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Master's Thesis

**Evolution of smart cities movements toward resilient cities.**
**A comparative analysis of case studies in Tokyo, Japan.**

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## Abstract

Cities are complex systems where more than half of the population of the world currently live and, moreover, they constitute the engine of the global economy. Nowadays, due to their complexity, cities tend to become "smarter" and that is why the smart city concept was rapidly developed across the globe. Besides, cities tend to become more resilient since they are also very fragile places because chronic stresses such as the effects of climate change and acute shocks considered as natural hazards such as earthquakes can seriously, constantly or suddenly, damage their structures. Indeed, the smart city concept and resilience, are topics that are discussed in many parts of the globe. In particular, Japan embraces both of them, since on the one hand is one of the most advanced countries in the world and on the other hand is characterized by natural and anthropogenic changes.

However, the smart city concept and resilience are two topics that are very little discussed as connected issues. Therefore, the main research question was posed: are smart cities resilient?. In order to answer this question, the research conducted focuses on the analysis of the evolution and the role for the resilience of the smart cities in the Japanese context, in particular, carrying out a comparative analysis of different case studies in the Greater Tokyo area. The methodology used is based on the review of the academic literature, the study of the various documents related to the issues analyzed, the interviews conducted, the meetings, workshops, and lectures attended and the visit to the case studies.

Accordingly, the aim of the research is to understand the evolutionary processes and the role that the smart cities in Tokyo have for the overall improvement of resilience. The structure of the research includes the theoretical framework of the topic, which is then contextualized in Japan and specifically in Tokyo where the different smart cities are analyzed. Concluding, a comparative analysis of the case studies is undertaken, and the results show a positive trend toward the improvement of resilience. However, tech and traditional solutions should be embraced by the smart cities in Tokyo and future developments should improve other sectors, beyond the energy one.

Le città sono un sistema complesso in cui attualmente vive più della metà della popolazione mondiale e, inoltre, costituiscono il motore dell'economia globale. Al giorno d'oggi, a causa della loro complessità, le città tendono a diventare "più intelligenti" ed è per questo che il concetto di città intelligente si è rapidamente sviluppato in tutto il mondo. Inoltre, le città tendono a diventare più resilienti poiché sono anche luoghi molto fragili, in quanto stress cronici come gli effetti dei cambiamenti climatici e gli shock acuti considerati come rischi naturali come per esempio i terremoti possono danneggiare seriamente, costantemente o improvvisamente le loro strutture. Infatti, il concetto di città intelligente e di resilienza sono argomenti discussi in molte parti del mondo. In particolare, il Giappone li abbraccia entrambi, poiché da un lato è uno dei paesi più avanzati al mondo e dall'altro è caratterizzato da cambiamenti naturali e antropogenici. Tuttavia, il concetto di smart city e di resilienza sono due argomenti che sono molto poco discussi come questioni connesse. Pertanto, è stata posta la principale domanda di ricerca: le città intelligenti sono resilienti? Per rispondere a questa domanda, la ricerca condotta si concentra sull'analisi dell'evoluzione e del ruolo per la resilienza delle città intelligenti nel contesto giapponese, in particolare, effettuando un'analisi comparativa di diversi casi studio nell'area della Grande Tokyo. La metodologia utilizzata si basa sulla revisione della letteratura accademica, sullo studio dei vari documenti relativi alle questioni analizzate, sulle interviste condotte, sugli incontri, seminari e lezioni frequentate e sulla visita ai casi studio.

Di conseguenza, l'obiettivo della ricerca è comprendere i processi evolutivi e il ruolo che le città intelligenti di Tokyo hanno per il miglioramento complessivo della resilienza. La struttura della ricerca include un quadro teorico dell'argomento, che viene poi contestualizzato in Giappone e in particolare a Tokyo, dove vengono analizzate le diverse città intelligenti. Concludendo, viene intrapresa un'analisi comparativa dei casi studio e i risultati mostrano una tendenza positiva verso il miglioramento della resilienza. Tuttavia, le città intelligenti di Tokyo dovrebbero abbracciare la tecnologia e le soluzioni tradizionali e gli sviluppi futuri dovrebbero migliorare altri settori, oltre a quello energetico.

# 1. Introduction

The proposed Master's Thesis is the result of an extensive research conducted in Japan for a period of time of five months at the Department of Urban Engineering of The University of Tokyo. The research was carried out within the Urban Land Use Planning Unit through the crucial support of Prof. Akito Murayama and his research team.

The research abroad was characterized by a rich amount of activities personally conducted such as interviews with relevant stakeholders and visit to case studies, which were decisive to get to know to the issues analyzed, while the various lectures, meetings, and workshops attended gave different perspectives and enriched the research. Moreover, the academic collaboration with Professors and Researchers from the Georgia Institute of Technology, the KTH Royal Institute of Technology of Stockholm and The National Institute for Environmental Studies of Japan was fundamental to deepen the topic examined. Eventually, the literature reviewed, and the documents analyzed were the references useful to comprehensively conduct the analysis.

The activities shortly introduced represented the foundation of the Master's Thesis, which concerns the study of the evolution of the smart cities in Tokyo which tend toward the improvement of resilience. Therefore, a comparative analysis of different case studies in Tokyo is undertaken. From this point of view, Japan provides an interesting context where to carry out the analysis since both smart cities and resilience are issues generally discussed in the country. Indeed, in relation to smart cities, Japan has always been characterized by innovation and therefore the development of smart city projects has always been implemented since the beginning of the development of the smart city concept. Moreover, in relation to resilience, the natural shocks in the country such as earthquakes and the effects of the global anthropogenic variations related to climate change such as heatwaves and flooding are concerns that have been always carefully examined. Accordingly, the main research question was posed: are the smart cities in

Tokyo resilient? The relation between smart cities and resilience is a concern very little discussed in the literature and that is why this topic was chosen.
Therefore, the aim of this Master's Thesis is to analyze the evolution of the smart city concept and its role towards the improvement of resilience in cities. In order to do that, a comparative analysis of various case studies in the Greater Tokyo area is made.
Indeed, the research constitutes a source useful to contribute to explain the relationship between the smart city concept and resilience in the Japanese context, specifically in Tokyo.

The foundations cited, which characterize the research, were useful to divide into three main parts the thesis. The first part can be considered as a theoretical framework composed by two chapters in which the discussion focus on the issues of smart cities and resilience from a general perspective and then contextualizing the topics in Japan. Instead, the second part is related to the analysis of case studies in Tokyo, which is discussed in two chapters where the analysis of existing and on-going smart cities is carried out and a consequent comparative analysis is made. The third part instead is related to the conclusions which discuss how the smart city concept should be considered, making reflections and discussing future developments.

In particular, the first chapter is developed through the review of the academic literature and the analysis of various documents related to the topic. This allowed to discuss about the smart city concept and the different definitions that try to define it and then the discussion move on the topic related to resilience starting from its evolution to its complex structure. Eventually, the discussion focuses on the relation between the smart city concept and resilience, examining its characteristics.

The second chapter is based on the analysis of documents and lectures attended and it introduces the issues discussed about the discourse on smart cities in Japan, from the perspectives of the Japanese government, the Japanese companies and criticizing their approach introducing the Urban System Design concept. From this analysis, the link with resilience in Japan is discussed through a comprehensive framework about the need for resilience in the country, starting from the analysis of earthquakes to the climate change effects.

From the possible relation discussed between the smart city concept and resilience, the third chapter describes the evolution of the smart cities in Tokyo and their role for the resilience, introducing different existing case studies and an on-going one. The analysis is based on the different documents examined and the interviews conducted with the stakeholders involved in the case studies. Moreover, the different meetings and workshops attended and the visit to the case studies allowed to have a better understanding of the projects.

The fourth chapter is based on the previous chapter, since it introduces a comparative analysis of the case studies from their evolutionary processes and their role for the resilience, synthesizing both of them.

In conclusion, the fifth chapter discusses the importance to consider the various smart city projects as laboratories and experiments useful to generate an interconnected system of smart cities where every smart city project can learn from each other for the overall improvement of resilience. Besides, some reflections from the overall analysis and future developments about the smart city projects are proposed.

## 1.1 The smart city concept

Since the development of the smart city concept, a common and shared definition for it seems not to exist. Even if many researchers tried to define it there are different definitions each time. However, the smart city concept embraces a common keyword that seems to be the use of technology and, moreover, the relationship between the human being and technology recognize the urban and spatial dimension of it.

The smart city concept is a quite recent phenomenon. It was born in 1994, but papers that talked about it were very few (Dameri and Cocchia, 2013). Then in 2005, some papers emerged from the Clinton Foundation, since the former US president wanted to exploit the use the knowledge of Cisco in order to make cities more sustainable (Swabey, 2019). In 2010 there has been an increase of papers since the European Union started to use the "smart" term in order to define sustainable projects (Dameri and Cocchia, 2013).

Today, the smart city concept is used by many cities all over the world, to tackle problems such as pollution, poverty, traffic jam and so on, through the use of smarter urban spaces. However, a theoretical framework which should constitute the basis of a common definition of the smart city concept still lacks (Dameri, 2013). Indeed, there is not a common definition of the smart city concept (Sinkiene et al., 2014).

A popular model of this concept is underlined by Giffinger et al. (2007), which includes 6 dimensions: smart economy, smart people, smart governance, smart mobility, smart environment, and smart living.

Anyway, there is still a sort of confusion between the overall expectation and interpretations by the citizens of what the term "smart" means. This could be because the stakeholders involved in the smart city projects are not following a shared vision for what the term "smart city" could stand for. Accordingly, this could generate misinterpretation of the meaning of the smart city concept, and therefore there could be a disruption of the achievements that should be shared as the goal of the projects (Cavada et al., 2014).

Furthermore, the terminology used to refer to the same concept is quite different. The "smart" term seems to be the most used, however, there are other words used such as

Intelligent city, Digital city, Sustainable city, Technocity or Well-being city. All these concepts are not in contradiction since they are used to refer to the same concept, but this creates confusion in the development of a shared definition (Dameri, 2013).
In order to understand the main characteristics of a smart city, different definitions of the smart city concept from the literature review are identified. Some of them are listed below:

*"A smart city is a well-defined geographical area, in which high technologies such as ICT, logistic, energy production, and so on, cooperate to create benefits for citizens in terms of wellbeing, inclusion and participation, environmental quality, intelligent development; it is governed by a well-defined pool of subjects, able to state the rules and policy for the city government and development"* (Dameri, 2013).

*"A city (is) smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance"* (Caragliu et al., 2009).

*"A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects"* (FG-SSC, 2014).

*"Smart city is a type of city that uses new technologies to make them more livable, functional, competitive and modern through the use of new technologies, the promotion of innovation and knowledge management"* (Mishra, 2013)

As it is possible to see, each definition is different from the other. However, the use of technology within the smart city concept - especially ICT - is cited in every definition. Therefore, it is apparently possible to suppose that a smart city is a city that emphasizes the use of technology.
However, as underlined by Santangelo (2016), the smart city concept on one hand is certainly related to the use of technology but on the other, it considers no solution other

than that. Therefore, it seems that in order to become a "smart" city, it is enough just to apply innovative technologies.
Santangelo (2019) continues highlighting the fact that nowadays technology became more and more necessary in our society, and that is why the use of technology is one of the strong points of the smart city concept. The problem is that there is scarce attention about the context since smart city solutions seem to be applicable everywhere, without an analysis of the specificities of the different places.

In conclusion, it is possible to say that the smart city concept is still a non-defined idea. However, while the use of technology seems to play a crucial role in the development of smart city projects, other solutions seem not to be considered. Moreover, the use of technology underline also its strict relationship with the human being and therefore the urban and spatial dimension of it is clear.

## 1.2 Definition of resilience

The term "resilience" originally started to be used in ecological disciplines and then the definition applied in the urban context has been identified as well. Actually, it is possible to say that resilience is a complex concept that acts as an umbrella for different disciplines and, moreover, there are different types of resilience. Overall, in order to protect and promote development in a changing world, there is a need to invest in urban resilience.

At first, the word resilience was introduced in the ecological literature in order to understand the behavior of ecosystems under stress. Indeed, resilience was defined as:

*"… a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables"* (Holling, 1973)

This definition emphasizes the importance of the capacity to absorb change maintaining the same characteristics. Therefore, if a perturbation deflects a system from an equilibrium point, a resilient system can return to its original equilibrium level (Figure 1).

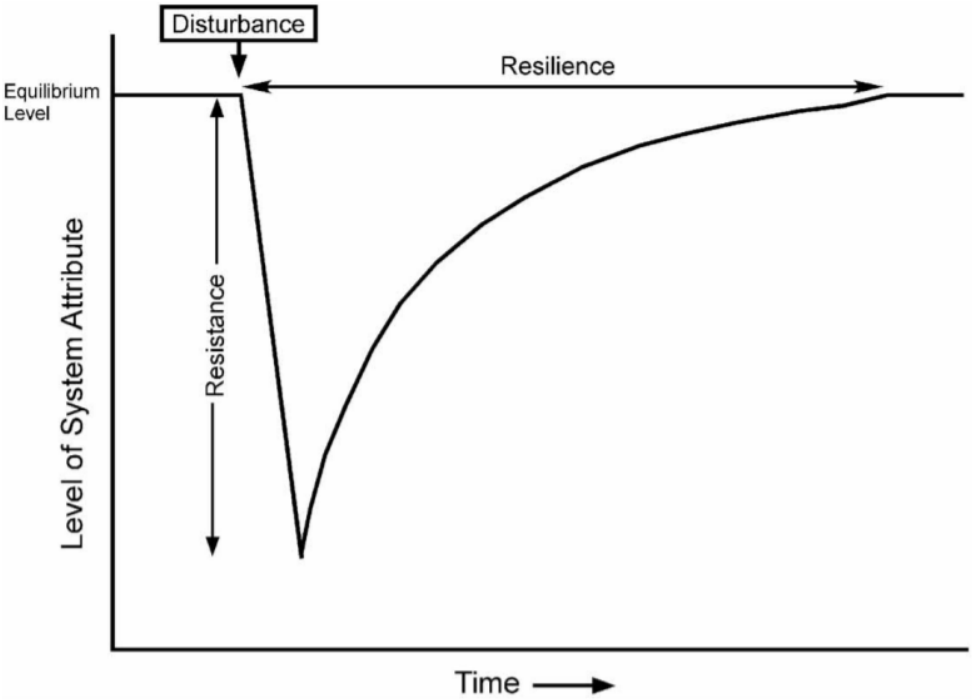


**Figure 1:** Diagrammatic representation of the traditional view of resilience (Pickett et al., 2014).

As underlined by Pickett et al. (2014), the global ecosystem includes an urban component which aims to become more sustainable. In order to do that, the ecological discourse can be used, since through the mechanisms of ecological resilience it is possible to promote the social and normative goal of sustainability. Indeed, highlighting the capacity to withstand and adjust to external disturbances, the ecological resilience seems to be particularly appropriate to urban system, because of the nature of the challenges that cities face. For instance, these disturbances can be identified in relation to global climate change as well as earthquakes. The first one is due to the changing temperature regimes which implicate different issues such as sea-level rise, storms, heatwaves, heavy rainfall, food

security and so on. The second one is a natural release of energy in the Earth's surface, and therefore even if there are substantial investments in infrastructures, during these events, they could be completely lost.
In particular, one of the main definitions of "urban resilience" is:

*"the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience"* (100 Resilient Cities, 2019).

As underlined by 100 Resilient Cities (2019), chronic stresses are considered as "slow moving disasters that weaken the fabric of a city" while acute shocks are "sudden, sharp events that threaten a city". However, the issues that cities have to tackle usually are not related just to a single chronic stress or an acute shock. Instead, they often have to face a combination of both, which weakens the resilience of a city. For instance, an acute shock as the Hurricane Katrina that hit the southeastern U.S. in 2005, was not the only cause of the crisis in New Orleans. Indeed, the disaster increased chronic stresses within the city such as violence, institutional racism, poverty, environmental degradation and so on.
The City Resilience Framework (CRF) (Figure 2) developed by 100 Resilient Cities (2019), helps to understand the complexity of cities and therefore their characteristics and capacities in order to be resilient, identifying a common set of systems and drivers. The systems identified are four: Health & Wellbeing**;** Economy & Society**;** Infrastructure & Environment**;** and Leadership & Strategy. Each of them contains three drivers that are useful for cities in order to improve their resilient approach.

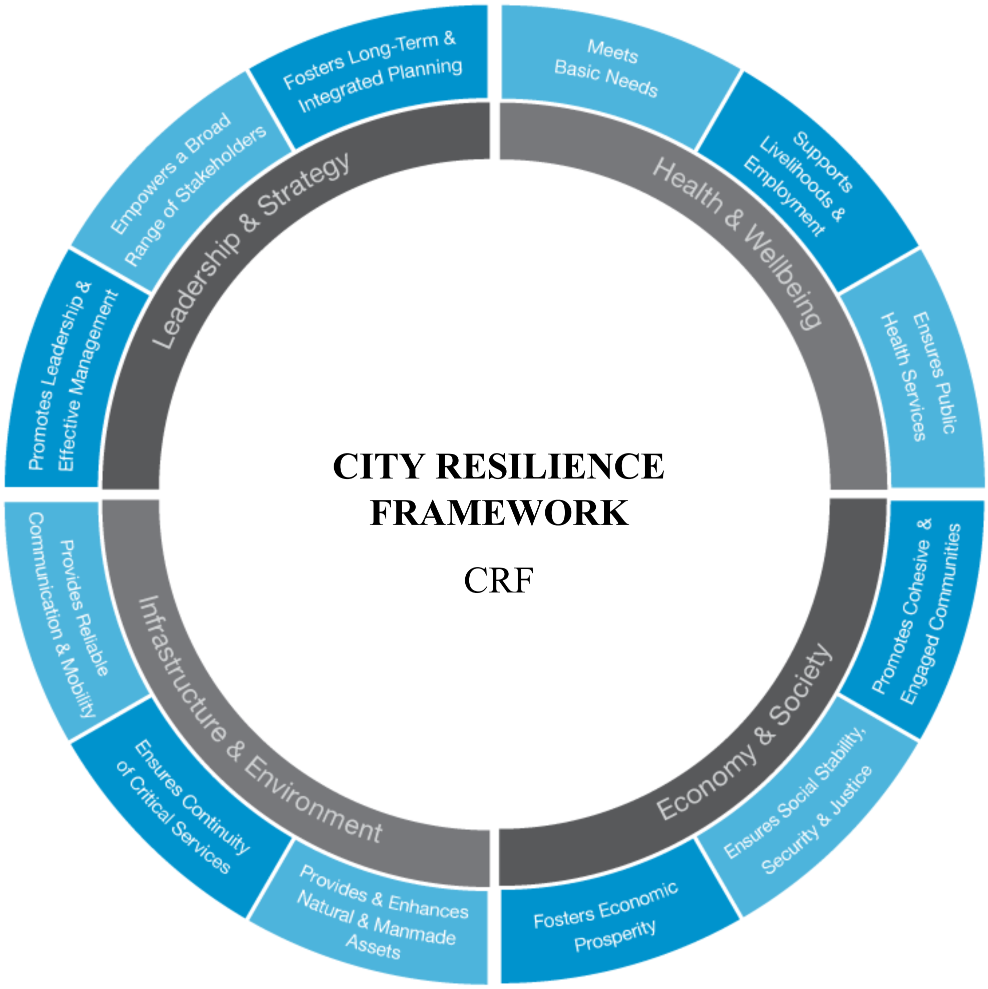


**Figure 2:** Conceptualization of the City Resilience Framework (100 Resilient Cities, 2019).

Following the approach of the CRF, as underlined by Brunetta et al. (2019), the term "resilience" is a complex concept that acts as an umbrella for different disciplines such as Ecology, Urban Systems, Logistics or Engineering. Within these disciplines, land use planning - which is the activity where technical, political and civil needs interact constituting the arena of negotiation in the decision-making process - plays a crucial role, since it identifies the vulnerabilities in the territory and thus the need for resilience. In particular, "territorial resilience" is the concept that relates the theory about resilience and the spatial identification of resilient needs in plans and projects. Furthermore, the recent international attention to this concept contributed to influence policy-makers in the process of making strategies and tool for land use planning, which will affect future territorial governments.

