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NO.106

Analysis of the Relationship between the Residential Distribution of the Elderly and the Accessibility to food Facilities in terms of Energy Load:

A Case Study in Hachioji City in the Suburbs of Tokyo

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Key words: aging society, family restaurants, fast food restaurants, convenience stores, National Census

Abstract: The purpose of this study is to clarify the relationship between the residential distribution of the elderly and the accessibility to food facilities. The household structure in Japan has changed since the World War II. The traditional large-scale households with multiple generations were dissolved and nuclear households became common during the period of high economic growth. Recently, the number of households consisting of an aged married couple only and the number of one-person households have been increasing. The backgrounds of this change include the increasing percentage of unmarried people, the declining birth rate as well as the drastic aging of Japanese society.

In the process of the change in the state of the families, their life style has also been changed. In particular, people used to have their meals together as a family while the style of meals has diversified recently. People now have meals outside their homes at family restaurants, fast food restaurants as well as buy precooked foods or packed lunches at convenience stores or take away lunch box stores more often than ever. This trend implies that in Japan cooking and dining, which used to be conducted at home usually, is now often done outside. The meal from external sources ratio, which is published by the Foodservice Industry Research Institute of Japan and is given by dividing the market size of the eating-out industry including the precooked food retailing industry by the total food and drink expenses of the nation, increased from 28.4 percent in 1975 to 43.9 percent in 2013. These figures show that people have become more dependent on eating out or buying precooked foods. Most popular websites for searching rental houses operated by major real estate agencies in Japan display information on access to the nearest convenience store, which suggests that many people prefer houses with easy access to the facilities for daily life, and that such facilities are

located responding to this demand. It can therefore be assumed that the distribution of residents and that of food facilities are closely related to each other. This assumption leads to the expectation that the accessibility to food facilities would be important for the sustainable urban planning of residential districts in countries including Japan where the size of households is decreasing and the society is rapidly aging.

Considering this background, a preceding study by the authors has developed a method to evaluate the accessibility to various facilities sharing the common purpose using a uniform index. This method was applied to the distribution of one-person households around the stations in Hachioji City of Tokyo suburbs. The results showed that the one-person households preferred houses with good accessibility to food facilities. However, the relationship between the residential distribution of the elderly and the accessibility remained unanalyzed despite its importance in Japanese urban planning. This study aims to fill this gap in the empirical study.

The method of analysis is as follows. The energy load of the utilization of a food facility is adopted as the index for the evaluation of the accessibility, which consists of the transportation load and the initial load. Multiple linear regression analysis is conducted to clarify the relationship around the stations in Hachioji City. The distribution of the elderly is represented by the following target valuables derived from the National Census in 2010: 1) the ratio of the persons at 65 years of age and over; 2) the ratio of the households consisting of persons at 65 years of age and over only, 3) the ratio of the one-person households at 65 years of age and over. The ratio of the households living in small dwellings with the total area of floor space not more than 29 square meters is also adopted as a t arget valuable. The accessibility to the food facilities is represented the following two types of explanatory variables: 1) the loads for the nearest cafe, convenience store, fast food restaurant, family restaurant, supermarket and take away lunch box store; 2) the distance to the nearest station. The loads are calculated in the following three cases: 1) the case of a round trip from home to the facility; 2) the case of stopping by a facility on the way from his/her home; 3) the case of stopping by a facility on the way to his/her home.

The results show that the ratios concerning the aged are high in the area of good accessibilities to cafes, family restaurant and stations, which implies that the aged households has continuously been located near food facilities for families with children even after their children became independent. In contrast, the ratio of the households living in small dwellings is higher in the area where the accessibilities to the convenience stores and fast food restaurants are higher. This implies households of smaller scale prefer inexpensive and convenient food facilities.

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A Study of Winter Wind Environment Comfort in Courtyard of Vernacular Architecture

A Case Study A Case Study of Tulou Fuyu Building in Fujian Yongding

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Key words: Wind field, Tulou, Vernacular architecture, Ecological architecture, Sustainable development

Abstract: Global warming is worsening. Therefore, indoor environment comfort has become increasingly dependent on air-conditioning systems, but the urban heat island effect speed up by the hot-air emission, which forms a vicious cycle. Vernacular architecture is a type of architecture that highlights local characteristics, emphasizing harmony with the natural environment and in line with local conditions. Tulou that is listed as one of the world heritage sites maintains a livable internal environment warm in winter and cool in summer through appropriate locations of openings and patios. People feel comfortable even without devices. It adheres to the concept of sustainable development through ecology and energy conservation, which is a good example to learn from in modern architectural planning and design.

