone in Indonesia were never going to happen. Therefore, I interviewed 2 Indonesia locals that I knew from my Bachelor GPE at the Radboud University. This is not the most ideal way to capture the real opinions and feelings from locals. With regards to how difficult it is to find professionals to interview, I highly underestimated this. This caused a slight lack of general information. This lack of general information was partially solved by an extensive secondary (literature) data research and the translation of the Jakarta Post newspaper. Perhaps, I could have also consulted my supervisor at the UGM University, Dr. Rini Rachmawati, more.

To increase the reliability of this research, data triangulation has been used to understand the problems and current situations in the Yogyakarta region. Existing literature and prior studies have been extensively read and analyzed for this. Although this was done extensively, the lack of 'hands on' research in Yogyakarta caused me to have a hard time making assumptions. Therefore this research is also somewhat more limited in its value for later researches.

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9. Appendix

Interview guide Smart City

Introduction

My name is Jelle van Bethraij. I am a Geography, Spatial Planning and Environment student at the Radboud University in Nijmegen, The Netherlands. For my bachelor thesis I am doing research to answer the following main question: *How can the concept of Smart City help to empower more vulnerable populations in the Central-Java region in dealing with safety and development issues through natural hazards?* I would like to talk to you about the Smart City concept in Central-Java (or Indonesia in general). If you do not mind, I would like to record this interview because I do not want to miss any of your comments and make the best use of it. The information given in this interview will only be used for this research and be kept confidential. At last, I will ask you if you wish to stay anonymous in the final thesis version.

Overview of the interview

I will first ask you several 'personal' questions as an introduction. From this, we move on to the main part of the interview, the Smart City concept. At the end of the interview, there is time to add comments, if you wish so.

Introduction

- Could you introduce yourself?
- What is your relation to the Smart City Concept?
- Could you give me your personal meaning of the Smart City Concept?

Smart City

- Is there any implementation of Smart City in Indonesia (Yogyakarta) and how is this done?
- To which extent can the Smart City concept be implemented in Indonesia (Yogyakarta), with regards to financial, logistical etc. resources?
- Can the Smart Infrastructure needed for the Smart City Concept be applied in Indonesia (Yogyakarta)?
- Can the Smart City Concept be applied to all parts of society?

Cities in Indonesia (Yogyakarta) are expanding rapidly due to urbanization with several oncoming problems.

- How can the Smart City Concept facilitate this rapid expansion?
- How can the Smart City Concept be the solution to these problems?
- How can the Smart City Concept have a full ripple through effect on all parts of society although the cities grow rapidly?

Hazard Management Systems

- Although this is not in your expertise, can you tell me anything about Hazard Management Systems in Indonesia?

If there is any knowledge about Hazard Management Systems.

- How can the Smart City concept help with the improvement of HMS?

Conclusion

Thank you very much for your time and effort. Is there anything else you would like to add which could be useful for my research?

Interview guide Smart City and Hazard Management Systems

Introduction

My name is Jelle van Bethraij. I am a Geography, Spatial Planning and Environment student at the Radboud University in Nijmegen, The Netherlands. For my bachelor thesis I am doing research to answer the following main question: *How can the concept of Smart City help to empower more vulnerable populations in the Central-Java region in dealing with safety and development issues through natural hazards?* I would like to talk to you about the Smart City concept and Hazard Management Systems in Central-Java (or Indonesia in general). If you do not mind, I would like to record this interview because I do not want to miss any of your comments and make the best use of it. The information given in this interview will only be used for this research and be kept confidential. At last, I will ask you if you wish to stay anonymous in the final thesis version.

Overview of the interview

I will first ask you several 'personal' questions as an introduction. From this, we move on to the main part of the interview, the Smart City concept. At the end of the interview, there is time to add comments, if you wish so.
If there are any questions that you cannot answer, this is perfectly fine and we will move on to the next question.

Introduction

- Could you introduce yourself?
- What is your relation to the Smart City Concept?
- Could you give me your personal meaning of the Smart City Concept?

Smart City

- Is there any implementation of Smart City in Indonesia (Yogyakarta) and how is this done?
- To which extent can the Smart City concept be implemented in Indonesia (Yogyakarta), with regards to financial, logistical etc. resources?
- Can the Smart Infrastructure needed for the Smart City Concept be applied in Indonesia (Yogyakarta)?
- Can the Smart City Concept be applied to all parts of society?