Moreover, the complexity of the term "resilient" is underlined by Batra, et al. (2017), since through the analysis of Twitter conversations, grey and academic literature, they identified different sectors or thematic areas in which the resilient term is used. For instance, the analysis of seven datasets on Twitter identifies eight sectors of resilience (climate, disasters, agriculture, food security, conflict, urban, water, economic). The examination of the grey literature included six themes (1. agriculture and food security 2. social inclusion and protection 3. conflict and security 4. disasters and climate resilience 5. urban and infrastructure resilience 6. measurement and resilience). While the analysis of the academic literature comprised five thematic areas (1. agriculture and food security 2. conceptual approaches, indicators and measurements 3. culture, politics and power 4. health 5. policy, planning and governance for building resilience). Therefore, as it is possible to see, some sectors or thematic areas are common in every source of analysis. However, this examination shows the complexity of the resilient term, and thus the need for a multidisciplinary approach in order to deal with it.

In conclusion and specifically in relation to urban resilience, as underlined by The World Bank (2015) there is a need to invest in it, since it is a crucial concept that deals with global issues such as the rapid urbanization, the growing concentration of economic activities in cities, the increasing exposure of people and assets to climate change and disaster impacts and the increase in expected losses from disasters in urban environments.

## 1.3 The relation between smart city and resilience

Smart cities and resilient cities are usually seen as two different concepts. Accordingly, the analysis underlines the relation between them examining its characteristics.

Eventually, the conclusion underlines that a smart city must learn to be resilient too.

As underlined by van den Bosh (2017), many cities use adjectives such as ‘smart’, ‘resilient’, ‘sustainable’, ‘sharing’ and so on. As previously discussed, there are many definitions of the smart city concept, while in contrast, the number of definitions for resilient cities is limited. Actually, these two concepts have completely different roots. Some authors consider resilience as a characteristic of smart cities, while others underline that resilience will replace smart. These concepts have their own roots and meanings for the city and thus for their citizens. However, it is possible to say that both smart and resilient cities are dealing with chronic stresses and acute shocks using different methods. The question that has to be highlighted is: do we need smart cities for resilience? Baron (2013), discuss that both concepts have similar characteristics and similar are the issues tackled. Each of them can be considered just as a technical method or as a societal complex system. Furthermore, it is important to underline that they apply to their citizens and to urban public services, not to individuals or dispersed systems. Even if smart cities and resilient cities can be considered as ‘container words’ it seems that they are becoming part of the same concept both as a technical process and in urban studies too.

A strong critique about the relation between smart cities and resilience is discussed by Chan and Zhang (2019). In particular, they underline that even if these two concepts are slowly becoming connected, urban resilience is supposed to require the use of smart city technologies. But these technologies are compatible with the goals of urban resilience? Analyzing their role for urban resilience can be certainly show that technology can play a crucial role in resilience. However, what about the vulnerabilities and threats that these technologies can bring against urban resilience?

For instance, there could be negative environmental effects of these smart technologies. Indeed, the smart city system requires energy, which in large smart cities is still consumed from fossil fuels. Therefore, urban resilience is undermined since these technologies destabilize the whole environmental system, using polluting technologies elsewhere. Moreover, based on the use of Al, smart city technologies can undermine urban resilience from a social and economic point of view, exacerbating, for instance, the inequalities through an overly simplistic socio-spatial analysis. In addition to that, Al technologies are not yet a self-critical method, therefore this automated process in urban planning can only get worse urban resilience.

Besides, the issues related to transparency and privacy about the data collected can undermine trust within the city and thus this can only worsen urban resilience.

Chang and Zhang (2019) conclude saying that it is not clear if smart cities are compatible with the aim of urban resilience. However, in order to decrease the tension discussed between these two concepts it could be useful to select the appropriate technologies that are most useful for urban resilience.

The redefinition of the smart city concept with a resilience approach is discussed by Arafah and Winarso (2017) which emphasize the fact that few academic literatures underline the relation between resilience in the smart city discourse. They highlight that cities should have the ability to be always resilient, especially when smart technologies fail or when there are natural or man-made disasters. Accordingly, they consider to re-define the smart city concept using a resilience approach, in order to make them complemented. This re-definition is based just on the tech approach of smart cities (without therefore considering smart city measures that do not use technologies). Through a combination of smart city definitions and resilience definitions, it can be said that:

*"A smart city with a resilience approach is a concept that utilizes ICT in enhancing awareness, intelligence, well-being, and community participation in dealing with pressures, shocks, and hazards in order to survive, adapt, be tough, and be able to transform to have a future with a better environment and higher quality of life, which is sustainable in facing the era of uncertainty"* (Arafah and Winarso, 2017).

Then, the governance for resilient smart cities is a topic discussed by Nel, D. and Nel, V. (2019) which propose different principles in order to link the smart and resilient concepts. They consider various approaches that can help a smart city to become more resilient:

1. Smart cities are for people (not only technology)

The technology used by smart resilient cities (such as social media or data sharing) could be used in collaborative planning processes in order to involve the residents in decision-making.

2. Social inclusion

Smart resilient cities are not just for smart people, but they should be open also for people that do not have the opportunity to get tech-knowledge.

3. Sustainability and regenerative development

A city that is unsustainable cannot be smart or resilient. Therefore, a smart resilient city has to be sustainable.

4. Learning, foresight and planning in the context of complexity

Innovation contributes to improving resilience. However, smart cities are more resilient when flexibility and creativity are foreseen.

5. Managing vulnerabilities

Smart cities have to deal with vulnerabilities. However, reliance on ICT rather than paper-based information could generate problems if the systems do not work anymore. Therefore, it is important that smart cities have a resilient approach as an ability to restore their systems rapidly.

Concluding, examining some case studies of smart cities in India, Dayal et al (2015) underline the importance also of resilient measures that are not related just with the use of technology (i.g low-cost measures for extreme heat such as cool roofs that can lower ambient temperatures by 3-4 degrees celsius). Therefore, smart cities offer many opportunities for their citizens, but in order to really tackle acute shocks and chronic stresses, they need to have a resilient approach. This highlight the importance that smart cities must learn to be resilient too, which does not strictly imply the use of technologies since the degree of smartness is not related to the amount of technology used.

## 2. Discourse on smart cities and the need for resilience in Japan

After a theoretical analysis of the smart city concept, resilience, and their relationship, these two topics are contextualized in Japan where a comprehensive understanding about the discourse on smart cities and the need for resilience in Japan is made.

The first part focuses on the discourse on smart cities in Japan, which includes the analysis of the governmental policies which aim to implement the so-called Society 5.0, which is based on the intensive use of various automated technologies in order to improve the quality of life in cities. Then, the analysis underlines the crucial role of the companies in the smart city projects in Japan, since they are usually the landowners of the areas where the projects are implemented, and they tend to implement their own "Smart City Strategies" through the implementation of smart city technologies. After that, a critique is made, since both the government and the companies seem to focus only on the importance of the technology within the smart city projects. Indeed, the discussion about the Urban System Design approach highlights that the use of technologies should be used in parallel with traditional solutions, which can also be smart.

The second part discusses the need for resilience in Japan. The definition previously discussed of urban resilience by 100 Resilient Cities, which identifies acute shocks and chronic stresses, is contextualized in Japan, since acute shocks can be considered as the natural shocks which are part of the daily life in Japan such as earthquakes and the chronic stresses can be considered as the effects of climate change which the main one in Japan are heatwaves and flooding. For both of them, the analysis highlight also what Japan is currently doing to tackle them.

## 2.1 Discourse on smart cities

### 2.1.1 Government policies: Society 5.0

The discourse around the smart city concept in Japan is part of the issues discussed by the national Government. Indeed, the idea is that in order to solve today's problems in Japan, it is important to implement smart cities and therefore the Government is pushing toward the realization of the so-called "Society 5.0".

Overall, it seems that the trend of the definitions about the smart city concept previously discussed underlined the importance of the use of technologies such as Big Data, IoT, ICT or Al in creating a smart city.
The definitions of the smart city concept are certainly different and not always clear, but technology seems to be the most used keyword.
The most probable reason why the technology is almost always associated with the smart city concept is that the developments of the technologies and the application of them into the city - using the smart city concept - gives a hope to solve today's problems. These problems are common in every place of the world, and that is why every country is pushing toward the implementation of the smart city concept.
Indeed, the smart city market is expected to reach USD 237.6 billion by 2025 with a compound annual growth rate (CAGR) of 18.9% from 2019 to 2025 (Grand View Research, Inc., 2019).
For instance, the Government of India in 2014 decided to make a strategy in order to develop 100 smart cities, which will use new different technologies (Deloitte, 2015).
In the case of Japan, Society 5.0 is the concept adopted by the Cabinet Office of the Government of Japan (Japan. Cabinet Office, n.d.). In particular, it was endorsed in the 5th Science and Technology Basic Plan in 2016 (Japan. Ministry of Education, Culture, Sports, Science and Technology, n.d.).
Society 5.0 is based on the idea that Japan should aspire to a next future society. This new society can be defined as a "human-centered society that balances economic advancement

with the resolution of social problems by a system that highly integrates cyberspace and physical space" (Japan. Cabinet Office, n.d.).

Indeed, this new society is the result and consequence of previous societies that characterized over the years the world. The previous societies were temporally based on hunting (Society 1.0), agriculture (Society 2.0), industry (Society 3.0) and information (Society 4.0) (Japan. Cabinet Office, n.d.) (Figure 3).

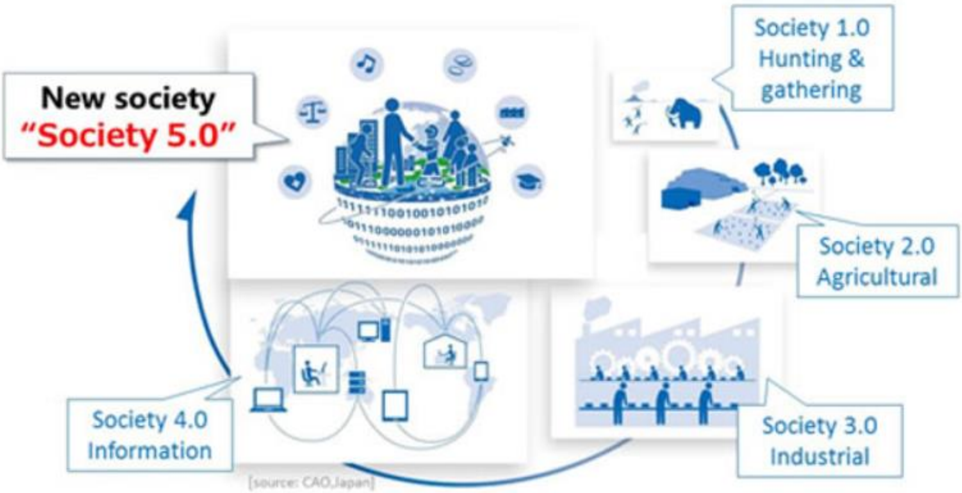


**Figure 3:** Temporal evolution of the different societies (Japan. Cabinet Office, n.d.)

The main problem with a society based on the use of information technologies is that all the data that every individual receive needs to be analyzed by humans in order to be used. The Society 5.0 aspires to be a solution to this problem, connecting the cyberspace with the physical space in a way that the Big Data collected is analyzed by the use of Al without the need of human interaction (Japan. Cabinet Office, n.d.). Therefore, individuals can use the data already analyzed in a more organized and efficient way, making the life of people more comfortable and sustainable providing them the information in the amounts and at the time needed (Japan. Cabinet Public Relations Office, Cabinet Secretariat, 2017).

This new society is possible to be implemented, since the transmission, storage, and analysis of data are becoming at a low cost. This analyzed data can give suggestions to the people and can be shared around the world, solving social issues (Keidanren, 2018a, p.6). As the economy grows in Japan and life is becoming cheaper, the demand for food is increasing, and the lifespan of people is becoming longer. Besides, the increase in international competition is causing problems related to the concentration of wealth. The social issues that must be solved in relation to such economic development are several. For instance, the need to reduce greenhouse gases (GHG) emissions, the increased food production, the need to find a solution in relation to the cost of the aging society, the coordination toward sustainable industrialization, the redistribution of wealth and the inequalities. The problem is that it is difficult to solve these problems while achieving economic growth. This is precisely what the Society 5.0 concept want to achieve (Japan. Cabinet Office, n.d.).

The social issues that a shift from Society 4.0 to Society 5.0 will help to solve are related for instance to the aging population, social polarization, depopulation and issues related to energy and the environment (Figure 4).

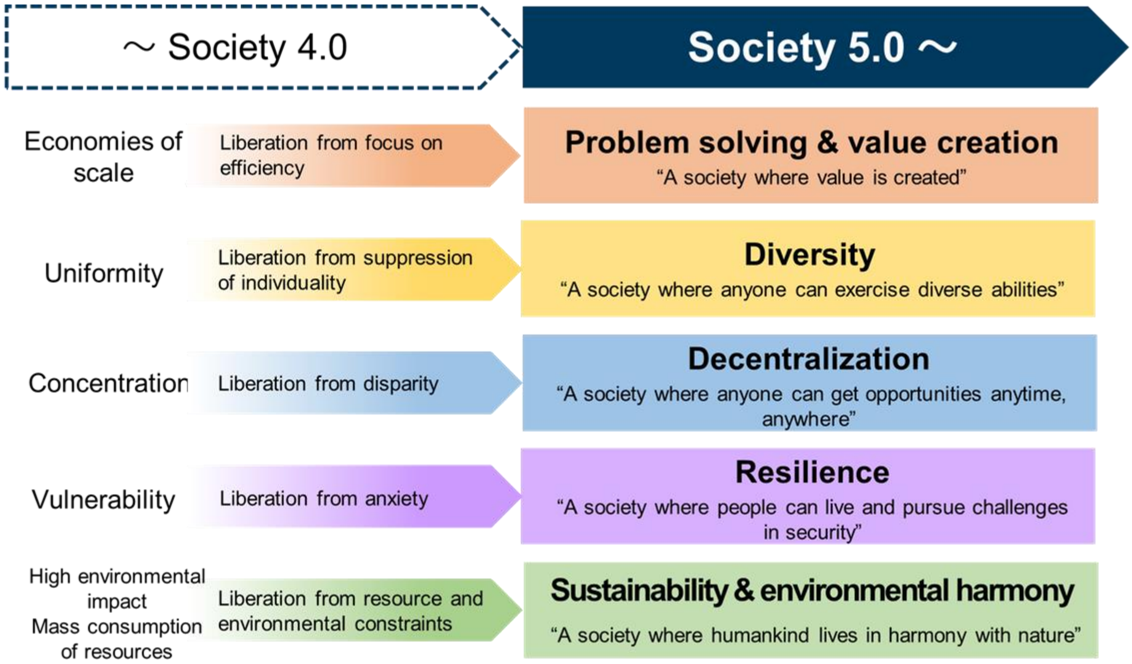


**Figure 4:** Shift from Society 4.0 to Society 5.0 (Keidanren, 2018b)

Moreover, even if the Society 5.0 is a concept that originates in Japan, its framework will certainly contribute to solve social issue worldwide (Fukuyama, 2018).
It is important to underline that Japan's budget for science and technology increased from 3.6 trillion yen between the years 2002 to 2017 to 4.2 trillion yen in 2019. This means that Japan's investment in technologies and specifically in the adoption of the Society 5.0 concept got a significant boost. In addition to that, in 2017 the Japan's Artificial Intelligence Technology Strategy was founded as a key pillar of Society 5.0. It aims to spread out the use of Al across people and services, building an ecosystem that will be managed effectively. In particular, this strategy has three priority areas: health, mobility, and productivity (United Nations Educational, Scientific and Cultural Organization, 2017).
Besides, there are several problems related to the adoption of this new Society 5.0. Indeed, the use of Big Data gives rise to worries about privacy and use of the data, and Al still needs to be fully comprehended. For example, if the use of Big Data and Al can help to the problem of the shrinking workforce - due to Japan's depopulation - it can also make unemployed many people, because of over-reliance to technology. Furthermore, Big data can improve efficiency, but it also can raise issues about privacy and transparency of the data. Eventually, there is a need to think seriously about the implications of the use of these technologies in the Japanese society in order to individuate the risks and minimize them (Hobson and Burgers, 2019).
Eventually, technology developments are unstoppable and taking into consideration the fact that they could generate negative effects, it is important to guide the direction of our future society. Instead of trying to foresee the future society, it is crucial to create a reform of the society based on human needs (Keidanren, 2018a, p.6).
Concluding, Japan represents one of the leader countries that is investing in creating a new society which through the use of the smart city concept will be effectively implemented and therefore it is crucial to monitor its development.

## 2.1.2 The role of the companies

In the discourse about smart cities in Japan, the Japanese companies involved in these projects play a crucial role. This is certainly due for two reasons. The first one is related to the fact that few big Japanese companies are the landowners of many of the areas where the smart city projects analyzed are usually implemented. The second reason is because many of these companies developed their own "Smart City Strategy", and even if they are not the landowners they are involved in the projects since many of them are tech-oriented companies which develop the smart city technologies.

The first reason behind the fact that few big Japanese corporations are the landowners of many of the areas where the smart city projects analyzed are usually implemented is related to the intensive land acquisition and development typical of the 1970s carried out by them. Indeed, this was due to the capital accumulated from the companies during this period.  This accumulation of capital was triggered by the rise of the Japanese economy since the 1960s (Oizumi, 1994), and by the continuing agglomeration of people into the Kanto Plain which surrounds Tokyo (Douglas, 2009).

In particular, six are the big Japanese companies (Mitsubishi, Mitsui, Sumitomo, FujiYasuda, Daiichi Kangin, and Sanwa) that were the key actors in this process.

Accordingly, in 1979, the Japan Project Industry Council (JAPIC) was established, in order to gather all the major companies in various sectors such as finance, automobile, electric power and so on. JAPIC had a great influence on the urban planning of the local and central government, for instance in the developments of the Tokyo Bay area. Then, urban developments in Japan in that period were a sort of containers for the capital accumulated, especially in major cities such as Tokyo (Oizumi, 1994).

Overall, the result is that around 1975 the companies mentioned before owned lots of land in Tokyo and if considered together, they owned a quarter of the natural resources in the entire country (Douglas, 2009).

This property boom, therefore, concentrated the landownership in big cities, and this is still clearly visible today in Japan. That is why the companies are involved in many smart cities projects.

If we refer to the smart city projects analyzed, this landownership monopoly can be clearly identified. Even if there will be a better analysis in the following chapter, here there is just a mention of a few examples. For instance, the case study of Kashiwa-no-ha Smart City is a project in which the land was previously owned by Mitsui Fudosan (Kashiwa-no-ha Smart City, 2014a), which is one of the major Japanese companies mentioned, and the same company owns some buildings in the Nihonbashi Smart City project. In the case study of Otemachi, Marunouchi, and Yurakucho Area Management the land is instead owned by Mitsubishi Corporation (Mitsubishi Estate Group, 2013b), again a company considered as one of the major corporations previously mentioned.

Instead, in the land where the Fujisawa Sustainable Smart Town project was developed, as highlighted through a personal interview by the author with Sakamoto (2019), there was an old company of Panasonic, which is not one of the companies mentioned but is still certainly one of the biggest corporations in Japan. Same thing with the case of Funabashi Morino City, which is a redevelopment project set up on a former factory site of Asahi Glass Co., Ltd. (Nomura Real Estate Development Co., Ltd., 2016).

As a consequence of the landownership monopoly, it is important to underline that in Japan - as underlined during a three-day workshop attended by the author with Yamagata, Yang, Murayama and Minato Ward Officers (2019) - the redevelopment or regeneration projects start from an interest and therefore an investment from the property owners of the land. Therefore, in Japan urban development is related to a bottom-up approach, and not to a top-down approach initiated by the central or local governments. Therefore, the smart city projects are initiated only if the big property owners are interested and their involvement is then crucial.

The second reason about the involvement of Japanese companies in smart city projects is related to the development of their own "Smart City Strategy". Indeed, in the next chapter some of these companies such as Mitsui Fudosan, Mitsubishi, Panasonic, Tokyo Gas, and KDDI - respectively real estate, tech, engineering, and telecommunication companies - will be interviewed. However, in this part, there will be a synthesis of their smart city strategies.

For instance, the real estate company Mitsui Fudosan foresees in its long-term business plan for Innovation 2017 a strategy related to smart cities. Indeed, Mitsui Fudosan wants to use smart city initiatives as a key strategy to strengthen the competitiveness of its business. The need of today's society is the creation of smart cities which is embraced by the DNA of Mitsui Fudosan, since the Group has always innovated through the creation of neighborhoods and buildings - such as  the Kasumigaseki Building, the Okawavata River City 21 or the Tokyo Midtown - in accordance with the needs of the society.