Through field measurements and simulation wind environment comfort, this study adopted a square tulouFuyu House in Fujian Yongding whose climatic conditions and architectural forms are more in line with Taiwan's current environmental status as an example. Through comparisons on temperature, humidity, wind field the differences between the internal and external environment of the traditional communal residence were explored. The results show that tulou with windows and proper patio ventilation produced positive effects on indoor environment comfort. The design approach shall serve as a reference for future ecological building design.

1. INTRODUCTION

After the industrial revolution of the nineteenth century ,t he international style of architecture have to please the human needs and to functional requirements as design-oriented , it ignores the importance fact of local conditions (Fu, yun-song, Ni, jin-wei, Jiang, zheng-yue (2010)).

Due to the economic needs promote the rapid development of the city, their interaction also exacerbate urban heat island effect, so humans must rely on air conditioning system to regulate the indoor comfort. The environmental of energy consumption and emissions increased environmental impact. To solve the environmental damage caused by external effects, in 1992 The United Nations Conference on E nvironment and Development, UNCED, was held in Rio de Janeiro proposed sustainable development and sustainability point of view. The ecologically oriented viewpoint replace the old function (Sustainable Development Knowledge Platform (2014)), and gradually rise the concept of ecological building.

Over the centuries, people designed and built a building with engineering methods and using some ways to adapt to the local climate, materials, topography and cultural practices, and then the building was developed to fit the local environment. The definition of Vernacular Architecture for ecological building and local conditions is that ecological building is suitable for human habitation、using local natural materials, try not to use of modern energy and electro-chemical equipment；Vernacular Architecture is the original architecture or traditional houses which did not be contaminated by modern civilization. Tulou used immature soil as building material, in addition to resist foreign aggression in the form of construction, more use of the soil itself by capillary action , so that the building can be self-regulation , to adapt to modern climate change, to make the living environment pleasant , successful interpretation eco-building spirit

The studied subject which I have chosen is the Tulou Fuyu Building with wufenglou style located in Fujian Yongding. The Tulou is one of the World Heritage. Starts from the view of how to make human body more comfortable by the wind field, and survey the influence of Tulou on environments. Through the analysis and discussions, we have learned that the evolution of Tulou, and how it to accommodate the changing of environments. That would be great to use that for ecological building design in the future.

2. BACKGROUND OF THE CAES STUDY

2.1 Tulou

Fujian Tulou appeared in the Tang, Song and Yuan Dynasties and continued ever since, the construction and development process and western Fujian Hakka history and culture are closely related. (Li Xie, Ya-Fen Von (2011)) Experienced several large-scale migrations after the chaos in Yongjia, created the clans and settlement of foreign and largely closed life (Li-Dong Chen (2005)). Tulou mainly distributed in the subtropical climate zone of lower latitudes, most built in the hilly areas, mountain valley and basin. (Han-Min Huang (1994a))

With thousand years of history in a strong defense of Tulou, because the concept of equality of ethics and group life and other factors, creating diverse architectural form and space characteristics. In addition, use the sedimentary soil as construction material, make the interior environment is warm in winter and cool in summer, become a v ernacular architecture of eco-building with elements. (Ying-Ming Su, Tz-Yue Yang (2012))

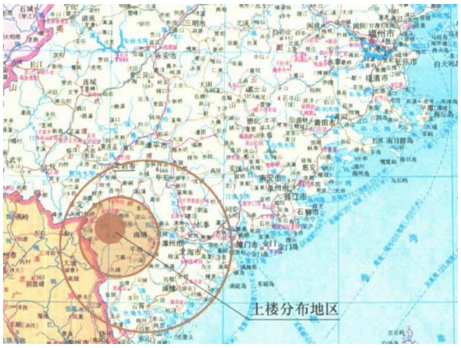


Figure 1. location about tulou

Figure 2. Tulou

From: China Architecture & Building Press (2010)

Tulou building form originated from the Central Plains of the North courtyard houses, transformed from Wufenglou into round forms, affected by geology, climate and the prevailing social environment in Fujian. Round building, square building or Wufenglou, "interiority", "symmetry" and "axis-symmetric layout" in the interior space is associated with customs and life philosophy. (Han-Min Huang (1994b))

Round and square Tulou divide into corridor style and units of formula. Within the corridor style is mainly Minxi Hakka inhabited architecture, unit type is mainly inhabited by Minnan buildings in the community. Both of them appearance are similar, but the layout is two different patterns. (Dong Liu, Qi Tang(2009))

Tulou main material is constituted by sedimentary soil, is one of the earliest in the materials used. Adapts to the local climate and geographical environment, is a regional eco-building. With rammed earth technology and special structure design, load-bearing wall of the building thickness up to 1 m, and has the following advantages listed in Table 1 (Tz-Yue Yang (2013))：