Cities in Indonesia (Yogyakarta) are expanding rapidly due to urbanization with several oncoming problems.

- How can the Smart City Concept facilitate this rapid expansion?
- How can the Smart City Concept be the solution to these problems?
- How can the Smart City Concept have a full ripple through effect on all parts of society although the cities grow rapidly?

Hazard Management Systems

Indonesia's fast growing cities are a negative aspect to the safety of people to natural hazards such as tsunamis, volcanoes and earthquakes. Hazard Management Systems need to be updated and expanded to secure safety for people who live in a country which is regularly affected by these disasters.

- How is the state of Hazard Management Systems in Indonesia at the moment?
- How can the Smart City concept help to improve and expand these Hazard Management Systems?
- How is the support base for smart infrastructure to be implemented for Hazard Management Systems?
- Is the rapid expansion of cities a problem with regards to Hazard Management Systems and to which extent are people safe?
- How can all Hazard Management Systems have a full ripple through effect on all parts of society although the cities grow rapidly?
- To which extent does daily life improve in central-Java with a better Hazard Management System and which side effects could it have?

Currently, we have only spoken about phenomenon's that happen physically, such as earthquakes, tsunamis etc. But at the moment, Covid-19 is affecting our world massively.

- To which extent is Indonesia (Yogyakarta) affected by this Covid-19 outbreak?
- Can Hazard Management Systems be improved to tackle such nonphysical phenomenon's such as viruses?
- and How can the Smart City concept be implemented in this improvement?

Conclusion

Thank you very much for your time and effort. Is there anything else you would like to add which could be useful for my research?

Interview guide Locals

Introduction

My name is Jelle van Bethraij. I am a Geography, Spatial Planning and Environment student at the Radboud University in Nijmegen, The Netherlands. For my bachelor thesis I am doing research to answer the following main question: *How can the concept of Smart City help to empower more vulnerable populations in the Central-Java region in dealing with safety and development issues through natural hazards?* I would like to talk to you about the Natural Hazards in Central-Java (or Indonesia in general) and their influence on daily life. Furthermore, I would like to talk to you about the importance of Hazard Management Systems. If you do not mind, I would like to record this interview because I do not want to miss any of your comments and make the best use of it. The information given in this interview will only be used for this research and be kept confidential. At last, I will ask you if you wish to stay anonymous in the final thesis version.

Overview of the interview

I will first ask you several 'personal' questions as an introduction. From this, we move on to the main part of the interview, the Hazards and Hazard Management Systems. At the end of the interview, there is time to add comments, if you wish so.

Information about Hazard Management Systems and Natural Hazards

A hazard is an occurrence of natural, biological, technological, social or complex phenomenon that causes physical, economic, social and structural (property) harm to people, animals and larger systems (economies, networks and ecosystems). Several examples of these hazards are; natural: earthquake; biological: disease (Corona or COVID-19, for instance); technological: industrial accidents; social: terrorism; complex: desertification. When a hazardous situation becomes a real phenomenon and there is damage (in any for), it is called a disaster.

A Hazard Management System is a system in which data on for instance water levels or movement in the earth is measured and transmitted to datacenters. When data measurements rise above a certain level, in case of water levels to an extent that there is a flood risk, the centralized point (datacenter) transmits a warning to all parts of society. Depending on the degree of technological development, this is done by means from messages on telephones, to vehicle manual warnings

Introduction

- Could you introduce yourself?

Natural Hazards

- Have you encountered any Natural Hazards yourself? If yes, explain them please.
- How does the presence of Natural Hazards influence daily life in Indonesia?

Hazard Management Systems

- How is the presence of Hazard Management Systems in the area that you are from?
- How is the rate of inclusion of the Hazard Management Systems in the area that you are from? (Are they available in every part of your area and for everyone?)
- If they would upgrade the Hazard Management Systems with technical or smart solutions, would you feel safer (Apps that warn you when a hazard occurs etc.)?
- Is there any support in your area for a smart solutions such as Wi-Fi, electricity etc.?

Smart City

- Do you know anything about the Smart City Concept, in general or in your area specifically?
- How can this Smart City Concept be the solution to total inclusion of Hazard Management Systems and how could this impact the community in your area?

Conclusion

Thank you very much for your time and effort. Is there anything else you would like to add which could be useful for my research?