Three are the main concepts behind Mitsui Fudosan Group's Strategy for smart cities (Mitsui Fudosan Co., Ltd., 2018):

1. Communities that address issues faced by humankind
2. People as the main focus  (take the customer's perspective) "work smart, live smart"
3. Communities that continue to grow through mixed-use premiums and town management

The first concept is related to the promotion of the smart use of energy, the coexistence with the environment, the improvement of the safety and security as well as the health and longevity, revitalizing industries.

The second concept instead underlines the importance of the community creation, since the aim of Mitsui Fudosan is to create communities where people are proud to work and live in an environment that includes environmentally friendly and resilient measures.

The third concept underlines the fact that beyond the creation of buildings, retail properties, parks and so on, it is crucial to be engaged in town management activities in order to improve the value of the community.

Furthermore, the tech company Mitsubishi, through the use of the "Smart & Share Town

Concept" foresees to develop Eco-Friendly town developments. This concept includes three elements (Mitsubishi Corporation, 2012):

1. Development of cutting-edge technologies and other innovations seen in recent smart cities
2. Development of systems to create bonds among residents (for instance opportunities to share common values)
3. Development of systems for sharing innovative social systems from the first two elements in terms of infrastructures and services, in order to continue to generate environmental values.

Overall the "Smart & Share Town Concept" refers to the development of cutting-edge environmental technologies that link people together.

Besides, the tech company Panasonic is involved in various "Smart Town" projects in Japan and abroad. The "Smart Town" concept underlines the importance to avoid the creation of smart towns that are just full of technologies, but instead, they highlight the human-centric aspect, in the sense of how the technologies are embraced by the people and which benefits they can exploit from them (Panasonic Newsroom Global, 2018).

Not only tech companies, but also Tokyo Gas - which is an engineering company and the main provider of the gas to many cities in the Greater Tokyo Area - is involved in some smart city projects. In fact, their involvement is related to the implementation of Smart Energy networks in smart city projects, improving the efficiency of the entire system. Indeed, the three key elements that Tokyo Gas try to achieve are the combination of Smart Energy, Smart Green and Smart Communities (Tokyo Gas Engineering Solutions, n.d. a).

Eventually, KDDI - which is a telecommunication company - is involved as well in smart city projects since its aim is to expand and improve the telecommunication system in cities using technologies such as 5G or IoT (KDDI Corporation, n.d.), which are initiatives typical of a smart city.

Concluding, this analysis included just a few examples of Japanese companies involved in the smart city projects in Japan - since there are many other companies such as Hitachi, Fujitsu, Toshiba, Toyota, and so on involved as well - explaining their crucial role in smart city projects.

### 2.1.3 Urban System Design concept

The discourse about smart cities in Japan is also discussed from an academic perspective by Research Centers and Universities. Indeed, through the lectures attended by the author at The University of Tokyo in collaboration with the National Institute for Environmental Studies of Japan and the Georgia Institute of Technology, it was possible to get to know to a new concept called "Urban System Design". This concept seems to give a better idea of what a smart city is, differently from the approaches previously discussed about the discourse on smart cities from the government and from the companies point of views in Japan.

As underlined through a lecture made by Yamagata (2019a) the Urban System Design concept underlines the importance of the combination of the traditional urban planning/design with the emerging smart/green technologies (Figure 5).

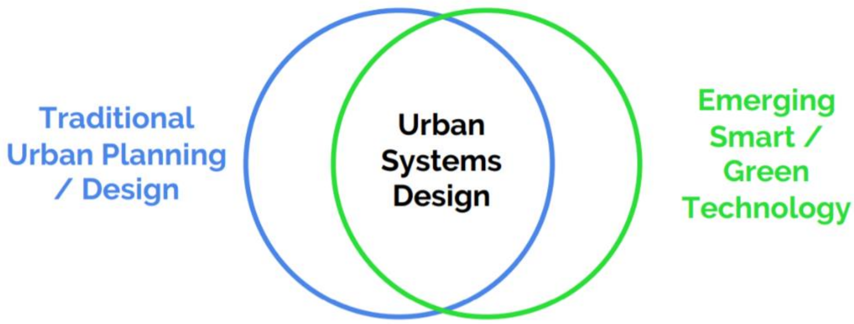


**Figure 5:** Urban Systems Design conceptualization (Yamagata, 2019a)

This concept can be used as a theoretical framework in the process of construction of a smart city. Indeed, it explains a relation between the use of technologies - such as IoT, Big Data, ICT, Al - together with the use of green innovative initiatives - considered as the implementation of green and blue infrastructures - and the traditional urban planning or design methods.

In particular, as underlined by Yamagata (2019a) the Urban System Design concept seems particularly useful in order to tackle today's problems such as climate change (i.e.

heatwaves and flooding) and earthquakes using a resilient approach and exploiting both the use of technologies and the traditional methods.
Yamagata (2019b) defines four stages for the adoption of the Urban System Design concept:

1. Problem Identification
2. Technological Innovation
3. Merging Traditional Methods with New Technology
4. Integrated Urban Systems Strategy

As highlighted through a lecture made by Yang (2019a), he describes the Urban System Design concept as a model for future cities.
In particular, he defines the shift from the Traditional Urban Design to the Urban System Design.
The first one "tend to be deterministic in form making. Traditional physical design treats ecology in cities as ways of preserving or adding ecological elements such as green spaces to urban environment", while the second one "advocates an inherently ecology-structured urban system, and sees ecology (and emerging technologies?) as a driving force of urban transformation to reconstruct ecosystems compatibility by linking the urban forms and flows of material, energy, water and organism across the boundaries of urban, industrial and natural ecosystems" (Yang, 2019a).
Besides, the lecture made by Murayama (2019a) focuses on the implementation of the Urban System Design concept in the Japanese urban planning context and on the usefulness of it for the improvement of resilience, specifically in relation with disasters. Furthermore, he underlines the fact that there is a need to rethink the process of planning, urban design, and community development in the Japanese context, starting with a conceptual framework for tasks in plan-making (Figure 6):

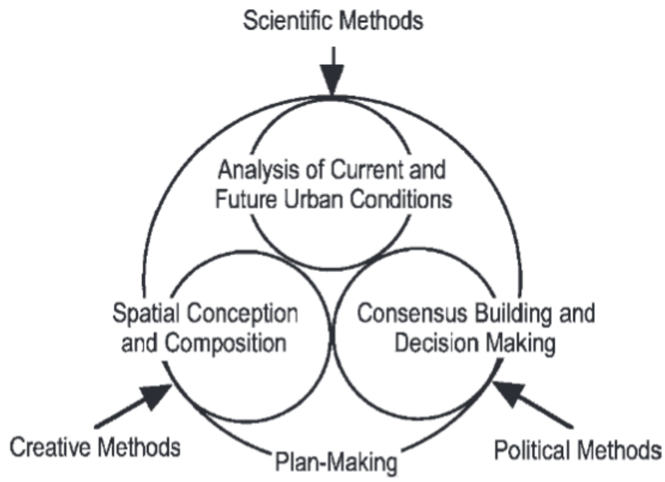


**Figure 6:** Three aspects and supporting methodology of plan-making tasks (Murayama, 2009)

This concept individuates three aspects of the tasks in the plan-making process: “analysis of current and future urban conditions”, “spatial conception and composition”, and “consensus building and decision making”. Each aspect is respectively supported by Scientific, Creative and Political Methods, which are useful for the analysis of each of them (Murayama, 2009). Overall, this concept it is useful as a theoretical framework which could embrace the Urban System Design concept and the implementation of it in the Japanese context, since every aspect and methods - specifically in relation with the analysis and spatial composition aspects - are crucial for the development of smart city projects (Murayama, 2019b).

Eventually, as discussed in the lecture made by Yang (2019b), the Urban systems design is an approach to design Future Smart Cities, and overall it is possible to say that a “Smart city is about place making. The IoT and pervasive computing create a new paradigm of place making by integrating the physical and digital world, in which proximity, urban context and physical form of cities are crucial. The design of smart city consists of smart home, smart spaces and smart infrastructure systems that are situational, responsive and resilient for future changes”. (Yang and Yamagata, Editorial in the theme issue Urban Systems Design, Environment and Planning B: Urban Analytics and City Science, to be published in 2019).

Indeed, the Urban System Design concept gives a better idea of what a smart city is, since the discourse about smart cities previously discussed both from the Japanese government - in relation to the idea of the Society 5.0 - and from the major Japanese companies - in relation to their tech-oriented approach - seem to underline too much the importance of just the use of technologies in the smart city projects. In doing so, they fall into the trap to define a “smart city” as a city that uses technology. Instead, the reality is much more complex, and today’s problems need to be tackled through a combination of many initiatives, which are better described by the urban system design concept, including certainly the use of technologies.

In the next chapter, there is going to be an analysis about the evolution and the role for the resilience of different smart city projects in the Greater Tokyo Area. In particular, the role for the resilience of each case study will be analyzed through an identification of the resilient measures undertaken by the smart city projects. These resilient measures do not deal just with the use of technologies, instead, the analysis underlines the importance to focuses on every type of  “smart” measure that is resilient, even if does not involve the use of technologies. Furthermore, as previously discussed, it seems that there is not a clear and shared definition of what a smart city is, apart from the fact that is something that exploits the use of technology. Therefore, in order to carry out the analysis of the case studies, the smart city concept is defined here through the use of the Urban System Design concept

Concluding a smart city is not just a city that uses technologies - otherwise it would be called a “tech city” - while it is a complex urban system, designed by the combination of technologies and the use of green and blue infrastructure initiatives with the traditional urban planning and design methods which overall make a city a concrete “smart” human settlement, that can tackle current global challenges - such as the need to improve the resilience of cities - promoting a sustainable development. In particular, in the next part, there is going to be an analysis of the issues in Japan that require a resilient approach.

## 2.2 The need for resilience in Japan

### 2.2.1 Acute shocks: earthquakes

The analysis about earthquakes in Japan is based on the identification of acute shocks from the definition of urban resilience by 100 Resilient Cities previously discussed. Therefore, the first part will focus on the discussion about the problems related to earthquakes and the second part will examine what Japan is currently doing to tackle them.

Japan has experienced around 10% of the world's earthquakes, even if its land is just 1% of the world's total land area. The biggest ever recorded earthquake was the 2011 Earthquake off the Pacific Coast of Tohoku (also called the Great East Japan Earthquake). Japan can be then considered as one of the world's most earthquake-prone countries (The Headquarters for Earthquakes Research Promotion, 2017). Moreover, Japan suffered so much from earthquakes and the consequent tsunamis because of the fact that around 70% of its national land that includes population, assets, industries and infrastructures is concentrated in coastal areas, where tsunamis are probably to happen (Mimura et al., 2011). The reason why there are so many earthquakes in Japan is due to the fact that Japan is located where four of the plates that cover the earth's surface collide (Figure 7). This means that a large energy is accumulated between the plates which move in different directions at a speed of several centimeters per year and when the rocks mass fractures, an earthquake occurs (The Headquarters for Earthquakes Research Promotion, 2017).

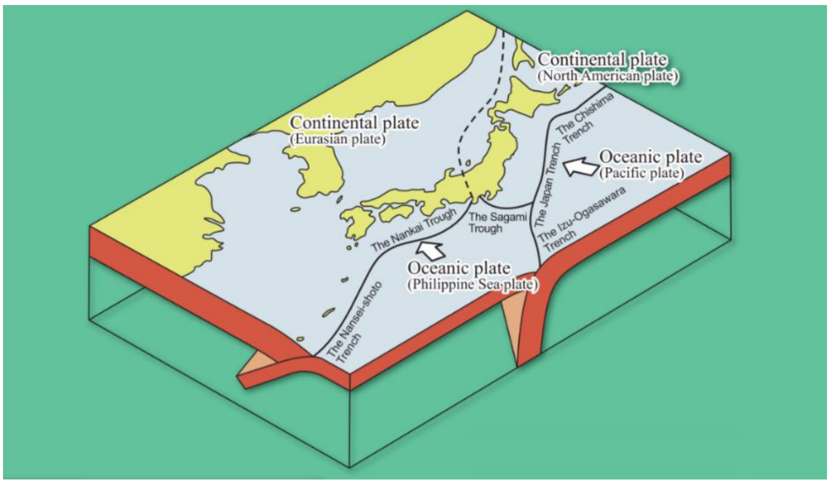


**Figure 7:** The plates surrounding Japan (The Headquarters for Earthquakes Research Promotion, 2017).

In particular, the Great East Japan Earthquake of 2011 had a magnitude of 9 and seismic intensity of 7. The reason why this earthquake was the biggest ever recorded is due to the fact that the size of the fault that moved was huge, approximately 450 km in length and 200 km in width. The number of deaths were 15,843, the missing persons 3,469, the number of injures 5,890 and the number of evacuees 138,620. Furthermore, the dwellings totally destroyed were 127,091 and the ones partially damaged 230,869 (Hatanaka, 2012).
The Great East Japan Earthquake was so destructive because of the tsunami that occurred as a consequence of the earthquake. Indeed, the tsunami was about 30 meters high, and basically all of the people were drowned by it. Besides, the tsunami damaged the Fukushima Daiichi nuclear power plant and therefore there was a massive amount of radiation released into the ocean. Due to the radiation the Prime Minister, Naoto Kan, evacuated 50 million people from the Greater Tokyo region and 160,000 people left their homes (Norwegian University of Science and Technology, 2017).
The tsunami was so destructive that it had influences even in other countries such as Russia, the Philippines, Indonesia, Australia, New Zealand, Papua New Guinea, Fiji, Mexico, Guatemala, El Salvador, Costa Rica, Nicaragua, Honduras, Panama, Columbia, Ecuador, Peru, Chile, and the United States (Norio et al., 2011).
Based on the risk described, the Japanese government each year prepare a national seismic hazard map in order to foresee earthquakes (Figure 8). The problem is that since 1979, the earthquakes that caused 10 or more deaths, were located in areas that in the national seismic hazard map are classified as “low risk”. Accordingly, the government should admit that earthquakes in Japan cannot be predicted, and all of Japan is at risk. It is important instead to improve the measures useful to adapt to them because earthquakes are literally unexpected (Geller, 2011).
Therefore, the need for resilience to earthquakes in Japan is crucial, since as defined by 100 Resilient Cities, acute shocks are “sudden, sharp events that threaten a city”, which in this case as described are not even predictable.

From the point of view of resilient measures for earthquakes, Japan has already implemented many actions and system to adapt to them. For instance, it has developed an efficient "earthquake early warning system". Through the use of seismometers seismic waves are detected and therefore a warning is issued to TVs or mobile phones before the strong shaking starts. This allows informing the citizens about an earthquake that is coming soon and therefore the people can take actions to adapt to it (The Headquarters for Earthquakes Research Promotion, 2017).

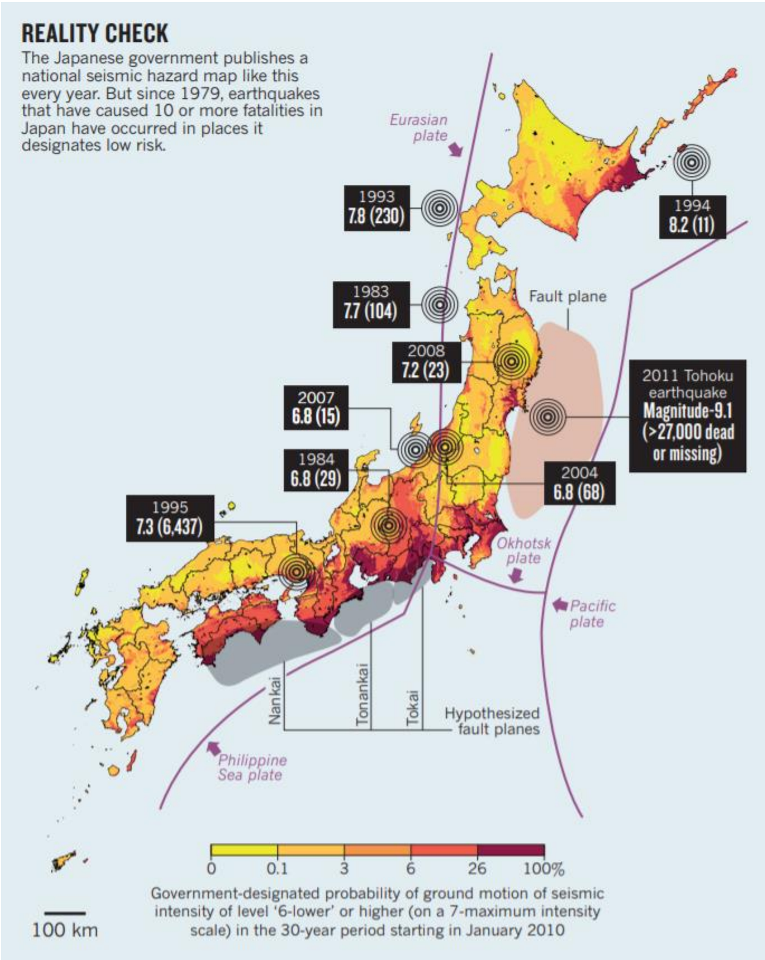


**Figure 8:** Example of the national seismic hazard map (Geller, 2011)

The National Research Institute for Earth Science and Disaster Resilience's E-Defense Lab Building makes many experiments on the destruction buildings at a full-scale. The buildings are positioned on a platform where the same shaking of a real earthquake takes place. Therefore, through these experiments, it is possible to design stronger buildings that can adapt to earthquakes. Moreover, Japan has a system called the Dense Oceanfloor Network System for Earthquakes and Tsunami (DONET) which is installed in proximity to the coastal areas more at risk. This system exists only in Japan and it allows to detect a tsunami that is coming from the ocean, allowing to alert the population and take actions about (The Headquarters for Earthquakes Research Promotion, 2017).

Furthermore, schoolchild in Japan are very familiar with disaster drills, which take place each month and all offices and houses have emergency kits and medical equipment. This allows creating a resilient community both in schools and offices, which is prepared to tackle earthquakes (Foster, 2011).

Japan is also promoting the use of ICT, in order to develop for instance systems that can allow sharing information to the people in case of earthquakes. In fact, it is improving the optical networks systems, since it can transmit huge quantities of data very quickly in order to improve early warnings (Suzuki, 2018).

The use of technology is also exploited through advanced robots that can search for people that need help after a disaster since as experienced in the Great East Japan Earthquake the radiations could not allow entering into the buildings or in the ocean (Matsutani, 2015).

In conclusion, it is possible to say that there are different resilient measures to tackle earthquakes already undertaken by Japan. However, firstly it is crucial to always improve them, and secondly, they should be part of a system of measures under the Smart City concept which using the Urban System Design approach, should identify both tech and traditional measures. In the next chapter, there will be an analysis of different resilient measures for earthquakes in various smart city case studies in the Greater Tokyo area.

### 2.2.2 Chronic stresses: climate change effects

Climate change in Japan will be analyzed based on the identification of chronic stresses from the definition of urban resilience by 100 Resilient Cities. Indeed, the discussion will focus on the effects of climate change in Japan - flooding and heatwaves - and then on what Japan is currently doing to tackle them.

Climate change is affecting every part of the planet and Japan is not excluded. As underlined by the Ministry of the Environment et al. (2018), the temperature over Japan is rising faster than the global average. Indeed, at the end of the 21st century temperatures in Japan will increase from 0.5 to 1.7°C (Figure 9).