Table 1 Concept of Tulou

Structure:	After being rammed earth walls strength up to 4MPa~8MPa can effectively disperse soil building load, combination of masonry foundation and the wooden structure of the pinning force, fire and earthquake of up function, , can also resist invasion of strong winter the northeast monsoon.
Comfort:	Due to high specific heat, material of earth has superior heat and insulation to facilitate building warm in winter and cool in the summer and the living environment. Immature soil with large porosity that can absorb moisture in the air, the wall can adjust the heat dissipating, calendar in adapting to mountain humid climate.
Recycling:	After the waste can return to nature and achieve the purpose of recycling and utilization of natural resources and ecological balance.
Suitability:	Exempted from pests erosion makes the main structure is not destroyed and long regulate the physical environment, further to preserve the natural environment and harmonious coexistence.

From：Tz-Yue Yang(2013)

2.2 Wind Environment Comfort

Good ventilation design is the prerequisite of reduce the building energy consumption from the air conditioner, the most natural construction of energy-efficient practices, and the most important to green building climate control Strategies. (Hsien-Te Lin(2006))。Changes in air flow around the building is very complex, influenced by many factors, including architecture geometry, Surface projection of building, wind direction, nearby buildings... etc. (朱佳仁，2003) Air temperature and humidity can adjust the air flow distribution by natural ventilation, and rule out unhealthy indoor air and pollutants. If the air current into the interior without affecting the comfort of blowing through user activity area from buildings openings, can improve the body's heat, excess heat and moisture outside, makes human feel cool.

Air Velocity effect on the human body and operation as table 2.

Table 2 Effect on the human body and operation

Air Velocity (m/s)	Effect on the human body and operation
0~0.25	Imperceptible
0.25~0.5	Pleasant. Not affect the work
0.5~1.0	Pleasant. Need to beware of the tissue to be blown.
1.0~1.5	Slightly annoying wind hit. Grass surface and the paper is blown. Obvious wind hit. Thin paper be drifted, thick stock be blown.
1.5~7.0	Appropriate path required to correct air volume and wind control to maintain good and health working conditions

From: Rong-ping Lai (1980)

The skin temperature will cause heat transfer and change with the external environment when the skin exposed to the external environment. As air velocity speed can make skin temperature drops more rapidly, there will be closer to the air temperature. For human, comfort of low-temperature environment influence by the temperature difference, and wind speed are closely related. Therefore, the breeze into the room not only can take away the surface heat of the human, but remove indoor pollutants, increase of ventilation rate at indoor air. Enhance humans indoor comfort range to reduce the use of cold room does reach the goal of energy-saving.

This study focuses on promote natural ventilation effect of use the wind guiding at courtyard, with the air velocity as the most important factor of environmental comfort.

3. METHODOLOGY

This study measured physical environmental factors including to air velocity, average air temperature and relative humidity at the indoor environment and outdoor space. The experiments to measure wind environment of comfort at Tulou, thereby investigate the form, structures, construction materials and other factors.

3.1 Fuyu Building

Fuyu building, an outstanding representative of mansion style at Yongding Tulou, is located in Yongding County of Fujian Province Hong Keng Village.

Yongding is in the vicinity of the Tropic of Cancer (24 ° 40'N, 116 ° 58'E), the average annual temperature in 20-21 ℃. Smaller temperature difference between winter and summer, but with a larger month gap between high and low temperatures and abundant rainfall (Fujian Province Local History Compilation Committee (1994)). The annual average wind speed is 13.89km/hr, revailing wind is northeasterly only in the summer from the southwest, relative humidity is 72.52% (weather underground(2014)).

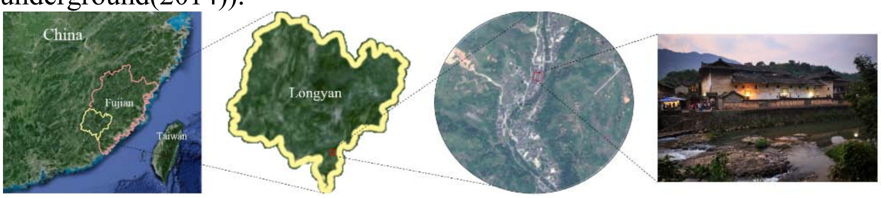
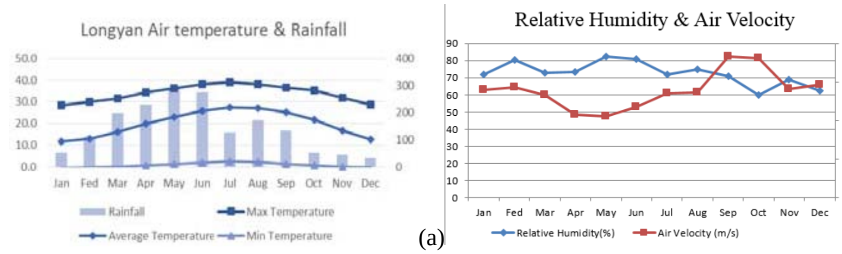


Figure 4. Location of Fuyu Building



(a) (b)

Figure 5. weather information in Yongding

(From: Thematic Database for Human-earth System & weather underground)

Fuyu building covering more than 7000 m², antechamber for the building of two floors, as the ancestral hall use, there are five floors at the main hall, with Horizontal house on both sides of the cross-connected, high buildings around the enclosure constitute a more defensive layout. Is kind of form of variation excessive. The front, main and back the hall raised the roof higher by layers, roof slope steeper than other types of Tulor. The passage and rooms constitution six courtyards, courtyards are 2 floors high on 2 sides, 3 units of wings, the back hall is 9 units, divided into three units, each 3 units. The stairs of every floor is in the front of the halls. There are two rooms in the back part of the halls. The structure is the same in buildings are over two floors. There is an attic on the top of the halls. There are both a well on left and right sides of the main hall. The cross floor which connect front and main hall is 6 meters tall, is made by bricks and wood. And it is bilateral is kind of Interior Corridor. There are bungalows made by bricks and wood out of the bungalows. It's also bilateral. They are use as restrooms, sties, warehouses, and mills. (Han-Min Huang (1994c)) 。

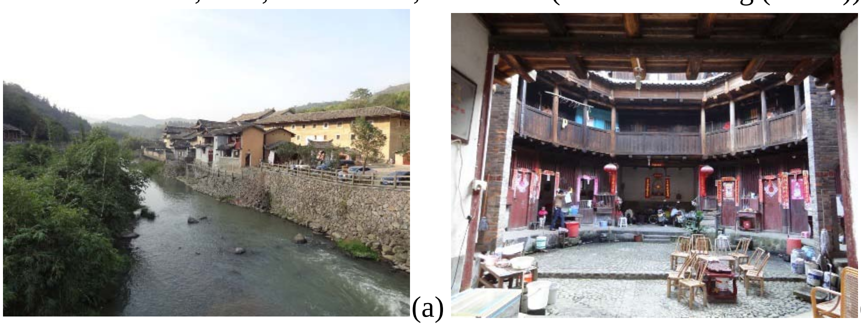

(a) (b)

*Figure 6.*Ssituation

2.1 Field measurement

A period of continuous measurements took place in 2013, from 9:00 on November 19th to 09:00 on November 20th. Measurements were taken of autumn, the rapid temperature change and low temperature, in key positions at the measured points to measurement of 24 hours. Experiment data to comparison of different spatial differences, were measured at 1.5m height, which will range of pedestrian comfort by the wind field as benchmark. Comparison of different spatial differences and observed regulatory of physical environment at Tulou in different periods.

Figure 7 shows the status of environment images of passage, front yard and courtyard in Fuyu Building. The coordinates of 20 monitoring point, for the sake of experimental accuracy, the principle is increase the measuring point.

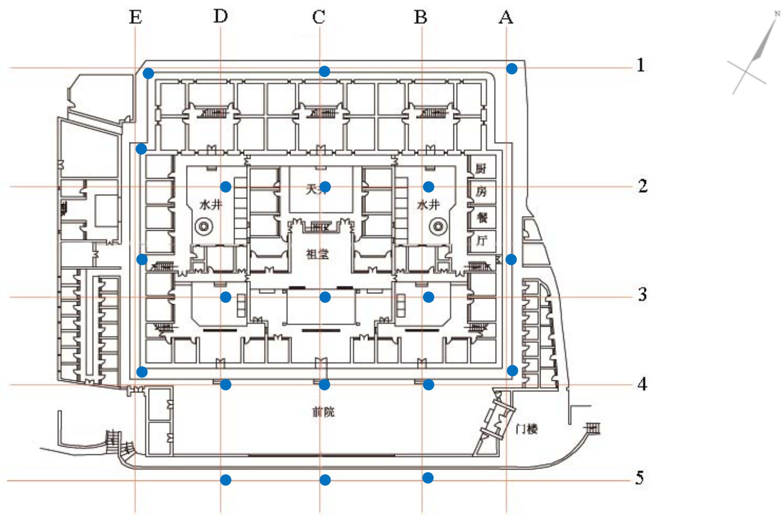
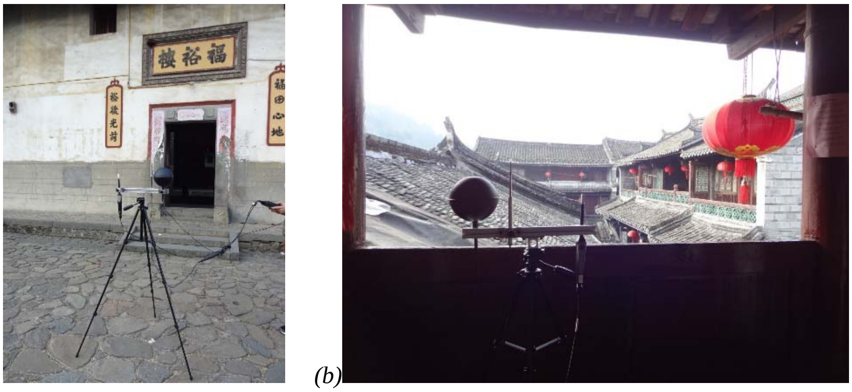