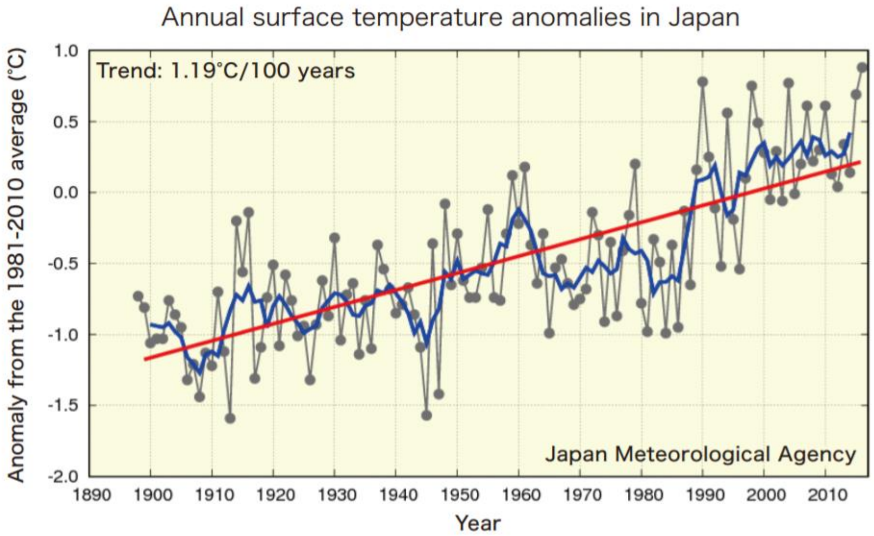


**Figure 9:** Annual surface temperature anomalies from 1898 to 2015 in Japan (Ministry of the Environment et al., 2018)

The report continues highlighting that the number of days with a maximum temperature of 30°C/35°C or above is increasing. These increases were recorded between 1931 and 2016. For instance, in the Okinawa and Amami Region, there will be an increase, at the end of the 21st century, of around 54 days where the temperatures are going to be 35°C or above (Ministry of the Environment et al., 2018).

Furthermore, heavy rainfall events are increasing and the number of days with precipitation is decreasing (Figure 10). From a statistical point of view at the end of the 21st century, there will be increases of extreme precipitation and the number of days without precipitation will increase everywhere in Japan (Ministry of the Environment et al., 2018).

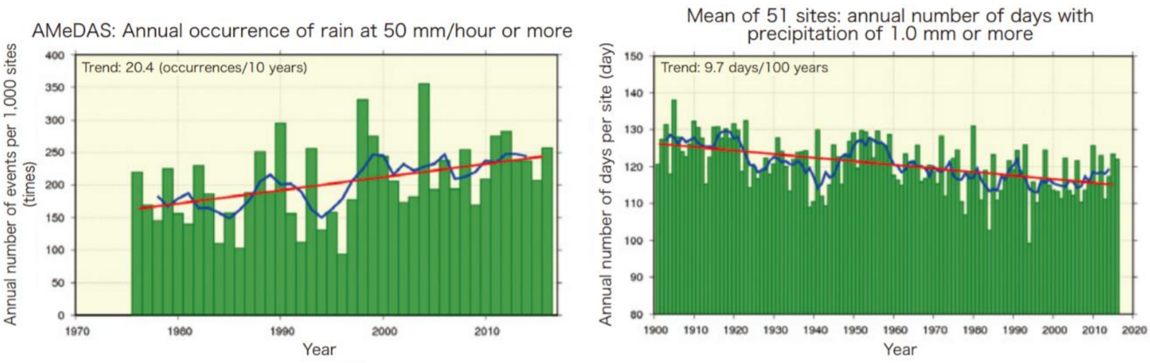


**Figure 10:** Change in the annual number of events with precipitation of 50 mm/hour or more per site (Ministry of the Environment et al., 2018)

Moreover, snow depth will decrease, and heavy snowfall could increase in inland areas. Accordingly, at the end of the 21st century the snow depth will decrease specifically on the Sea of Japan and heavy snowfall could increase in the Honshu and Hokkaido Islands (Ministry of the Environment et al., 2018).

Therefore, these projections will have various impacts in different sectors such as agriculture, forests, fisheries, urban life, natural ecosystems, water, coastal areas, economic activities and so on.

For example, the incidence of heat illness will increase, due to the increases in the temperatures that will cause heatwaves. Indeed, based on the projections the number of people that will need an ambulance due to heatwaves will increase from the present period to 2031-2050 (Ministry of the Environment et al., 2018).

In the graph below it is possible to see that in 2010 it was recorded the period of the peak in terms of the number of deaths since in that year, there were extreme temperatures (Figure 11).

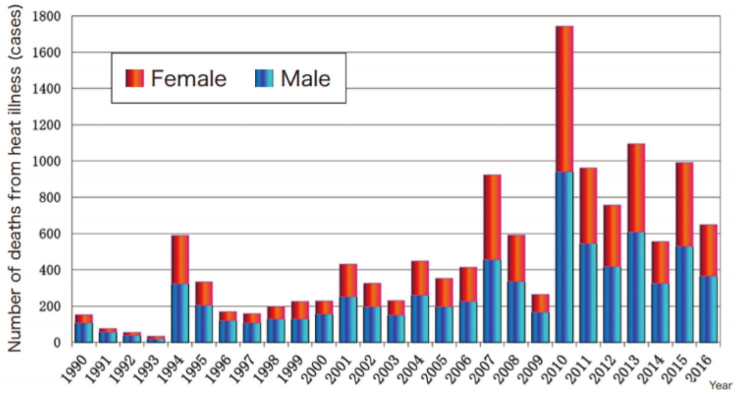


**Figure 11:** Number of deaths from heat illness by year and gender between 1990 and 2016 (Ministry of the Environment et al., 2018)

Another impact is related to the change in the river flow conditions. In fact, due to the heavy rainfalls and snowfalls, it is projected that at the end of the 21st century various area in the coasts of the Sea of Japan will experience a change in the river flow conditions. As a consequence, this will probably cause more flooding (Ministry of the Environment et al., 2018).

Overall, it is possible to say that two are the main effects of climate change in Japan: heatwaves and flooding. Indeed, as underlined by Sauer (2018) "The July 2018 heatwave, which killed 1,032 people, saw temperatures reach 41.1C, the highest temperature ever recorded in the country. Torrential rains also triggered landslides and the worst flooding in decades". As emphasized by Imada et al. (2019) the event would never have happened without global warming.

Resilient measures to tackle climate change are already undertaken by Japan, for instance through the National Plan for Adaptation to the Impacts of Climate Change (Japan. Cabinet Office, 2015). This plan foresees different actions in order to adapt to climate change. In relation to flooding events, the Government underlines the importance to improve the facilities useful to control the flooding, such as flood control barriers and sewer systems. Moreover, it highlights to use information and communication technologies (ICT) to analyze the condition of the rivers and through the use of video monitoring (CCTV) get information about flooding (Japan. Cabinet Office, 2015).

While in relation to heatwaves the Government focuses the attention on raising the awareness in relation to prevention and treatment of heat illness caused by heatwaves. Besides, since the labor in the agriculture, forestry and fisheries industries, is performed under severe working condition due to heatwaves, the Government want to make use of information and communication technologies (ICT) and robots to be introduced in the workplaces in order to reduce the exertion level of the work (Japan. Cabinet Office, 2015).

Moreover, as underlined by Anderson (2011), climate change effects - considered as flooding and heatwaves - and disaster risk reduction - such as in case of earthquakes - share a common goal: the need to reduce the vulnerability of the people that experience these events.

Therefore, the education of the community is crucial to ensure the safety of the people, helping the overall system to adapt to climate change and disasters.

In conclusion, as previously discussed about the acute shocks, different are the resilient measures to tackle the main effects of climate change in Japan. It is important to steadily improve them, and to make them part of the measures under the Smart City Concept using the Urban System Design approach, since the measures analyzed were related to the use of technology and also through traditional methods. Also, for the resilient measures for climate change, in the next chapter, there is going to be an analysis of the ones implemented in the Greater Tokyo area in various smart city projects.

# 3. Evolution of smart cities and their role for the resilience in Tokyo

The contextualization of the issues related to the smart city concept and to resilience in Japan was useful to shift the analysis in particular in Tokyo where different existing and on-going smart city projects are examined. On the base of the possible relationship previously discussed between the smart city concept and resilience, the evolutionary processes and the role of the case studies for resilience in Tokyo is discussed.

First of all, each case study is analyzed, since their construction phase to date, showing their characteristics and the stakeholders involved. An important event that has always modified each smart city project is the Great East Japan Earthquake of March 2011, since it raised a general awareness about the importance to improve the resilience.
In addition to that, the role for the resilience of each case study is carried out, identifying every resilient measure, using the Urban System Design Approach, which tends to tackle the acute shocks considered as earthquakes and the effects of climate change, considered as flooding and heatwaves.
The methodology adopted utilizes the documents, the visit to every smart city project, and the meeting and workshops attended related to the case studies. Furthermore, interviews with relevant stakeholders involved in each smart city project are carried out. In particular, in relation to the existing smart cities, interviews are conducted with:

- Kashiwanoha Smart City: UDCK - Urban Design Center Kashiwanoha
- Fujisawa Sustainable Smart Town: Panasonic Corporation
- Yokohama Smart City: Mitsui Fudosan Corporation
- OMY Area Management: Mitsubishi Corporation
- Nihonbashi Smart City: Mitsui Fudosan Corporation

Exceptionally, for the case of Funabashi Morino City, it was not possible to receive an answer from Mitsubishi Corporation. Instead, for the on-going smart city, the Shinagawa Smart city project includes the attended meetings and workshops with The University of Tokyo, the Georgia Institute of Technology, the National Institute for Environmental Studies of Japan, the Minato Ward office and KDDI Corporation.

## 3.1 Existing smart cities

### 3.1.1 Kashiwa-no-ha Smart City

The first case study that has been analyzed is the Kashiwa-no-ha Smart city project. From the analysis of the documents related to the project, the visit to the site and the interview with the project manager from UDCK (Urban Design Center Kashiwa-no-ha), the aim was to understand the evolution and the role for the resilience of probably one of the most well-known smart city projects in Japan.

The evolution of Kashiwa-no-ha Smart City starts from the construction phase in 2005. This date makes it the first project in Japan defined as a smart city. It is a redevelopment project, since the aim was to make a transformation of the area previously occupied by the United States Air Force Communication Base and then by Mitsui Fudosan's Kashiwa Golf Club (Kashiwa-no-ha Smart City, 2014a). Located 25 km away from Downtown Tokyo, it is the result of a private-public-academic partnership formed by companies such as Mitsui Fudosan and the Metropolitan Intercity Railway Company, by public institutions such as Chiba Prefecture and Kashiwa City Government and by the academic sector with The University of Tokyo and The Chiba University. Furthermore, an important stakeholder is the Urban Design Center Kashiwa-no-ha (UDCK), which is an independent organization located on-site (Boon Ping, 2019).
As many smart city projects in Japan, the evolution of Kashiwa-no-ha has been influenced by the Great East Japan Earthquake of March 2011. In particular, the goals of the project have changed before and after the earthquake. In fact, before the aim was to build a Low-Carbon and Environmental Friendly Smart city that would have improved the energy saving, energy creation and the use of greenery. After the earthquake two were the issues underlined: technology-oriented issues and activity-oriented issues. The first one focused on the importance to store electricity using it in case of disasters and build resilient infrastructures and buildings, while the second one highlighted the importance of

community risk management, business & life continuity plan (BLCP) and smart service business (Nikken Sekkei, 2016).

Furthermore, in 2016 Kashiwa-no-ha Smart city became the first Japanese project that earned the LEED® Neighborhood Development (LEED-ND) Platinum certification (Figure 12), which is the highest international standard for ecological and sustainable neighborhood development (Urban Design Center Kashiwa-no-ha, Mitsui Fudosan Co. Ltd., 2016). Afterwards the certification earned as a LEED-ND PLATINUM project, in 2016 the Japanese government has chosen Kashiwa-no-ha as a leading urban planning initiative in order to encourage the adoption of innovative practices, therefore recognizing the maturity of the project (Japan. Ministry of Land, Infrastructure, Transport and Tourism, 2016, pp. 6-7).

As underlined through a personal interview by the author with Mimaki (2019), the national government is now promoting new concepts related to the smart cities. In fact, he said, they push toward the exploitation of new technologies such as IoT, ICT, and new sensors. This makes a new change in the evolution of Kashiwa-no-ha Smart City, because the project will shift from the focus on the energy system due to the earthquakes to a new understanding of the smart city concept. Moreover, he emphasizes the role of UDCK as a co-site to facilitate the collaboration among the different stakeholders based on the triple helix partnership and the citizens, since even if the implementation of new technologies pushed by the government is important, the collaborative process is crucial as a key success factor of a smart city.

The role for the resilience of Kashiwa-no-ha Smart City is going to be discussed through a differentiation of the resilient measures - based on the definition previously discussed from 100 Resilient Cities - for acute shocks and for chronic stresses.

The resilient measures for acute shocks are connected with the event of the Great East Japan Earthquake of March 2011. Since this date, the main issue was to find new solutions to store the energy in order to use it in case of future disasters.

For that purpose, the AEMS (Area Energy Management System) developed in Kashiwa-no-ha is a facility that has the aim to function as a smart grid to share power between the different buildings and infrastructures in the area in case of emergencies (Akiyama, 2015). In particular, the Kashiwa-no-ha Smart Center (Figure 13) controls the AEMS and, as highlighted by Mimaki (2019), it manages the storage batteries that are useful to provide electricity for 3 days in case of disasters, and in addition to that, it monitors energy information during disasters, electricity usage in residences, commercial and office buildings (Kashiwa-no-ha Smart City, 2014b). Therefore, the resilient function of the AEMS is crucial in case of energy shortages in the event of earthquakes.

Then, the HEMS (Home Energy Management System) is a service installed in each apartment that gives energy conservation advices to residents in order to control air-conditioning and lighting to make residents contribute to increase power conservation (Akiyama, 2015). The advices to the residents are displayed through the use of different devices such as tablets, personal computer or smartphones to see the carbon dioxide ($CO_2$) emissions of their apartments (Kashiwa-no-ha Smart City, 2014b). Accordingly, the HEMS contribute to build a resilient community which helps to be prepared in case of earthquakes through the improvement of energy conservation by residents, storing in the batteries the unused energy.

Part of the energy is generated through renewable sources such as solar panels (Figure 14), wind power and solar heat use which then is going to be stored through the AEMS system (Mitsui Fudosan, 2018d). Then, the use of renewable sources is a measure that from a resilient perspective in case of earthquakes helps to generate clean energy to be stored in the batteries.

Furthermore, in the Kashiwa-no-ha area the water can be sourced through groundwater pumps (Kashiwa-no-ha Smart City, 2014b), meaning that this is a resilient measure since even in case of earthquakes water can be provided.

The cogeneration system is another resilient measure used in some buildings in the area. It transforms the gas in electricity and heat (Mitsui Fudosan Co., Ltd., 2017) and so, in that way, it is possible to store and use the energy and the heat produced even in case of earthquakes because of the robustness of the system.

Besides, all the buildings in the project are earthquake-proof as underlined by Mimaki (2019), since they have anti-seismic structures introduced for all the building in Japan from the Building Standards Law that was amended in 1981 to the latest laws on building resistance to earthquakes (Kamemura, 2016).

Moreover, the electric vehicle recharging stations provided in the project (Mitsui Fudosan Co., Ltd., 2017), beyond the reduction of vehicle-related CO2 emissions, they act as a resilient measure, since it could be possible to use the energy from the charging station in case of energy shortages due to earthquakes.

The resilient measures for chronic stresses instead are connected to the need to tackle flooding and heatwaves. Both of them are faced by the "Aqua Terrace" as underlined by Mimaki (2019), which is an urban pond (Figure 15) that acts as a regulating reservoir for flood control promoting also the human interaction (Mitsui Fudosan, 2016) and it contributes to maintaining the temperature in the area cooler.

In order to tackle the heatwaves in the area, Mimaki (2019) emphasize the importance of the greenery through the use of parks, green alleys and green walls (Figure 16) in the Kashiwa-no-ha project, which contribute to lower the surface and the air temperatures by providing shade and evapotranspiration (United States Environmental Protection Agency, 2016).

Furthermore, lectures are provided to the citizens to improve the resilience of the community (Kashiwa-no-ha Campus Town Initiative Committee, 2014).

Eventually, the design of the buildings of the commercial part of the site, ensure natural heat and air, to lower the energy usage of about 40 %, contributing to maintaining the buildings as liveable places even in case of no energy due to disasters, tackling extreme temperatures (Kashiwa-no-ha Smart City, 2014b).


**Figure 12:** LEED certification (Ales F., 2019)

**Figure 13:** Kashiwa-no-ha Smart Center (Kashiwa-no-ha Smart City, 2014b)

**Figure 14:** View of Kashiwa-no-ha and solar panels in the façade (Ales F., 2019)

**Figure 15:** Urban pond 'Aqua Terrace' (Ales F., 2019)

**Figure 16:** Green alley and green wall in the multi-storey car parking (Ales F., 2019)

### 3.1.2 Fujisawa Sustainable Smart Town

The Fujisawa Sustainable Smart Town project is the second case study that has been examined. The documents analyzed, the visit to the case study and the interview with the project manager from Panasonic Corporation have been useful to apprehend the evolution and the role for the resilience of the most unique project among all the case studies analyzed in terms of uniformity of the physical form and cohesiveness of its community.

The evolution of Fujisawa Sustainable Smart Town begins in 2008, when the development process of the project started. Before that, as highlighted through a personal interview by the author with Sakamoto (2019), there was an old company of Panasonic that closed in 2007. Therefore, after the demolition of the company the redevelopment project was set up. It is a project located around 50 km away from Tokyo and it was promoted by the Fujisawa SST council, which is organized by 18 companies, including Panasonic as a lead organizer and other companies such as Mitsui Fudosan, Tokyo Gas and Fujisawa City within the advisory board (Fujisawa SST, 2016b).
As underlined by Sakamoto (2019), when the project started in 2008 the trend of the smart city concept of Fujisawa SST was focused only about the energy system. Then, when the Great East Japan Earthquake occurred in 2011, this date represented a turning point for Panasonic that strengthened the theme of resilience. However - he continued - the plan did not change because of the earthquake but the overall goal of the project became clearer, arranging the measures with the term “resilience”.
In September 2013 Fujisawa SST was adopted by the Japanese government as a model project for promoting $CO_2$ reduction in housing and building, acknowledging the sustainability of the project (Japan. Ministry of Land, Infrastructure, Transport and Tourism, 2014, p.10)
Afterward, the project was inaugurated in April 2014. Since this date, the residents began to move into the houses and the Fujisawa SST SQUARE, which is the town's core facility, opened in November (Panasonic Newsroom Global, 2015).

Furthermore, the project was awarded the Year 2017 Kanagawa Global Environment Award for Global Warming Countermeasures Plan getting the "S-rank" in the CASBEE which is the Comprehensive Assessment System for Built Environment Efficiency (Fujisawa SST, 2018a).

The role for the resilience of Fujisawa SST is going to be discussed differentiating the resilient measures for acute shocks and for chronic stresses.
First of all, the resilient measures for acute shocks focus on the importance to be prepared in case of future earthquakes. For instance, each house is provided with a solar power generation system (Figure 17) and storage battery units to provide energy in case of disasters. In fact, the SMARTHEMS (Home Energy Management System) in connection with the use of solar power systems allows storing the energy created to make sure it is available in case of earthquakes. This system is based on the Fujisawa SST concept of "self-creation and self-consumption of energy" for every house and, customers can choose between different types of technologies, based on their particular lifestyle energy needs (Fujisawa SST, 2015a).
Moreover, the ENE-Farm household fuel cell cogeneration system - which transforms the gas in electricity and heating - is linked through the Energy Creation-storage Linked System for Home, with the solar power generation system. In that way, it is possible to store all the energy produced in the storage batteries in order to use it in case of emergencies (Fujisawa SST, 2015a).
Furthermore, as all the buildings built after the Building Standards Law that was amended in 1981 (Kamemura, 2016), the houses in Fujisawa SST are earthquake-proof because of their anti-seismic structures.
In Fujisawa SST there are also resilient measures that are adapted for both acute shocks and chronic stresses. For instance, the security of the citizens of Fujisawa SST is guaranteed by the CCP (Community Continuity Plan). It is a plan that provides extending medium-pressure gas pipes into the middle of the project where it is located a meeting point in case of disasters. Due to the robustness of the pipes, even in case of disasters such

as earthquakes or flooding, the citizens are then provided with all the primary necessities for 3 days (Fujisawa SST Council, 2018, p.4).
Besides, as underlined by Sakamoto (2019), there are power lines and optical fibers underground that are strong and therefore prepared for disasters such as earthquakes and flooding, allowing the connectivity of the citizens in every condition. For the same purpose, he also emphasizes the importance of the surveillance cameras (Figure 18) both for security reasons within the area and in case of disasters, to be ready to assist the citizens in danger. In addition to monitoring by cameras, there are streetlights in specific places that remain on for security reasons (Fujisawa SST, 2015b).
Sakamoto (2019) continued to talk about the temporary shelter facility useful in case of earthquakes. In fact, the citizens of Fujisawa SST can gather into the shelter which includes solar panels on the roof and LED streetlights with storage batteries. In addition to that, they can use the facilities provided there such as the convertible benches to be used as a stove for cooking and temporary toilets installed in the manholes (Figure 19).
Another temporary shelter for the citizens in case of flooding mentioned by Sakamoto (2019) is the Committee Center. It is an elevated structure provided with solar panels that allows the residents to be safe. Besides, the structure includes Electric Vehicles charging stations which can contribute to be a source of energy.
In addition to that, push notification TV system from the Town Management Company are installed in every house (Figure 20). The information delivered regards alerts on disasters such as an earthquake, contributing building an aware resilient community (Fujisawa SST, 2015b).
A resilient measure for chronic stresses specifically focused on heatwaves is the resilient design of the project. In fact, the passive design of project utilizes for instance wind power, sunlight, water and ambient heat to decrease the extreme temperatures (Fujisawa SST, 2015a). Furthermore, there is a demonstration experiment of a green external air conditioner which reduces heat in outdoor areas (Fujisawa SST Council, 2018, p.24).