Figure 7. Measuring point

In this study, the total velocity magnitude and air temperature of the air were measured by a thermal flow velocity sensor and irrespective of flow direction as well as a relative humidity sensor The related accuracy values of air velocity magnitude and temperature were within 0.03 m/s and 0.5 °C, respectively, in the measuring ranges of 4-10 m/s and-20 to 70 °C. To avoid the effect of device to moving cause airflow disorder, the measuring period was at least 10 min duration with the data recorded 1 second for each every point Moreover, the mean radiation temperature was recorded by a globe sensor globe diameter of approximately 150 mm) with the accuracy of 0.5 °C. Having all instruments installed on a tripod, the aforesaid probes were connected to a multi parameter indoor climate meter (Testo 480) for accurate measurements of the flow velocity, temperatures and relative humidity (Figure. 8). Based on the above data obtained, the data will be used to evaluate the high-rise building arcade in summer and autumn wind environment. ◦



(a) *(b)*

Figure 8. Measuring Ssituation

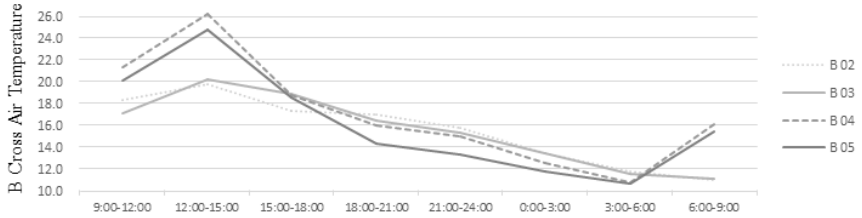
4. RESULTS AND ANALYSIS

4.1 Air Temperature

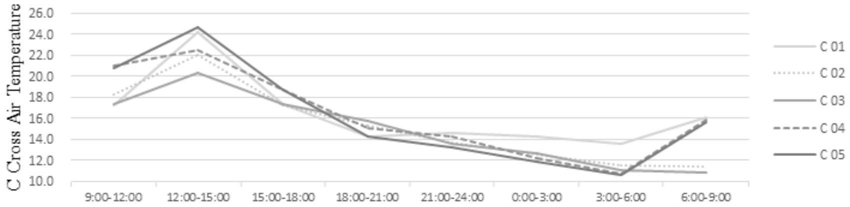
Air temperature measurements results as shown in figure 9(a)~(c), between 10.6~26.5 ℃. Monitoring point B-05 had the maximum temperature up to 24.8 ℃ at noon. Monitoring point B-05, C-05 and D05 had minimum temperature is only 10.6 ℃ at 3:00. 14.2℃ temperature different from day and night. Due to adjacent waters and the impact of geographical environment,. The temperature during the day won't be exorbitant pass through evapotranspiration. After nightfall, dew point lower, condensation effect makes temperature plummet. Resulting in larger temperature difference between day and night As shown in figure 9(d), the highest temperature 26.5℃ at monitoring point D-04 at front yard afternoon. The lowest temperature 10.6℃ at monitoring point D-04 before dawn. About 15.9℃ temperature differences, is the region's highest temperature difference between day and night. According to figure 9(e), temperature around the building part of the corridor and front yard dramatic changes. In comparison the courtyard inside the building more stable ambient temperature changes. Monitoring point C-02 at courtyard is approaching windward side had the highest temperature 22.1℃. The lowest temperature 11.0℃ appeared at early morning. Due to windward side blocked by architecture volume, monitoring point B-03, C-03 and D-03 had smaller in temperature changes. Wherein monitoring point C-03 had most moderate temperature changes in six months, due to its position located in central axis of the building, had less affected by the architecture volume on both sides.

The overall temperature of the highest temperature occurs in the afternoon slot, after the sunshine can't continue to provide heat with blocked by the mountain, rapid temperature drop. Due to thermal radiation dissipate in the afternoon, outdoor temperature begins to lower than indoor temperature, in the evening the temperature drops speed is gradually leveling off until sunrise. Temperature will rise again.

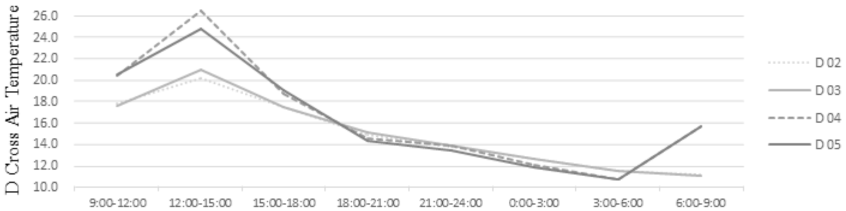
(a)



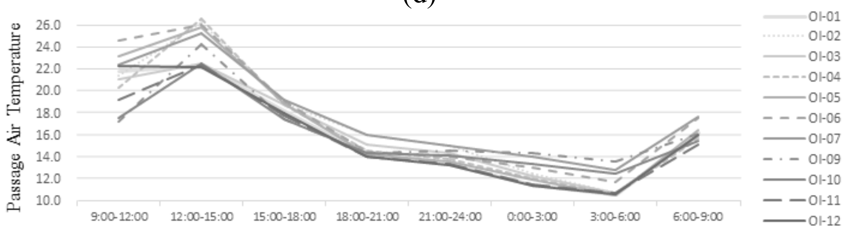
(b)



(c)



(d)



(e)

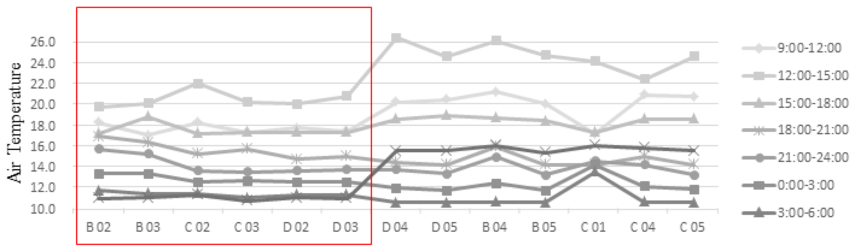


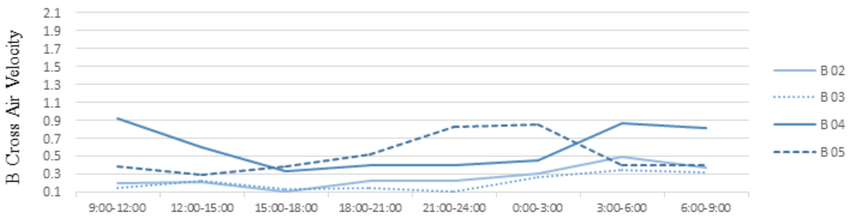
Figure 9. Air Temperature

4.2 Air Velocity

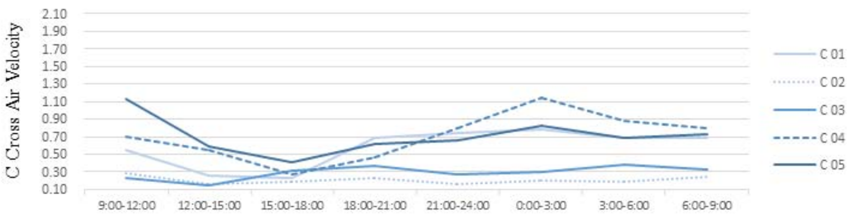
Measurement result of air velocity as shown in figure 10. The average air velocity between 0.11 m/s ~ 2.09 m/s. Figure 10 (a) ~ (c) shows result of outdoor air velocity measured is stronger, day and night had quite different wind speed, wind speed between 0.20 m/s ~ 2.09 m/s. According to figure 10(d), air velocity increase because of monitoring point E-04 opening is unblocked, effect of temperature difference between land and water and mountain breeze appeared maximum air velocity 2.09 m/s at noon. As figure 10(e) shows that front yard monitoring point D-04 adjacent waters affected by the temperature difference between land and water, formation windward side vortex make the wind speed increases because of blocked by building, higher than B-04 and C-04, monitoring point D-04 had maximum air velocity 1.18 m/s in the morning. Monitoring point B-02 had maximum and minimum air velocity, maximum air velocity 0.49 m/s appeared at 3 Am, minimum 0.11 m/s appeared at 3 Pm. By the drop in temperature, the amount of building body and the courtyard effect thus courtyard air velocity has more than 0.2 m/s, slightly higher than the others. Due to the impact factor less at monitoring point C-02, the wind field is more stable because obstruct by the front of living space and the ancestral hall.