Furthermore, in order to lower the temperatures, different parks are present in the Fujisawa SST. These include the "Active Park", the "Forest Park", the "Breeze Garden" and the "Circle Garden" (Fujisawa SST, 2015d).
Finally, lectures are provided to the residents in order to improve the resilient awareness between the community (Fujisawa SST, 2016a).

**Figure 17:** Detached house with solar power panels (Fujisawa SST, 2015c).

**Figure 18:** Security camera (Fujisawa SST, 2015c).

**Figure 19:** Ordinary condition on the upper part and emergency condition on the lower part. Respectively, temporary shelter, convertible benches and toilets installed in the manholes (Ales F., 2019)

**Figure 20:** The Town Management Company on the left side connected with the Home TV on the right side (Ales F., 2019)

### 3.1.3 Funabashi Morino City

The third case study analyzed is the Funabashi Morino City project. The study of the documents related to the initiative and the visit to the site have been useful to examine the evolution and the role for the resilience of one of the larger suburban redevelopment projects based on the connection of technology and green.

The evolution of Funabashi Morino City starts in 2010, when the project owners acquired the project site, while the construction began the next year.

The redevelopment project was set up on a former factory site of Asahi Glass Co., Ltd. (Nomura Real Estate Development Co., Ltd., 2016). The site is located around 20 km from central Tokyo and it was initiated by Funabashi City in collaboration with Nomura Real Estate Development and Mitsubishi Corporation. In particular, Mitsubishi Corporation acquired the project site, made the zoning, the town development concept and it managed the consortium for the implementation of the project (Nomura Real Estate Development Co., Ltd., 2016).

The Funabashi Morino City is not literally defined as a “smart city project” but the main

concept of it is based on the “Smart & Share Town Concept” (Nomura Real Estate Development Co., Ltd., 2017).
Indeed, Funabashi Morino City won the World Smart Cities Award that was assigned to it in the Smart City Expo World Congress 2013 held in Barcelona, Spain. The award was issued based on the “Smart & Share Town” concept of the project which includes smart city measures related to the energy system exploiting ICT and environmental measures such as the use of the greenery (Mitsubishi Corporation, Nomura Real Estate Development Co., Ltd., 2013).
Furthermore, in 2014 Funabashi Morino City has been chosen by the Japanese Government as a model project based on the sustainable solutions in relation with the adoption of the smart city concept (Japan. Ministry of Land, Infrastructure, Transport and Tourism, 2014, p.9)
The whole project was completed in July 2014 while the resident began to move in the last residential unit (Nomura Real Estate Development Co., Ltd., 2017).
Finally, in 2016 the Ministry of Housing and Sustainable Homes of France assigned to Funabashi Morino City the ÉcoQuartier Certification (eco-district certification), therefore, becoming the first project outside France to win it. The certification was recognized because of the effort of the project to build a low-carbon society making sensible use of the space and the energy exploiting ICT (Nomura Real Estate Development Co., Ltd., 2016).

The role for the resilience of Funabashi Morino City is discussed through the differentiation between the resilient measure for acute shocks and the resilient measure for chronic stresses.
The resilient measures for acute shocks are based on the energy sector in order to be prepared in case of disasters. In fact, the “Smart-Energy System” of Funabashi Morino City is called “enecoQ" and it provides an Energy Management System that combines the regular electric power grid with the electricity produced by solar panels. When the total electricity is combined, then the system exploits ICT in order to store the energy in proper

storage batteries. In that way, the resilient aspect is related to the fact that the electricity stored can be used in case of emergencies such as an earthquake. Moreover, the system adopted the Town Energy Management Service (TEMS), in order to manage the energy of the entire area, adjusting the energy efficiently, and the same thing, at the condominium-scale, is done using the Mansion Energy Management Service (MEMS) (Nomura Real Estate Development Co., Ltd., 2017).

Another resilient measure is connected with the possibility that residents have access to a service installed in each house called “My Page” where they can view – on computers, smartphones or living panels installed in every apartment - their past power usage (Figure 21). Therefore, tracking their consumption they can adjust their habits, for instance using household appliances - such as dishwashers or washing machine - at different times and during low-rate time zones. In that way, the energy generated by solar panels can be saved, stored and used in case of disasters. Besides, the digital information provided will switch into an emergency mode during natural disasters, and so residents can get emergency information, improving the resilience of the community (Nomura Real Estate Development Co., Ltd., 2017).

The solar panels provide also energy to the electric vehicles - there are 200 chargers for EVs - and during a power outage, the energy of the EVs (Figure 22) can be used as a source of energy that can be sent to the clubhouse. In fact, the clubhouse (Figure 23) is a temporary shelter where citizens can gather in case of disasters (Nomura Real Estate Development Co., Ltd., 2017).

Furthermore, in case of emergencies the internet through the wireless LAN can be provided to the residents that can gather emergency information (Nomura Real Estate Development Co., Ltd., 2017).

Then, the Morino City Residents Association organize meetings for residents and businesses to discuss their requests. In fact, the Association includes activities for instance for disaster defense, organizing disaster drills, contributing to improve the resilience of the community (Nomura Real Estate Development Co., Ltd., 2017).

Moreover, all the buildings built after the Building Standards Law of 1981 got anti-seismic structure in case of earthquakes (Kamemura, 2016) and the performance of new houses are evaluated by the development company including structural stability evaluation in case of earthquakes (Japan. Ministry of Land, Infrastructure, Transport and Tourism, n.d, p.17)

Regarding the resilient measures for chronic stresses, there are five parks in the project (Figure 24) - the Japanese Stewartia Park, Azalea Park, Dogwood Park, Zelkova Park and the Sakura Park - that contribute to tackle heatwaves, lowering the temperature through evapotranspiration (Nomura Real Estate Development Co., Ltd., 2017). In addition to that, there are green walls on the balconies that contribute to the same purpose (Japan. Ministry of Land, Infrastructure, Transport and Tourism, n.d, p.16)

Finally, the project designed the buildings in a way that they can allow the cool wind from Tokyo Bay to flow throughout the area during summer, tackling extreme temperatures (Japan. Ministry of Land, Infrastructure, Transport and Tourism, n.d, p.16)


**Figure 21:** Different devices connected to “My Page” to view the past power usage by the residents (Nomura Real Estate Development Co., Ltd., 2017).


**Figure 22:** EV charging station (Ales F., 2019)

**Figure 23:** Temporary shelter in the Clubhouse (Ales, F., 2019)

**Figure 24:** The greenery system (Nomura Real Estate Development Co., Ltd., 2017).

### 3.1.4 Yokohama Smart City

The Yokohama Smart City Project is the sixth case study that has been analyzed. Through the study of the documents of the initiative, the visit to the case study and the interview with the project manager from Mitsui Fudosan Co., Ltd., it has been possible to understand the evolution and the role for the resilience of the first smart city project that is spread out in three different districts in Yokohama.

The evolution of Yokohama Smart City started in 2010 when the city of Yokohama was chosen by the Japanese Government to become a "Next-Generation Energy Infrastructure and Social System Demonstration Area" (Mahmood, 2018, p. 254). Based on this date, Yokohama Smart City is the first known regeneration smart city project within the Greater Tokyo Area.

As underlined through a personal interview by the author with Miura and Amemiya (2019) the Yokohama Smart City project was planned before the Great East Japan Earthquake of March 2011, and at that time, the idea of resilience was not discussed. Nevertheless, after the earthquake, the idea of resilience became one of the keywords in the project, since there was a need to be prepared for future possible disasters.

The need to make a regeneration project came from the fact to use innovative ideas using the smart city concept to solve different issues that nowadays Yokohama has to face - as well as Japan in general - such as climate change, declining birthrate and an aging population (IUC-Japan Secretariat, 2017).

The Yokohama Smart City project focuses on three different districts of Yokohama: the Minato Mirai 21 district (Figure 25), the Kohoku New Town district, and the Yokohama Green Valley district (Tokoro, 2015, p. 81). However, as highlighted by Miura and Amemiya (2019), each district does not include clear borders in relation to the implementation of the project and therefore there are no data about the size of the overall project. Actually, he continues highlighting that few buildings joined the project, so it is possible to say that the area is not very big.

Furthermore, the project is located around 30 km away from central Tokyo and it involves the municipality of Yokohama as well as the national government, 34 businesses - including Mitsui Fudosan, Nissan, Panasonic, Toshiba, TEPCO, Tokyo Gas - and the local community (IUC-Japan Secretariat, 2017). For instance, Mitsui Fudosan - as a private business company - was in charge of a demonstration project, implementing technologies for an Energy Management System (EMS) for the Yokohama Mitsui Building, Park Homes Okurayama, and the Fine Court Okurayama Master's Hill (Mitsui Fudosan, 2018a).

As underlined by Miura and Amemiya (2019), Toshiba was developing within the project, the Energy Management System and it called for companies to join its demonstration experiment. Mitsui Fudosan was one of the participants and in particular developed the Demand Response (DR) technology, conducting the experiment from 2012 to 2014.

In 2012, the demonstration project has been adopted by the Ministry of Economy, Trade and Industry of Japan as a Next-Generation Energy and Social System Demonstration Project, recognizing the innovations of the project (Mitsui Fudosan, 2018b). Moreover, in 2014 the project was concluded and in the same year, some buildings owned by Mitsui Fudosan, have been awarded the Action Award as a part of the 21$^{st}$ Yokohama Environmental Activity Award (Figure 26), recognizing the effort from the citizens, companies, children, and students who engaged in the environmental activities in the project, contributing to cut $CO_2$ emissions (Mitsui Fudosan, 2018a).

Eventually, as discussed by Miura and Amemiya (2019), there are no future progress for the project, since even if Mitsui Fudosan has the interest to develop and spread in other districts of Yokohama the DR technologies, it is hard to do it without the implementation of the overall Energy Management System developed by Toshiba. However, from this demonstration project, many crucial aspects related to the smart city concept and to resilience has been learned.

The role for the resilience of the Yokohama Smart City project is discussed through the differentiation between the resilient measures for acute shocks and the resilient measures for chronic stresses.

The resilient measures for acute shocks - like many smart cities in Japan already analyzed - are connected with the need to store the energy and use it in case of disasters such as an earthquake.

In fact, to fulfill this requirement, the project uses storage batteries, cogeneration systems, renewables such as solar panels and electric vehicles. In order to manage all of them in a single system, different types of Energy Management Systems (EMS) are developed (Figure 27). Indeed, there are Building Energy Management Systems (BEMS) for office and commercial buildings, Factory Energy Management Systems (FEMS) for factories and Home Energy Management Systems (HEMS) for private homes. Moreover, the use of Community Energy Management Systems (CEMS) is useful to reach an optimal equilibrium between energy demand and supply (IUC-Japan Secretariat, 2017).

Overall, as underlined by Miura and Amemiya (2019), the main goal of the project was to control electricity supply and demand and lowering the power usage in order to be able to store as much energy as possible to be prepared in case of disasters. Indeed, between 2010 and 2014, the project provided around 4,2000 private houses with the HEMS system, 37 MW of solar panels, 2,300 units of electric vehicles and a combined area of 1.6 million $m^2$ with the BEMS system (Mahmood, 2018, p. 256).

So, basically the resilience of this system is related to the fact that every area that has been involved in the project can combine all the energy produced by the different technologies and store it in the storage batteries, therefore using it in case of disasters, because of the robustness of the system.

Therefore, the innovation of the project is to join all the different technologies together, trying to manage them in a single system for different areas. Besides, the other innovation is the fact that all of this has been done - as already said - in the nation’s largest demonstration smart city project, meaning that the effort was to implement innovations not just in a local project but in a larger area composed by three districts.

Furthermore, all the buildings built after the Building Standards Law of 1981 got anti-seismic structure in case of earthquakes (Kamemura, 2016).

Then, in relation to both acute shocks and chronic stresses, the project called the Yokohama Eco School project (YES) had the aim to increase citizen participation in the Yokohama Smart City project educating citizens about environmental issues and global warming through lectures, events, and workshops, building an aware resilient community educated and prepared in case of disasters (Nobutoki, 2016)

Finally, the project is surrounded by greenery such as green alleys which contribute to providing shadows in the three districts making cooler the temperature tackling heatwaves.

**Figure 25:** One of the three districts where the YSCP was implemented - Minato Mirai 21 (Ales F., 2019)


**Figure 26:** Buildings owned by Mitsui Fudosan that have been awarded (Mitsui Fudosan, 2018a)


**Figure 27:** The different types of Energy Managements Systems (EMS) developed (Nobutoki, 2016)

### 3.1.5 Otemachi, Marunouchi, and Yurakucho Area Management

The fifth case study analyzed is the Otemachi, Marunouchi, and Yurakucho Area Management in the Daimaruyu area. Studying the documents related to the project, visiting the case study and interviewing the project manager from Mitsubishi Corporation, it has been possible to understand the evolution and the role for the resilience of the largest international financial-commercial-business center in Japan.

The evolution of the initiative is analyzed starting from the adoption of the measures undertaken included in the Business Continuity District (BCD) plan that was designed in 2011 (The Council for Area Development and Management of Otemachi, Marunouchi, and Yarakucho, 2016). The plan was implemented in the already built-up Daimaruyu area (Figure 28), in which Mitsubishi Corporation owns most of the land (Mitsubishi Estate Group, 2013b). Therefore, it can be considered as a regeneration project.

The initiative is located in the center core of Tokyo and as underlined through an email-interview by the author with Mariko (2019), the Daimaruyu area promoted the area management of OMY to improve disaster-resilience and coexistence with the environment through a private-public partnership initiated by The Council for Area Development and Management of Otemachi, Marunouchi, and Yarakucho in collaboration with an NPO - the OMY Area Management Association – and The Ecozzeria Association (The Council for Area Development and Management of Otemachi, Marunouchi, and Yarakucho, 2016).

The adoption of the BCD plan was due to the fact that since the Great East Japan Earthquake of 2011, the Council recognized the importance to be prepared in case of future disasters and therefore it drawn up a proposal related to disaster prevention based on the advices of experts, government officials, and landowners. The proposal includes measures to become an area where business continues even in the case of disasters (The Council for Area Development and Management of Otemachi, Marunouchi, and Yarakucho, 2016).

The project is not advertised as a "smart city". However, three governmental recognitions have been given to it, recognizing the development of the initiative under the smart city concept. Indeed, in 2014 the initiative has been chosen by the Japanese Government as a model project based on the BCD plan creation and on the resilient measures adopted (Japan. Ministry of Land, Infrastructure, Transport and Tourism, 2014, pp.6-7).

As highlighted by Mariko (2019), in 2015 the Plan for Urban Regeneration and Safety in Otemachi/Marunouchi/Yarakucho Districts was drawn up and since this date, Mitsubishi Corporation has intensified his efforts to improve the resilience of the BCD area.

Moreover, Mariko (2019) continued underlying that in 2016 the government identified the project as a leading urban planning initiative in order to encourage the adoption of innovative practices in Japan, recognizing the role of Area Management to increase disaster preparedness (Japan. Ministry of Land, Infrastructure, Transport and Tourism, 2016, pp. 8-9).

Eventually, in May 2019 the government carried out an open call for smart city model projects that solve urban and regional issues utilizing new technologies and the OMY Area Development initiative has been chosen in order to be promoted by raising its business maturity (Japan. Ministry of Land, Infrastructure, Transport and Tourism, 2019, p.8).

The role for the resilience of the OMY Area Management takes into consideration the resilient measures for acute shocks and the resilient measures for chronic stresses within the initiative.
First of all, some resilient measures for acute shocks are related to the energy sector. In fact, in the OMY area there is a combination of stable cogeneration systems and emergency power generators (storage batteries), to guarantee the energy supply for all the buildings, even in case of disasters such as an earthquake. Moreover, the OMY area uses district heating and cooling systems that are earthquake-resistant because the plant and the distribution pipes are installed deep underground and they are inside resistant structures and tunnels (Mitsubishi Estate Group, 2013a).
Furthermore, there are solar panels and EVs charging stations in the area which can be used as a source of energy in case of disasters (Ecozzeria, 2012).
Besides, the area adopted intermediate-pressure gas pipes (Figure 29) with seismic resistance in order to supply the gas in every condition. Then, the area uses a water treatment facility to purify the polluted water to make it drinkable and therefore use it in case of disasters (Mitsubishi Estate Group, 2013a) and potentially it can be useful for chronic stresses as well to spread the water out in the district to decrease temperatures to tackle heatwaves.
Then, regarding to the buildings of the area, if they were built after 1981 - when the Building Standards Law was amended (Kamemura, 2016) - they have top-class seismic performance able to resist to extreme earthquakes (such as *shindo* seismic intensity of 7), while if they were built before 1981 the project provided seismic retrofitting measures

such as additional walls and wall-column reinforcements (Mitsubishi Estate Group, 2013a).
Related also to resilient measures for chronic stresses, there are temporary shelters for stranded people during disasters in common areas - such as earthquake or flooding - with blankets provision for everyone (Mitsubishi Estate Group, 2013a).
Moreover, disaster drills are held in the OMY area, during the “Disaster Preparedness Day” (Figure 30), on September 1 of each year when the companies cooperate with their employees to improve the resilience of the community within the area. Furthermore, around 70 buildings have dedicated optical fiber lines and free Wi-Fi areas to make the connection fast and easy for the people that are in the OMY area in the event of a disaster (Mitsubishi Estate Group, 2013b).
In order to tackle the heatwaves, the resilient design of some buildings in the area - such as the Marunouchi Eiraku Building (Figure 31) - have green walling and airflow windows to decrease the temperature naturally (Ecozzeria, 2012). Moreover, the creation of a network of greenery within the area (Figure 32) contributes to the same purpose (Mitsubishi Estate Group, 2013b).
Eventually, for flood prevention, there are areas of water-retentive pavement (Ecozzeria, 2012) and tide barriers (Figure 33) in the main doors of the office buildings ensuring the safety of the people (Mitsubishi Estate Group, 2013a).


**Figure 28:** The three districts involved in the Daimaruyu area. From the right side to left side, respectively Otemachi, Marunouchi, and Yarakucho area (Japan. Ministry of Land, Infrastructure, Transport and Tourism, 2014, p.6).

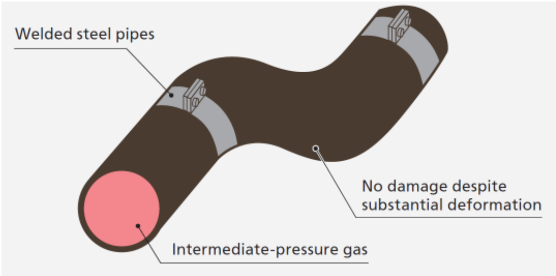


**Figure 29:** Illustration of the intermediate-pressure gas pipes implemented in the OMY area (Mitsubishi Estate Group, 2013a).

**Figure 30:** Activities in OMY area during the Disaster Preparedness Day (Mitsubishi Estate Group, 2013b).

**Figure 31:** Green walling and air flow windows systems in the Marunouchi Eiraku Building (Ales F., 2019)

**Figure 32:** Network of greenery in OMY area which provide shading (Ales F., 2019)

**Figure 33:** Flood barriers installed in a building in the OMY area, which is higher than the conventional barrier (Mitsubishi Estate Group, 2013a).

### 3.1.6 Nihonbashi Smart City

The sixth case study analyzed is the Nihonbashi Smart City project. The inspection of the documents related to the project, the visit to the site and the interview with the project manager from Mitsui Fudosan Co., Ltd. have been crucial to know about the evolution and the role for the resilience of a project implemented in one of the most important business districts of Tokyo.

Nihonbashi Smart City started its evolution in 2012 when the Nihonbashi Muromachi San-chome District Urban Redevelopment Plan was set up. Since it is a regeneration project (Figure 34), the effort was to revitalize a central urban district implementing smart city solutions (Mitsui Fudosan, 2018c). Therefore, it is located in the core of Tokyo and it unifies the public and private sectors as well as local residents and businesses (Nihonbashi Muromachi 3rd District Project Association, Mitsui Fudosan Co., Ltd., 2019). In particular, the key private stakeholder is Mitsui Fudosan that owns some of the buildings and is in charge of the implementation of the plan.
As underlined through a personal interview with Amemiya and Nakaide (2019), the project was implemented during the Great East Japan Earthquake of 2011 and due to this event, there was a blackout in Tokyo. For that reason, the project evolved toward the improvement of the energy system to deal with "blackout-proof" demand.
Moreover, the Nihonbashi Smart City Project was developed after many previous experiences of smart city projects and it is so far the last known existing smart city project implemented in Tokyo. Therefore, it learned many things from the past. Besides, in 2014, based on a self-evaluation from the stakeholders involved, the project resulted in the CASBEE S-Rank (Nihonbashi Muromachi 3rd District Project Association, Mitsui Fudosan Co., Ltd., 2019).

The role for the resilience is discussed differentiating the resilient measures for acute shocks and the resilient measures for chronic stresses. Related to the first one, the cogeneration system can provide energy in case of earthquakes up to 72-hours (Ichikawa, 2016). In fact, the Nihonbashi Smart City project is one of the first Japan's initiative to supply electricity and heat from independent distributed power sources (Mitsui Fudosan, 2018c). As mentioned through a personal interview by the author with Amemiya and Nakaide (2019) in the project there is the idea of the "duplication of electricity". This idea is based on the fact that when the electric supply fails the gas will not stop, because of the cogeneration system, and therefore it will be possible to survive with the gas power that is transformed in energy and heat. They underlined the fact that this is possible to do it only in new buildings because in existing buildings there is no space to put in the gas turbine. However - they continued - the solution provided by the project was to have a power plant into the basement of a new building which can supply all the electricity to send in the entire district. In particular, the electricity can be sent to 20 buildings. Therefore, the innovation of the Nihonbashi Smart City Project is to make resilient not only new buildings but also existing building, converting the whole area into a resilient district prepared for possible earthquakes.

Furthermore, many buildings got the latest anti-seismic structures for major earthquake up to magnitude 7 (Nihonbashi Muromachi 3rd District Project Association, Mitsui Fudosan Co., Ltd., 2019).

Besides, the project uses also resilient measures for both acute shocks and chronic stresses. In fact, there are medium pressure certified non-incendiary gas pipelines (Figure 35) which strengthen the resilience of the area, because even if the normal power grid does not work during a disaster - such as earthquakes or flooding - electricity will continue to be supplied into the area (Mitsui Fudosan, 2018c).

Moreover, the company Cisco worked in the Nihonbashi Project in the safety and security field. In fact, Cisco provided security cameras that use Al, ICT, and Wi-Fi. Therefore, in case of disasters such as earthquakes or flooding, if a person is in danger, the Disaster prevention center Cisco KINETIC for Cities (Figure 36) can detect him and he will be immediately helped (Takayama, 2018).

Then, there are temporary shelters for stranded commuters and visitors who are unable to return home in case of disasters and Mitsui Fudosan staff works 24 hours a day, 365 days

a year to respond quickly whenever a disaster may happen. Furthermore, the resilient community is crucial in the Nihonbashi Smart City project. In fact, disaster drills are provided constantly to the citizens and to the employees of the area (Tawrasha, 2019).
Finally, the use of green alleys around the area provides shades to the people and through evapotranspiration they contribute to making cooler the district, tackling heat waves.

**Figure 34:** The concept of the regeneration project (Tawrasha, 2019) and the photographs of the buildings involved (Ales F., 2019)

**Figure 35:** The concept of the medium-pressure gas pipelines (Tawrasha, 2019)

**Figure 36:** The concept of the disaster prevention center (Tawrasha, 2019)

### 3.1.7 Focus on a resilient measure: the cogeneration system for acute shocks in Nishi-Shinjuku

The last case study shortly analyzed is the cogeneration system for acute shocks in Nishi-Shinjuku. Even if the area of Nishi-Shinjuku is not considered as a "smart city project", it is crucial to examine this case study. Through the analysis of the documents of the initiative, the visit to the case study and the meeting attended with the Staff from Tokyo Gas Co., Ltd., the aim was to understand the evolution and the role for the resilience of the Smart Energy Network that uses a cogeneration system considered as the world's largest district heating and cooling center in the world.

In particular, the reason why it is crucial to analyze the Nishi-Shinjuku case study, it is because every existing smart city project that has been analyzed so far it includes a resilient measure related to the use of a cogeneration system. Therefore, the importance of this resilient measure is decisive to tackle acute shocks such as an earthquake.
The evolution of the cogeneration system of Nishi-Shinjuku starts in 1971 when the Shinjuku Shin-toshin District Heating and Cooling Center was built. In particular, the Tokyo Metropolitan Government moved in Shinjuku and due to the high energy demand from it, the system was crucial. Indeed, it provides energy to 20 skyscrapers in the area (Figure 37). Besides, it has a gross floor area of 2,200,000 square meters and freezing and heating capabilities respectively of 207,680 kW and 173,139 kW, making it the world's largest energy facility (Tokyo Gas Engineering Solutions, n.d. b).

The role for the resilience of the cogeneration system in Nishi-Shinjuku comes from the fact that through it, it is possible to transform the gas in electricity, heating, and cooling. Therefore, in case of an earthquake, if the power grid does not work anymore due to power outages, the cogeneration system will continue to provide electricity, heating, and cooling. Indeed, the cogeneration system will continue to work because of its overall robustness. Tokyo Gas promoted a disaster-resilient strategy based on the use of the cogeneration system. Beyond the provision of energy, heating, and cooling during disasters, the cogeneration system started to share the heat since 2013 through underground pipelines, thus becoming able to give the energy to specific buildings in case of needs (Tokyo Gas Engineering Solutions, n.d. b). As underlined during a meeting attended by the author with the Tokyo Gas Staff (2019) to the Nishi-Shinjuku cogeneration system, they mentioned the importance of two aspects. First of all, the cogeneration system has a mitigation function, since it reduces by 16% $CO_2$ emissions, and secondly, it has a resilient function, since it can resist even during disasters. Indeed, it has been possible to visit the actual cogeneration system and get an insight into the disaster-resistant aspects of it (Figure 38).


**Figure 37:** Supplied area from the cogeneration system in Nishi-Shinjuku (Tokyo Gas Co., Ltd., 2019)


**Figure 38:** Project model of the Nishi-Shinjuku district heating and cooling center on the left side and underground pipelines and evaporators disaster-resistant on the right side (Ales F., 2019)

## 3.2 On-going smart city

### 3.2.1 Shinagawa Smart City Project

The Shinagawa Smart City project is the last case study analyzed. Through the analysis of the documents related to the project, the visit to the case study and the different meetings and workshops attended with relevant public, private, and academic stakeholders possibly involved in the project - respectively Minato Ward Office, KDDI Corporation and The University of Tokyo in collaboration with the National Institute for Environmental Studies of Japan and the Georgia Institute of Technology - it was possible to understand the evolution and the role for the resilience of one of the most important smart city project in one of the largest built-up areas which aim to become the new gateway of Tokyo.

The evolution towards the realization of the Shinagawa Smart City project starts in 2012 when the area around Shinagawa and Tamachi Station has been designated as a “Special Priority Area for Urban Renaissance” and, in 2014, a “National Strategic Special Zone”. The reason why the area was designated under these terms was because there is an overall potential of the area based on the fact that there is an increase of international flights from and to Haneda Airport and also because in 2027 the Linear Chuo Shinkansen high-speed maglev train service will be launched. Therefore, the Tokyo Metropolitan Government published the “Area around Shinagawa Station and Tamachi Station Community Development Guidelines” in 2014 with the aim to transform the Shinagawa area as the new gateway of Tokyo.

Eventually, in 2016, some plans were approved by the city council for the Shinagawa Station Block District and for the District Around Shinagawa Station North (Japan. Bureau of Urban Development - Tokyo Metropolitan Government, 2018, p.11).

As it is possible to see in the plan about the guidelines for the area from the Tokyo Metropolitan Government (Figure 39), these two priority districts are located respectively in proximity to the Shinagawa Station and to a scheduled new station.

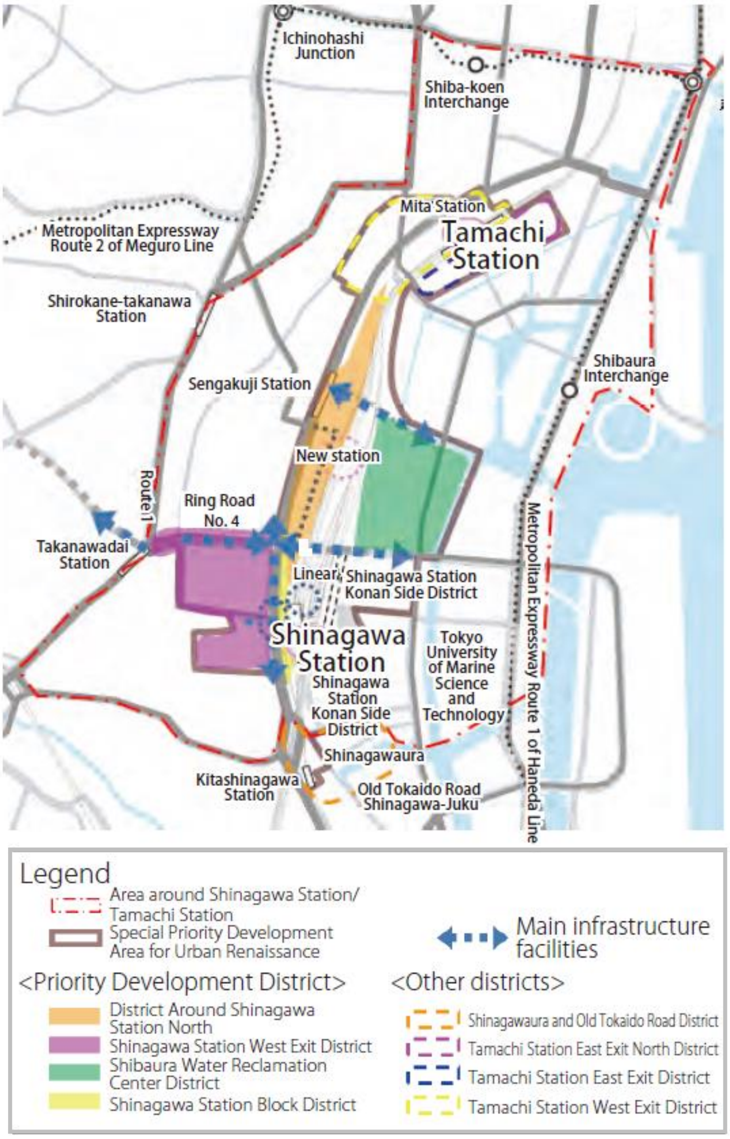


**Figure 39:** Area around Shinagawa and Tamachi stations (Japan. Bureau of Urban Development - Tokyo Metropolitan Government, 2018, p.11)

In particular the new scheduled station is called Takanawa Gateway Station and it has a strategic position, since it is located between the central Tokyo - only 11 minutes by train - and the Tokyo International Airport Haneda - only 13 minutes by train - and therefore, here is where the Tokyo Metropolitan Government aims to transform the Shinagawa area as the new gateway of Tokyo. Besides, Takanawa Gateway Station is very close to Shinagawa Station - only 2 minutes by train - and relatively close to vibrant places in Tokyo such as Shibuya and Shinjuku stations - respectively 15 and 21 minutes by train (East Japan Railway Company, 2019) (Figure 40).


**Figure 40:** Distances from the new Takanawa Gateway Station (East Japan Railway Company, 2019)

The new station, being under construction (Figure 41 and 42), it is scheduled to open in 2020 - with full operations in 2024 - ahead of the Tokyo Olympic and Paralympic Games (Kyodo, 2018). Moreover, the trains that will operate in the new station will be managed by the East Japan Railway Company (JR East).

A project has been approved for the area around the new station which is located on a 13-hectare former rail yard (Hosozawa, 2018). The invested money for the project is 500 billion Yen and it includes the development of high-rise buildings between 164 and 173 meters tall, and a 45 stories-high residential unit with 860 apartments, an international school and a commercial tower that will include a hotel, a conference hall and an exhibition center (Japan Property Central, 2018).

**Figure 41:** The area in Tokyo’s Minato Ward where the new Takanawa Gateway Station is under construction (Hosozawa, 2018).

**Figure 42:** The new Takanawa Gateway Station under construction (Ales F., 2019)

Three main policies were developed for the project in the area next to the new station:

1. Integrated station and city urban infrastructure that connects to the world and connects the region.
2. Introducing various urban functions that are suitable for an international business exchange base.
3. State of the environmental urban development led by the strengthening of the disaster prevention force (East Japan Railway Company, 2018).

Therefore, from the policies, it is possible to understand the vision of the area. Synthesizing, it aims to become the new Gateway of Tokyo based on international businesses and disaster prevention.

The Special Urban Regeneration Area designated in the former railyard next to the new Takanawa Gateway station includes four blocks. The fourth block includes two towers and it is the block where the new station is under construction. Moreover, as it is possible to see from the detailed plan from JR East (Figure 43), there will be infrastructures to facilitate the connection from the new station to the east side of the area toward the Tokyo Bay Area. In particular, the two towers in the fourth block will include offices, business center, hotels and a retail area (Figure 44). Between, the two towers there will be a pedestrian square surrounded by greenery which will represent the main area where the users of the new station will gather (Figure 45). The design of the project for the new Takanawa Gateway Station has been assigned to world-famous design offices, Pickard

Chilton (East Japan Railway, 2019a) and the Japanese architect Kengo Kuma, which will use wood throughout the station, based on the Japanese style (Jhonny, 2016).

Eventually, the project has been accepted in 2019 as an official city planning determination from the prime minister based on the review by the National Strategic Special Zone Council for the Greater Tokyo Area and by the Council on National Strategic Special Zones (East Japan Railway, 2019a).

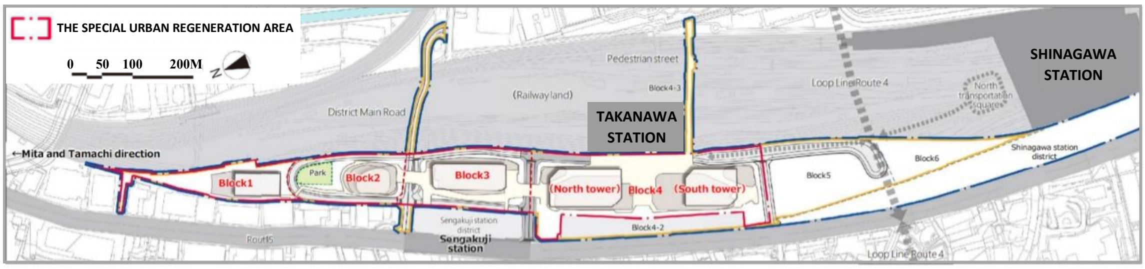


**Figure 43:** The special urban regeneration area around the new Takanawa Gateway Station (East Japan Railway Company, 2018)

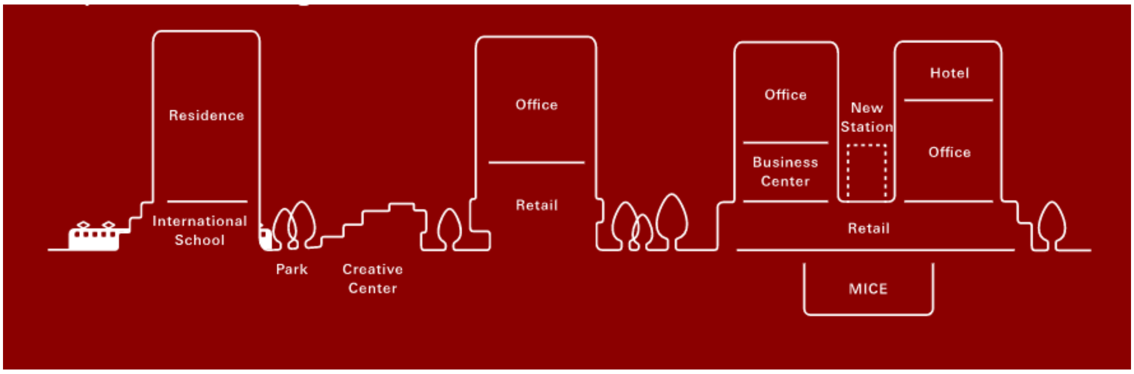


**Figure 44:** Section of the project under construction around the new Takanawa Gateway Station (East Japan Railway Company, 2019b)


**Figure 45:** Rendering of the plaza in front of the new Takanawa Gateway Station (East Japan Railway Company, 2018)

As underlined during a meeting attended by the author with Yamagata, Yang and Murayama (2019), the boundaries of the area of study where the Shinagawa Smart City project could be implemented involves the already identified special urban regeneration area where the new Takanawa Gateway Station is going to be located but it has a bigger overview. Indeed, it includes the area between the three stations mentioned - the Tamachi Station, the new Takanawa Gateway Station, and the Shinagawa Station - and the waterfront in the direction of the Tokyo Bay Area (Figure 46) where a system of canals is present (Figure 47).

Including the area on the east side of the new Takanagawa Gateway Station means that the area of study for the Shinagawa Smart City project does not include only the empty former rail yard where the new station will be constructed, but also the bigger areas around it. These areas include parts of the Shinagawa city to be redeveloped - since there are empty or abandoned spaces - and parts to be regenerated - since there are already built-up areas. In particular, on the east side of the area of study, it is possible to find industrial abandoned areas next to the waterfront, while on the west side there are already built-up wealthy neighborhoods.

Indeed, as underlined during a meeting attended by the author with Minato Ward officers and Murayama (2019), in the eastern part of the area of study it could be possible to build new buildings implementing smart city measures from scratch, while in the western part there are already projects implemented when it was introduced the Shinkansen about 20 years ago and so, in this case, it is necessary to apply the smart city measures in the existing buildings. Furthermore, as highlighted during a three-day workshop (Figure 48) attended by the author with Yamagata, Yang, Murayama and Minato Ward Officers (2019), the area of study is very fragmented, due to the fact that the land is owned by many different landowners and this creates uniformity and therefore a non-walkable and non-livable area.

Accordingly, the Shinagawa Smart City project has to take into consideration the complexity of this area, applying the smart city concept in different ways for the different areas.


**Figure 46:** Boundaries of the area of study around the Tamachi Station, the new Takanawa Gateway Station, and the Shinagawa Station (based on Hosozawa, 2018, own adaptation).

**Figure 47:** Canals within the area of study in Shinagawa (Ales F., 2019)

Besides, as underlined by Yamagata, Yang and Murayama (2019) the guidelines from the government about the application of the Society 5.0 concept should be implemented in the Shinagawa Smart City project. However - they continued - it could be possible to propose new ideas. Therefore, they underlined the importance to make a Platform about the different issues that the project has to address through the implementation of the Smart City concept, in order to explain the goals of the project and to make available the Platform as a Co-Design service that can be used for instance by practitioners. This Platform as underlined by Yamagata, Yang, Murayama and Minato Ward Officers (2019) should then be useful to co-design and therefore it should be coordinated by the planners that will involve the citizens and the possible different stakeholders that could be involved in the project.

**Figure 48:** Issues underlined during the three-day Shinagawa Studio Workshop (Ales F., 2019)

Furthermore, during the workshop, the Minato Ward officers underlined the fact that currently there is not a vision for the rest of the area of study beyond the Takanawa Gateway Station, especially financially. In fact, there is a masterplan from the City Planning Division of Minato City that says that the eastern part has to be just an industrial area. However, they said that if the big property owners of the land in the eastern part of the area of study will be interested in a proposal, the redevelopment and regeneration project based on the smart city concept for Shinagawa could start.

Moreover, they said that it is important that a proposal for this area will take into consideration all the functions within the Tokyo Bay area, making coordination with the other Wards next to Minato-ku, since the Shinagawa waterfront is part of a bigger system that plays a crucial role in Tokyo as a whole.