The case study of the winter prevailing wind is north easterly winds, but barrier by the mountains and buildings group at the northeast, so windward side of the occasional monsoons air velocity is lower. The main reason for the change of air velocity variation as mountain valley wind, land and water temperature difference formed. Significantly affect the waters of the same court and before the opening parallel to its normal direction.

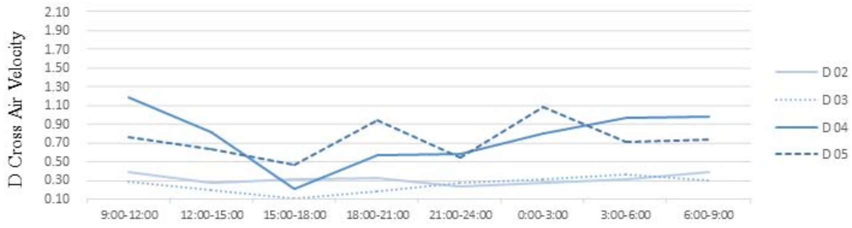
(a)



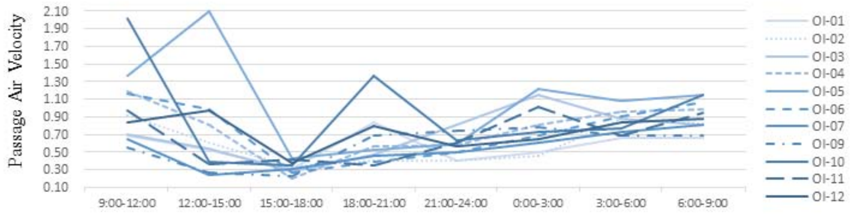
(b)



(c)



(d)



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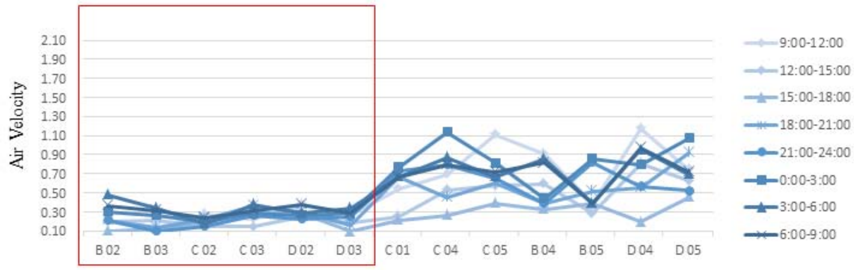


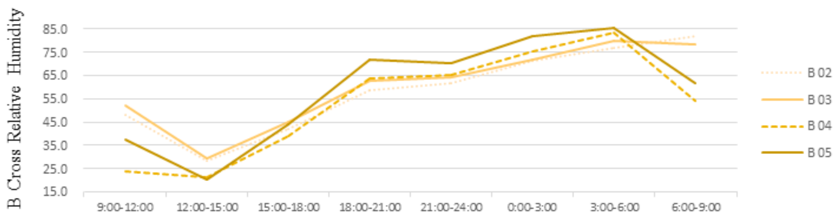
Figure 10. Air Velocity

4.3 Relative Humidity

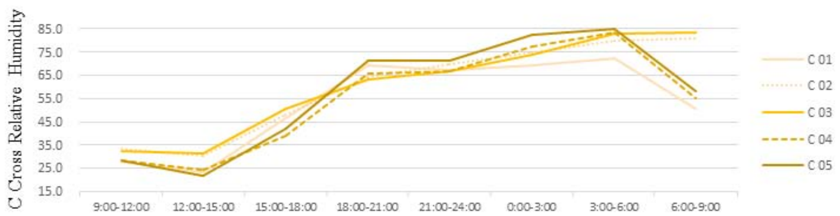
According to measurement results of relative humidity are shown in Figure 11, t he average relative humidity between of 20% ~ 86%. The measured results as Figure 11 (a)-(c) show the lowest relative humidity in the afternoon at outdoor space. Monitoring point D-05 under the influence of E-04 is the windward side moisture in the air is blown by the faster wind. The evapotranspiration is intense by sunshine, so that the minimum humidity occurred at noon was 20.4%. As shown in figure 11(d), the windward and leeward corridor humidity have great difference at the same time. Especially at 3:00, the maximum humidity 84.9% at monitoring point A-04 and the minimum humidity 72.2% with the difference of 12.7%. There are a large number of moisture in the wind thus the humidity rises when convection of the temperature difference between land and water valley wind and form of interaction. In addition to measuring point A-04 is located outside the windward side, also in building body to corner position make high humidity. As shown in Figure 11(e) shows, point B-04 only humidity had 23.6% at noon. By adjacent opening effects, front yard humidity is lower than the outdoor. Humidity began to rise when the afternoon sunshine was bloke by mountains, , until the morning after sunrise decline. In the courtyard, the humidity changes relatively ease. In the afternoon session the monitoring point B-02 and B-03 due to the terrain is steep, mountain breeze s n ot easy to enter, and therefore the two courtyard's humidity is higher than the other four.