Concluding, the evolution towards the realization of the Shinagawa Smart City project is still long, but certainly three aspects about the project has to be considered:

**1. CONTENTS**

**The contents of the Shinagawa smart city project depend:**

- on the experiences learned from the existing smart cities in Tokyo,

- from the case studies about European smart cities,

- from the workshops on smart cities organized over time in Tokyo**.**

**2. PROCESS AND ORGANIZATION**

**The process and the organization of the Shinagawa smart city project depend:**

- on the different phases that will be adopted. Three are the main phases: analysis, implementation of the project and monitoring.

- on the new governance structure that will be adopted in Shinagawa. Based on the different stakeholders involved the project will be organized differently

**3. CONTEXT**

**The context of the Shinagawa smart city project is related to:**

- the physical form of the project, such as buildings, streets, and squares.

- the urbanistic solutions of the project: redevelopment and regeneration.

The role for the resilience of the possible resilient measures that could be implemented in the Shinagawa Smart City project is going to be discussed differentiating them in resilient measures for acute shocks and for chronic stresses. Moreover, the resilient measures will be discussed in relation to the already proposed ones in the special urban regeneration project for the new Takanawa Gateway Station and in relation to the whole area of study. The resilient measures for the new Takanawa Gateway Station, are based on the third policy adopted already mentioned, related to the state of the environmental urban development led by the strengthening of the disaster prevention force (East Japan Railway Company, 2018). Indeed, two are the actions undertaken in order to apply the policy:

1- Strengthening of the regional disaster prevention force and energy network construction.
2- Effective use of unused energy and reduction of environmental load

Based on this action the project for the new Takanawa Gateway Station foresees different resilient measures that are going to be discussed analyzing the proposal from JR (East Japan Railway Company, 2018)

The first action, for instance, foresees a resilient measure for acute shocks and chronic stresses related to the development of a temporary residential facility for 10,000 people that can be used in case of disasters such as earthquakes or flooding. Moreover, the National Road 15 next to the Sengakuji station - which is a station close to the new Takanawa Gateway Station - will be used as a specific emergency transportation road in case of disasters, in order to supply goods and portable toilets for people unable to return home, and through digital signage connected with Minato City, information about disaster will be shared among the people (East Japan Railway Company, 2018). Then the use of anti-seismic structures in the buildings, based on the Building Regulation for new constructions built after 1981 (Kamemura,2016), will provide security for the citizens in the area around the new station in case of earthquakes.

Furthermore, the second action foresees some measures for acute shocks. In fact, there will be the construction of an independent and distributed energy network that, using cogeneration systems with strong-resistant medium pressure gas and storage batteries will allow storing the energy that can be used in case of earthquakes. In addition to that, a local heating and cooling facility will produce energy as well. Furthermore, the energy can be also produced and stored from the food waste products recycling facility in the east part of the area of study, contributing to having energy in case of an earthquake. Then, the installation of solar-powered water heater facilities, solar panels and wind power facilities will contribute to the same purpose (East Japan Railway Company, 2018). Then, in relation to chronic stresses, the on-premise tree planting that will constitute a resilient measure useful to decrease the heat waves, through evapotranspiration and providing shades. Besides, there will be tree-planting on rooftops and wall surfaces as well for the same purpose. In addition to that, the implementation of high reflection pavements will allow decreasing the amount of heat absorbed by the surfaces, decreasing the temperature. Then, the use of high heat insulation of external walls and roofs will contribute to keeping the temperature cool inside the buildings. (East Japan Railway Company, 2018). Furthermore - as underlined by Minato Ward officers and Murayama (2019) - the project for the new Takanawa Gateway Station has to maintain the height of the buildings low in order to flow the wind inside the area to cool the temperature.

Another resilient measure in the project for the new station related to acute shocks and chronic stresses is the use of a water treatment facility that is located within the area of study - called Shinagawa Season Terrace - that process the polluted water in order to be stored and used it in case of disaster such as an earthquake. Moreover, the processed water can be utilized as an external air-conditioner against the heat-island phenomenon (NTT UD, 2016).

The last resilient measure discussed, has been proposed during a meeting attended by the author with Kobayashi, Miyaoka, Nakarai, Im, and Murayama (2019) and is related to the application of the 5G technology from KDDI Corporation in the area of study where the Shinagawa Smart City project could be implemented. Indeed, KDDI is currently discussing with the Minato City Office to find new funding ways in order to effectively build this tech infrastructure in Shinagawa. In particular, from a resilient perspective, the

implementation of 5G could crucially help to improve the system to contain more data and make the circulation of them faster. This will allow communicating with more people in a faster way to inform them (for instance through their smartphones) about disasters such as earthquakes or flooding, improving the overall resilience of the community.
Concluding, the resilient measures discussed for the special urban regeneration area where the new Takanawa Gateway Station will be constructed can also be used for the whole area of study of the Shinagawa Smart City project, due to the proximity to the new station and therefore to the facilities.
Besides, the new resilient measure proposed by KDDI and the other resilient measure not mentioned but already implemented in the existing smart city projects analyzed can be applied as well.
Eventually, all these possible resilient measures for acute shocks and chronic stresses for the Shinagawa Smart City project are useful to understand the overall potential and the feasibility of the project that certainly can be considered as the future of smart cities in Japan.

# 4. Comparative analysis of the case studies

Based on the analysis previously discussed about the evolution of smart cities and their role for the resilience in Tokyo, a comparative analysis of the case studies will be made.

The first part will focus on the comparative evolution in order to understand chronologically the main characteristics of the case studies individuating differences and similarities. Then, the analysis will focus on the comparative role for the resilience of the different smart cities, in order to understand which kind of smart measures adopted can be considered resilient.

The whole analysis is carried out focusing on the resilient smart measures previously individuated through the urban system design approach. Therefore, the measures that exploit the use of technology and the ones that have a traditional approach will be indifferently considered.

Moreover, as already discussed, the measures identified were chosen based on their role for resilience. Indeed, the measures were selected identifying the ones that tackle acute shocks - considered as earthquakes - and chronic stresses - considered as climate change (which includes flooding and heatwaves), and the combination of them.

Eventually, a comparative synthesis combines the comparative evolution and the comparative role for the resilience analysis made. In particular, different generations of smart city movements will be chronologically identified and each generation will be described based on their role for the resilience. Overall the comparative synthesize will be useful to individuate the evolution of the smart cities movements towards resilience in Tokyo.

## 4.1 Comparative evolution

The comparative evolution of the smart cities in Tokyo is carried out differentiating the case studies between existing smart cities and the on-going smart city. For every project, the main characteristics are identified and for that purpose, a comparative table is proposed.

As defined in (Figure 49), chronologically three are the main developments of the smart city projects in Tokyo: 2005-2010, 2010-2012 and 2019. The first two periods are related to the existing smart cities, while the third one is related to an on-going smart city. The existing smart city projects are composed by Kashiwanoha Smart City, Fujisawa Sustainable Smart Town, and Funabashi Morino City. Instead, the on-going smart city project includes only the Shinagawa Smart City project.

The first period 2005-2010 is characterized by smart city projects that can be defined as local projects developed in unused areas, thus considered as redevelopment projects.

The second period 2010-2012 includes case studies which are identified as local projects developed in built-up areas and therefore they can be considered as regeneration projects.

The third period 2019 includes an area of study where a large project in a built-up area should be developed, and within this area redevelopment and regeneration projects should be implemented.

Furthermore, every project within each period is described through two main characteristics: location and land use. The location is classified in suburban, urban and city center, and the information were obtained through an analysis of the location of every project considering the Greater Tokyo Area as the area of study. The land uses for each project are described as mainly residential, mixed-use and commercial, and the information about it were obtained through the visits to the case studies which were crucial in order to get to know to the different projects.

All this information described highlights the differences and similarities among the case studies and provide useful information that are going to be used in the comparative analysis about the role for the resilience of the different case studies.

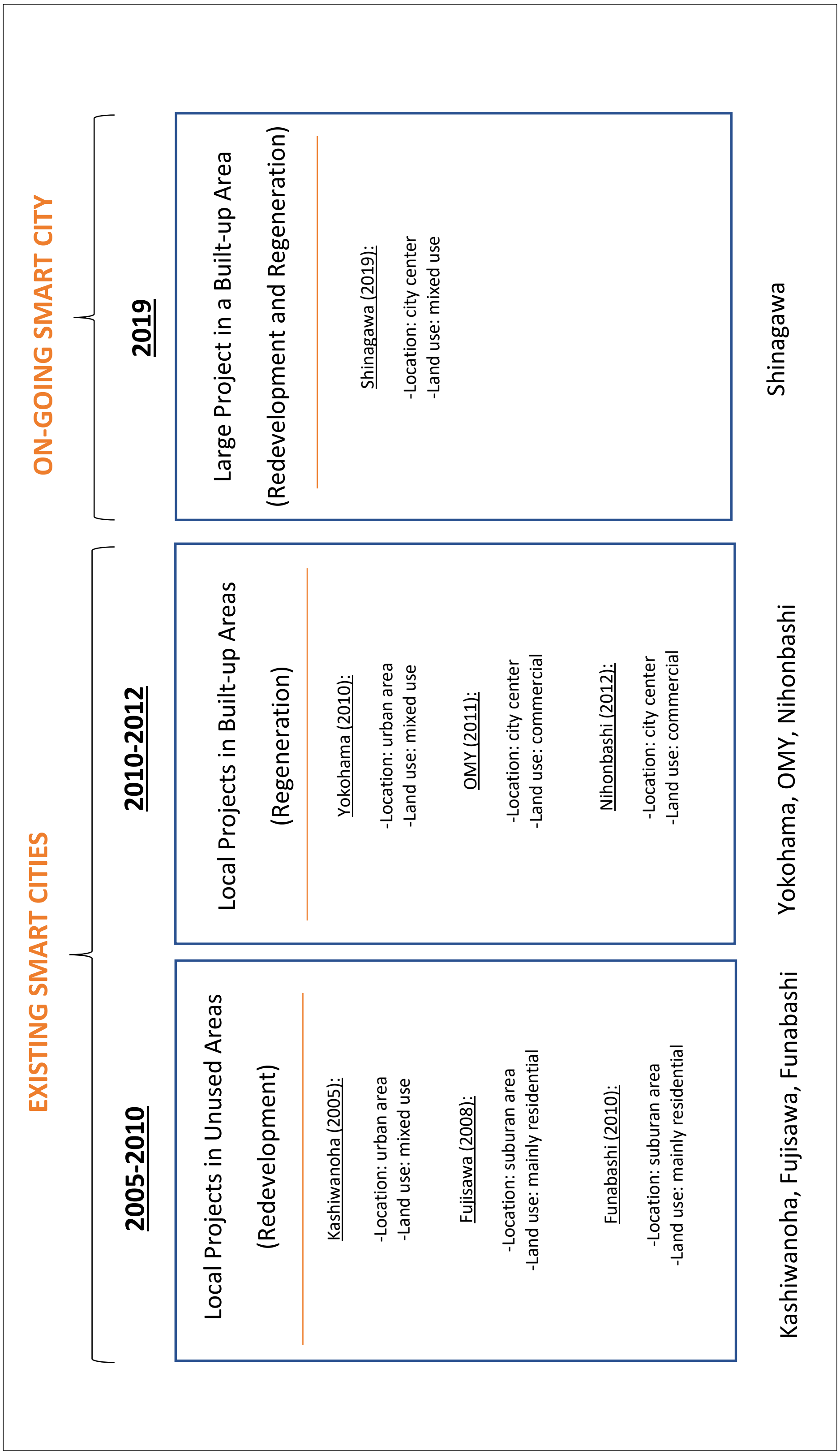


**Figure 49:** Comparative evolution table of the smart cities in Tokyo, own elaborate.

## 4.2 Comparative role for the resilience

The smart city case studies in Tokyo are also analyzed through the comparative role for the resilience, which is the next analysis developed based on the information previously discussed regarding the comparative evolution as well as information related to the different type of resilient measures. Indeed, for every smart city project, the resilient measures are identified in a proposed table, while different graphs explain the outcomes of it.

The analysis of the comparative role for the resilience of the different smart cities take into consideration the information related to land uses and location of each case study (Table 1).

| Smart cities / project features | LAND USE | LOCATION |
|---|---|---|
| **Kashiwanoha** | mixed use | urban area |
| **Fujisawa** | mainly residential | suburban area |
| **Funabashi** | mainly residential | suburban area |
| **Yokohama** | mixed use | urban area |
| **OMY** | commercial | city center |
| **Nihonbashi** | commercial | city center |
| **Shinagawa** | mixed use | city center |

**Table 1:** Smart cities analyzed and their land uses and location, own elaborate.

From this information, another analysis is carried out. In particular, all the different types of resilient measures included in the different smart city projects are individuated, differentiating them between earthquakes, flooding and heatwaves measures, and the combination of them (Table 2).

| Smart cities / Resilient measures | Ground water pumps | Storage batteries | Cogeneration system | Food waste reuse facility | District heating/cooling facility | Antisismic structures | Informations to the residents through tablets/TVs | Solar panels, wind power and orther renewables | EV charging stations | Tide barriers (main doors of the building) | Areas of water-retentive pavements | Greenery (parks and alleys) | Resilient design of the buildings/project to exploit the wind |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kashiwanoha | x | x | x | | | x | x | x | x | | | x | x |
| Fujisawa | | x | x | | | x | x | x | x | | | x | x |
| Funabashi | | x | | | | x | x | x | x | | | x | x |
| Yokohama | | x | x | | | x | | x | x | | | x | |
| OMY | | x | x | | x | x | | x | x | x | x | x | x |
| Nihonbashi | | x | | | | x | | | | | | x | |
| *Shinagawa | x | x | x | x | x | x | x | x | x | x | x | x | x |

| Smart cities / Resilient measures | External green air conditioning | Rooftop and wall greening | Implementation of high reflection pavements | High heat insulation of external walls and roofs | 5G | Free Wi-Fi | Temporay refuge for people during disasters | Strong medium or intermediate-pressure gas pipes | Disaster Lectures and drills | Specific emergency transportation road | Cameras | Dedicated optical fiber lines | Urban pond | Polluted water tratment facility |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kashiwanoha | | | | | | | | | x | | | | x | |
| Fujisawa | x | | | | | | x | x | x | | x | x | | |
| Funabashi | | | | | | x | x | | x | | | | | |
| Yokohama | | | | | | | | | x | | | | | |
| OMY | | x | | | | x | x | x | x | | | x | | x |
| Nihonbashi | | | | | | | x | x | x | | x | | | |
| *Shinagawa | x | x | x | x | x | x | x | x | x | x | x | x | x | x |

**Table 2:** Resilient measures within the smart city projects, own elaborate.

The details about the (Table 2), are explained in the legend below:

**Types of resilient measures**

- Earthquakes (red)
- Flooding (light blue)
- Heatwaves (green)
- Earthquakes / Flooding (orange)
- Flooding / Heatwaves (purple)
- Earthquake / Heatwaves (yellow)

**Origin types of resilient measures**

- x Measure (in the existing smart cities)
- x Proposed measure (from the existing smart cities)
- x New proposed measure (discussed in the meeting with KDDI)
- x Measure Takanawa (from the new station project)

**Types of project**

- Redevelopent
- Regeneration
- Redevelopment and Regeneration

Therefore, the types and origin of the different resilient measures included in the types of smart city projects are described. For the case of the Shinagawa Smart City project it is important to take into consideration that:

***Shinagawa**

Could potentially embrace:

- the resilient measures already adopted in the existing smart cities (proposed measure: x)
- the possible resilient measures that can be exploited in the area (new proposed measure and measure Takanawa: x x)

Moreover, three different methods are used in order to synthesize the information previously discussed:

1° Method (main) - Types of projects

2° Method - Land uses

3° Method - Locations

Each method relates all the information about types of projects, land uses, and location with all the types of resilient measures (earthquakes, flooding, and heatwaves). In particular the first Method is considered as the main one, since it gives a chronological analysis of the developments of the different smart city projects, while the other two methods are carried out in order to give other different perspectives.

The information that are used in the various methods are synthesized below (Table 3).

| **n. TYPES OF RESILIENT MEASURES** | |
|---|---|
| Earthquakes | 18 |
| Flooding | 11 |
| Heatwaves | 8 |
| total | 37 |

| Smart cities / n. types of resilient measures | **Acute shocks** | **Chronic stresses** | |
|---|---|---|---|
| | **Earthquakes** | **Flooding** | **Heatwaves** |
| **Kashiwanoha** | (8/18) | (2/11) | (3/8) |
| **Fujisawa** | (11/18) | (5/11) | (3/8) |
| **Funabashi** | (8/18) | (3/11) | (2/8) |
| **Yokohama** | (6/18) | (1/11) | (1/8) |
| **OMY** | (12/18) | (7/11) | (4/8) |
| **Nihonbashi** | (6/18) | (4/11) | (1/8) |
| **Shinagawa** | (18/18) | (11/11) | (8/8) |

**Table 3:** Total number of types of resilient measures and their distribution in the smart city projects, own elaborate.

## 1° METHOD (main) - **Types of project**

### Formula:

**n. types of resilient measures A / N +**
**n. types of resilient measures B / N +**
**etc. =**
**% of types of resilient measures for each types of project**

*where:*
*- A, B, etc.: are the smart cities within each types of project*
*- N: is the n. of total smart cities within each types of project*

### Results:

| Types of project / % types of resilient measures | Acute shocks | Chronic stresses | |
|---|---|---|---|
| | Earthquakes | Flooding | Heatwaves |
| Redevelopment | 50% | 30% | 33% |
| Regeneration | 44% | 36% | 25% |
| Redevelopment and Regeneration | 100% | 100% | 100% |

### Bar chart:

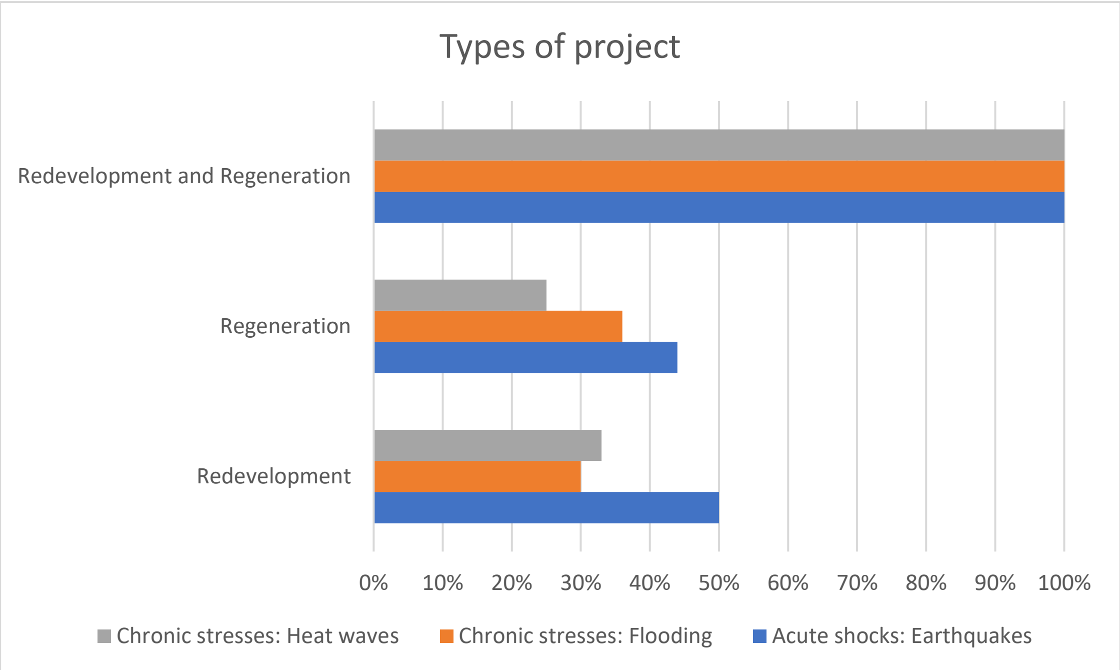


**Chart 1:** Percentages of the three types of resilient measures in the different types of project, own elaborate.

## 2° METHOD - **Land uses**

### Formula:

**n. types of resilient measures A / N +**
**n. types of resilient measures B / N +**
**etc. =**
**% of types of resilient measures for each land uses**

*where:*
*- A, B, etc.: are the smart cities within each land uses*
*- N: is the n. of total smart cities within each land uses*

### Results:

| Land uses / % types of resilient measures | Acute shocks | Chronic stresses | |
|---|---|---|---|
| | Earthquakes | Flooding | Heatwaves |
| Mainly residential | 53% | 36% | 31% |
| Commercial | 50% | 50% | 31% |
| Mixed use | 59% | 42% | 50% |

### Bar chart:

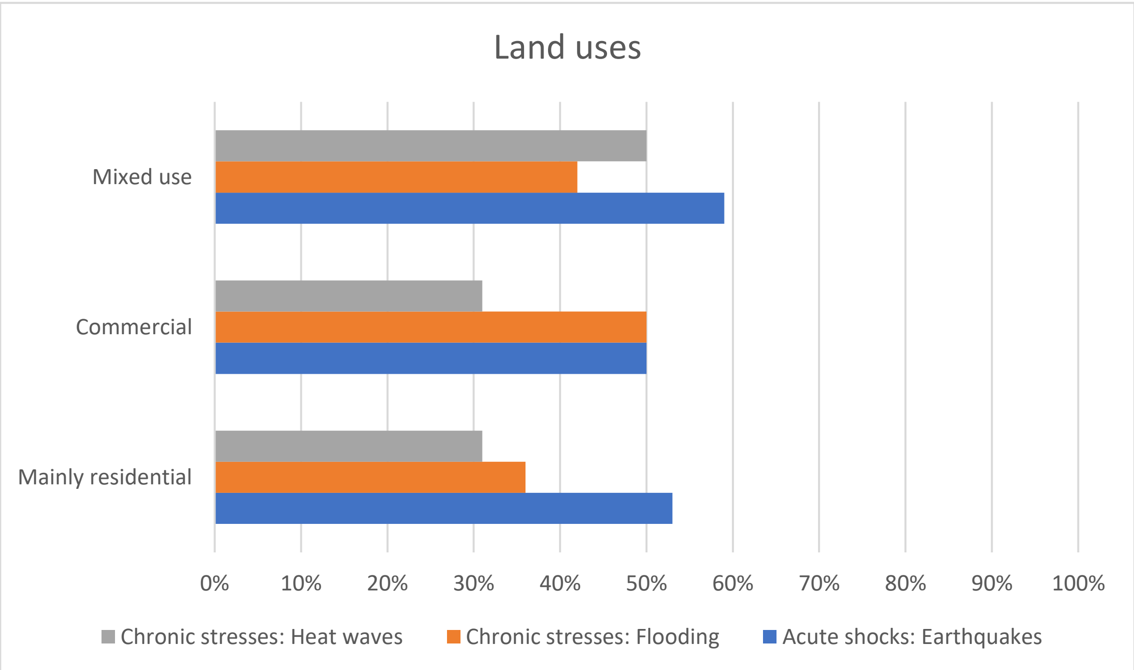


**Chart 2:** Percentages of the three types of resilient measures in the different land uses of the projects, own elaborate.

## 3° METHOD - **Locations**

### Formula:

**n. types of resilient measures A / N +**
**n. types of resilient measures B / N +**
**etc. =**
**% of types of resilient measures for each location**

*where:*
*- A, B, etc.: are the smart cities within each location*
*- N: is the n. of total smart cities within each location*

### Results:

| Location / % types of resilient measures | Acute shocks | Chronic stresses | |
|---|---|---|---|
| | Earthquakes | Flooding | Heatwaves |
| Suburban area | 52% | 36% | 31% |
| Urban area | 38% | 13% | 25% |
| City center | 66% | 66% | 54% |

### Bar chart:

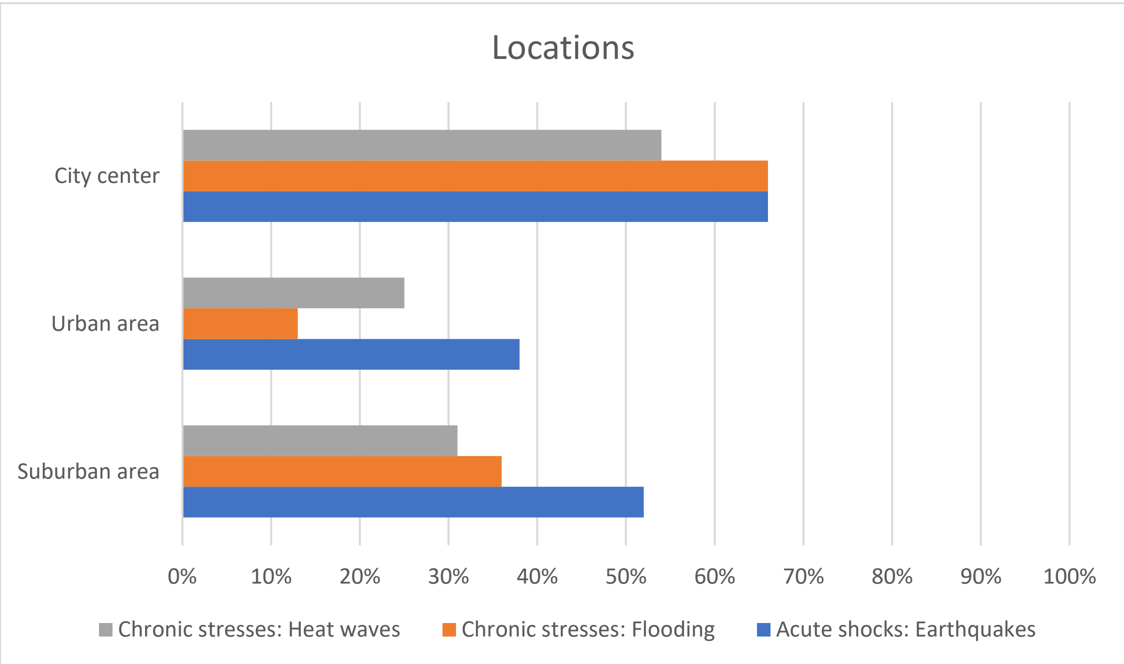


**Chart 3:** Percentages of the three types of resilient measures in the different locations of the projects, own elaborate.

Overall, each method analyzes differently the resilient measures that are included in the smart city projects considered.
In particular, the first method related to the types of projects - which is considered the main one - suggest that between the smart city projects considered as redevelopment and regeneration projects there is a decrease in relation to earthquakes measures and heatwaves measures, while there is an increase for flooding measures. The decrease could be justified since most of the earthquakes measures - such as anti-seismic structures or the use of storage batteries - and the heatwaves measures - such as the resilient design of the buildings or the implementation of parks - are hard measures that are more difficult to be implemented in regeneration projects since the redevelopment projects are developed from scratch. Instead, the increase could be justified since most of the flooding measures-- such as the use of tide barriers or the lectures and drills provided - are soft measures that can be easily improved in regeneration projects. Moreover, there is a general increase in the Shinagawa Smart City project - which is the only one considered as a project where redevelopment and regeneration initiatives take place - since all the resilient measures already adopted in the existing smart cities (proposed measures) and the possible resilient measures that can be exploited in the area (new proposed measure and the measures from the Takanawa project) could be potentially embraced by this on-going smart city project.
Furthermore, the second method related to the land uses suggest that the smart city projects which are mainly residential have a stable or little decrease in relation to earthquakes and heatwaves measures, while they all increase in mixed-use projects. This is probably due because the mix of commercial activities and people living in mixed-use projects allowed an increase in these types of measures. Differently, between mainly residential and commercial projects there is an increase of flooding measures - since there are probably more risks for commercial activities in the ground floor which are more exposed to flooding - while there is a decrease in mixed-use areas which is, however, higher than mainly residential projects.

Besides, the third method which takes into consideration the location of the smart city projects suggests that all the types of measures decrease from suburban to urban areas, probably because the projects considered in urban areas are slightly bigger than the projects in suburban areas and therefore it is more difficult to implement them. Instead, all the measures increase in the city center, since the presence of more infrastructures, people and activities require much more resilience.

## 4.3 Comparative synthesis

The comparative synthesis is carried out in order to organize all the information previously discussed about the comparative evolution and the comparative role for the resilience of the different smart city projects. Therefore, three generations of smart city projects in Tokyo are individuated.

The first method related to the types of project is used in order to do the comparative synthesis described below (Figure 50). That is because - as previously said - it gives a chronological perspective of all the smart city projects developed. Indeed, based on the differentiation between redevelopment, regeneration and redevelopment and regeneration projects, three generations of smart city movements are individuated. They are chronologically developed from 2005 to date and they are differentiated in existing and on-going smart city projects.

Kashiwanoha, Fujisawa and Funabashi are the smart city projects that are part of the first generation, while Yokohama, OMY and Nihonbashi are the smart city projects included in the second generation. Instead, the third generation is composed of just Shinagawa, which is the only on-going smart city projects.

The first generation is characterized by redevelopment projects while the second one by regeneration projects. From the first to the second generation there is a decrease of resilient measures related to earthquakes and heatwaves - since the hard measures that characterize them are easier to be applied in the first generation - while there is an increase for resilient measures related to flooding - since the soft measures typically included can be easily improved in the regeneration projects. In the third generation, instead, there is a general increase of all the types of resilient measures since the proposed measures from the existing smart city projects, and the new proposed measure from the meeting with KDDI and the measures from the Takanawa project could be potentially embraced by the Shinagawa Smart City project. Furthermore, it is important to underline that every project from each generation tend to move toward the next generations (especially toward the use of new technologies) since they are all projects that get updates over time.

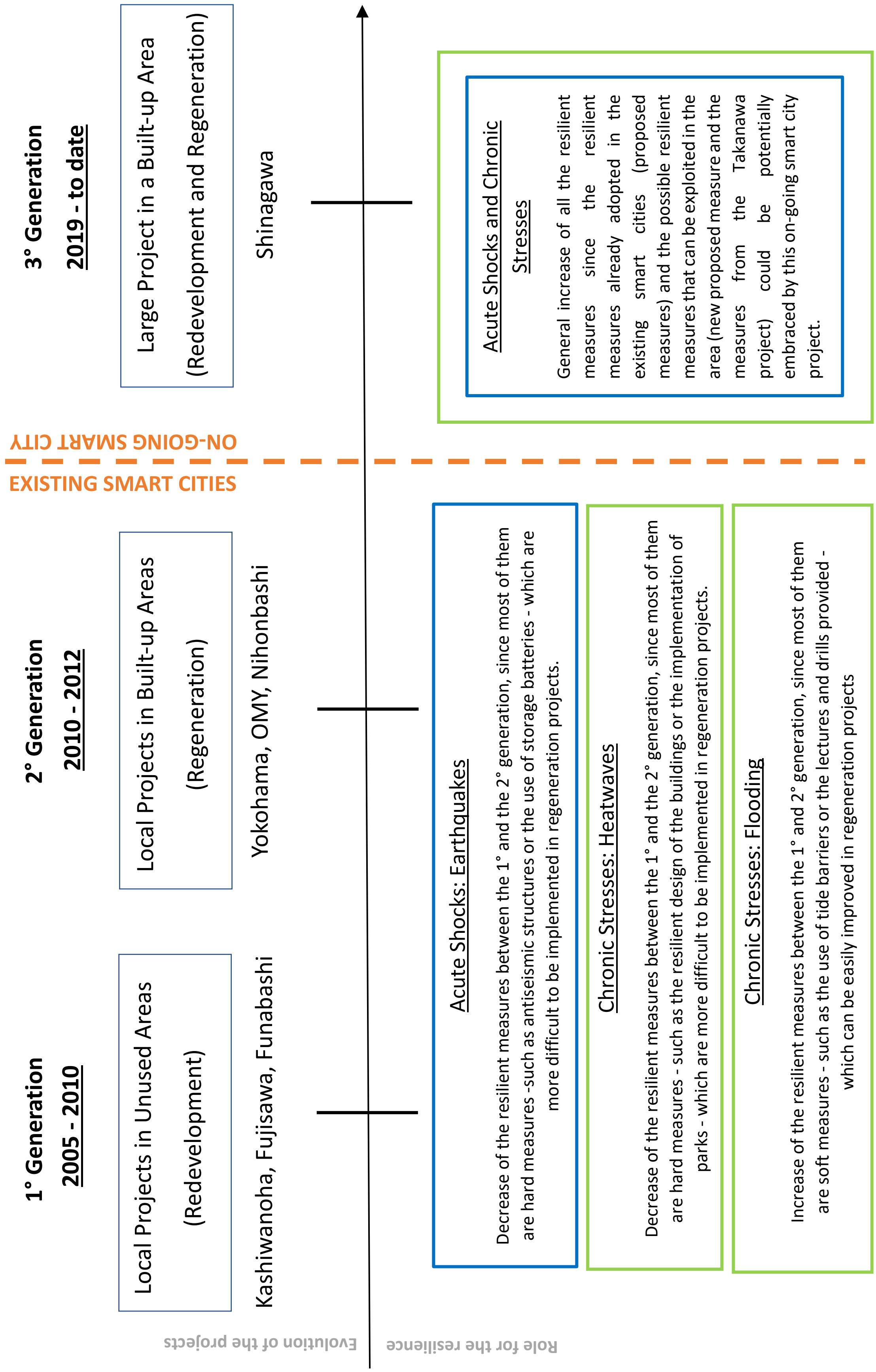


**Figure 50:** generations of smart cities movements toward resilience in Tokyo, own elaborate.

# 5. Conclusions

In conclusion, a focus on the approach of considering smart cities as laboratories and experiments is carried out and the interconnected system of smart cities generated is explained. Besides, final reflections from the overall analysis and future developments are proposed.

The generations of smart city projects analyzed in Tokyo are located in different places within the Greater Tokyo Area, they have different evolutions and different roles for resilience. Therefore, the approach of considering smart cities as laboratories and experiments seem to be suitable in order to explain the importance of considering the various smart cities as places non well-defined where new ideas take place and where these ideas can be scaled up in other districts. Accordingly, an interconnected system of smart cities would be generated within the Greater Tokyo Area, where each smart city would learn from each other for an effective overall improvement of resilience.
Furthermore, from the analysis of the meaning of the smart city concept, the definition of resilience and the relation between them, an analysis of the issues related to the discourse on smart cities and on the need for resilience in Japan was carried out. In addition to that, an analysis of the evolution and the role for the resilience of the existing and on-going smart city projects was undertaken and this brought to the identification of different generations.
The tendency of the smart city movements toward the improvement of resilience in Tokyo is good, however, some future developments are proposed.

## 5.1 Smart cities as laboratories and experiments

From the lectures attended by the author at The University of Tokyo in collaboration with the KTH Royal Institute of Technology of Stockholm, it was possible to get to know to the approach of considering smart cities as laboratories and experiment which explains how smart cities should then be considered. Furthermore, the outcome of it would be the generation of an interconnected system of smart cities that would generally improve the resilience in Tokyo.

As underlined through a lecture made by Karvonen (2019a), nowadays every city wants to be a Smart City. Indeed, from big cities such as Tokyo, Tianjin or Hong Kong to smaller cities such as Bristol, Cagliari or Stavanger there is a tendency towards the use of Smart approaches. Moreover, today there are over 1000 Smart Cities worldwide, which 500 only in China. There is an increase in their market value which tends to €200 billion by 2030. However, today's definition of smart cities is non-well defined, but their general characteristics are related to the use of technologies aim to improve the economy, quality of life and environmental condition in cities. The general formula used by them can be summarized as Measure + Analyze + Act = Smart, and this approach is most of the time focused on energy or transportation, while the rest seem not to be taken into consideration (even the use of non tech-oriented smart measures).
Overall, Smart Cities today are:

~~Imagined~~ Real

~~Novel~~ Common

~~Fast~~ Slow

~~Comprehensive~~ Patchy

~~Open~~ Closed

However, the adoption of the Smart City concept can effectively improve to run the city more efficiently, and therefore is something that we need it.

Karvonen (2019b) therefore suggest that Smart Cities today can be considered as laboratories and experiments for a new mode of urban governance.
Different names are used worldwide in order to define this approach:
-Urban Laboratories
-Living Laboratories
-Low-Carbon Districts
-Innovation Zones
-Platforms
-Testbeds
But what exactly is an urban laboratory?

*"Urban laboratories present an attractive mode of governance that foregrounds knowledge and innovation"* (Evans and Karvonen, 2014).

And what is experimentation?

*"Experimentation:*
*1. Involving a specific set-up of instruments and people that*
*2. aims for the controlled inducement of changes and*
*3. the measurement of these changes"* (Karvonen and van Heaur, 2014)

Moreover, if these experiments are successful usually they are translated into regulation, policies or programmes by the national governments.
Therefore, from the definition of experimentation it is possible to say that:

*"Part of the allure of experimentation is based on the assumption that it is possible to scale up from an individual project to the city through a process of trialling, learning and rolling out"* (Evans, Karvonen and Raven, 2016).

Eventually, there is a general tendency to move from the Rational to the Experimental City. The problem is that all these urban labs do not talk to teach other and so there is a need for more coordination between them in order to make a system and learning from each other. That is why an interconnected system of smart cities is needed. In particular planners, should connects - as coordinators - the different urban labs. Probably in the future this would be a very important part of the work undertaken by planners. By doing so, in the case of Tokyo, there would be a creation of a system where all the smart cities previously analyzed will be connected and will learn from each other in relation to new ways for a general improve of resilience in the whole Tokyo.

## 5.2 Reflections and future developments

Reflections from the overall analysis carried out are undertaken and future developments for the smart cities that tend toward the improvement of resilience in Tokyo are proposed.

The analysis of the meaning of the smart city concept underlined that different definitions are usually used and most of them tend to include the use of technologies. Indeed, the definitions seem not to considers solution other than the use of it. This underlines that there is a clear problem in the interpretation of the smart city concept since a city is considered smart only if it uses technologies, suggesting that instead of "smart" cities the smart city concept refers to "tech" cities, and does not take into consideration other smart traditional solutions.

Then, the definition of resilience suggested that crucial today's problems can be considered as chronic stresses and acute shocks and there is a need to tackle them through a resilience approach in order to survive and adapt.

The relation between them highlighted that the smart city concept could play an important role for the improvement of the resilience since both have many common aspects and similar goals and acute shocks and chronic stresses need to be solved through innovative approaches.

Analyzing the Japanese context, on the one hand the analysis underlined that the national government is pushing toward the implementation of the so-called "Society 5.0", while the Japanese companies are playing a crucial role in the smart city projects, since they own most of the land and they have their own "Smart City Strategies" usually developed through the use of tech-oriented solutions. Therefore, both the public and private sector interprets the smart city concept as an idea where the use of technologies is crucial. However, the Urban System Design concept, suggests that another approach should be used when considering the smart city concept. Indeed, this concept gives a better idea of what a smart city is since it should embrace tech and traditional solutions, in order to be actually “smart”.

Then, the resilience definition contextualized in Japan identified that climate change - considered as flooding and heatwaves - and earthquakes are the issue to be tackled.

Therefore, the Urban System Design concept is the approach used in the analyses of the existing and on-going smart cities in the Greater Tokyo Area which are examined from their evolutive processes and in order to understand their role for the resilience to tackle acute shocks and chronic stresses. The outcome of this is that three generations of smart city movements that tend toward the improvement of resilience in Tokyo are identified.

Eventually, these smart city projects within these three generations need to be considered as laboratories where experiments take place, and in doing so, an interconnected system of smart cities would be generated which would overall improve the resilience in Tokyo.

Therefore, overall it is possible to say that the tendency of the smart city movements toward the improvement of resilience in Tokyo is good since they tend to maintain or increase their resilient measures. However, it is important to underline that since Japan is a country where many tech-oriented companies are present and since they are involved in many smart city projects, they should not focus just on the energy sector - which from the comparative role for the resilience analysis seem to be the area where most of the resilient measures are focused. They should instead, exploit their knowledge more in other sectors, such as mobility, health, industry, quality of life in general and so on, in order to improve resilience from a wider perspective.

Nevertheless - as already said - the smart city concept should not consider just tech solutions but also other traditional ways of improving resilience. Indeed, this approach is partially already embraced by some smart cities analyzed in Tokyo.

In conclusion, it is crucial that future smart cities in Tokyo embrace the improvement of the use of technologies and other traditional initiatives which can effectively tend to the improvement of resilience. Moreover, considering them as laboratories where experiments take place can also trigger a process in which a system of interconnected smart cities generated allows to learn from each other in order to improve the overall resilience in the Greater Tokyo area.

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