From Figure 11 can be seen a turning point at noon, the temperature began to decline and the humidity increased at the same time. The outdoor humidity becomes greater than the ambient humidity inside the building in the afternoon. Monitoring point C-02 humidity relatively stable, the environment belong more comfortable courtyard because it did not face the wind rise and no well to influences.

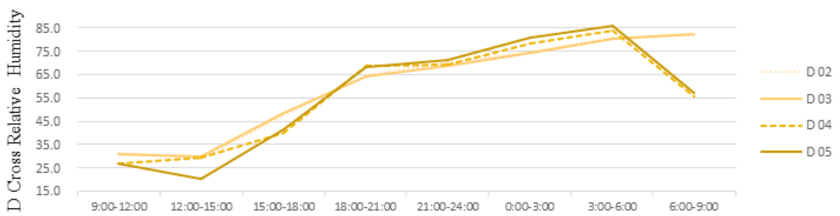
(a)



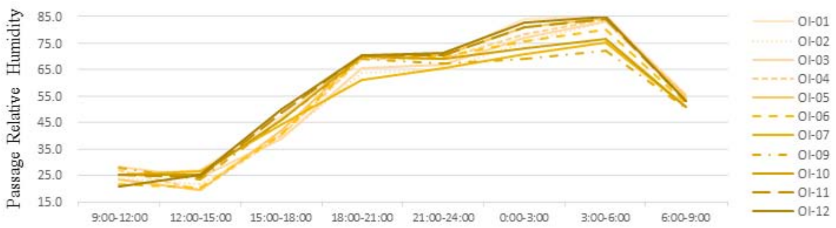
(b)



(c)



(d)



(e)

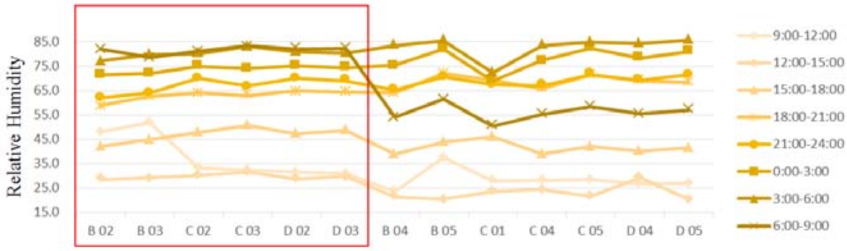


Figure 11. Relative Humidity

5. CONCLUSION

According to the results of this study show that Fuyu building is located in the valley, east and west sides is restricted by mountains and buildings block group, front yard close to the water, so the original winter northeast monsoon less effect on architectural volume. Main influencing factors to the wind field is caused by the wind from valley and surface temperature between land and water convection. Because Fuyu building is parallel with the waters of the antechamber, nave and purlin height increasing layers, the wind can be effectively introduced into the atrium space although it has external closed of architectural form. Self-regulating environment microclimate inside the building can improve e internal cycling of natural ventilation effect of wind field, interior environment less prone to discomfort of air stagnation. Surrounded by construction volume plastic out of the Atria can provide a good barrier to block the invasion of external wind, reducing the temperature difference between day and night, in the cold winter has a warm effect and reduce the incidence of cardiovascular disease. Courtyard design which can be proved with adjustable micro-climate of indoor environment, regardless of changes in the external space wind farm, neither vulnerable atrium space its effects, make the internal micro-climate more stable. In the premise of use mechanical ventilation to providing a more healthy and comfortable living environment and achieve the best benefit for natural ventilation.

Tulou as world heritage of the vernacular architecture put to good use of geographic conditions to ensure that the building interior environmental quality remained stable Appropriate to local conditions, echo good for the environment, and reduce the negative impact of the physical environment through the use of its architectural forms and materials. Local materials would reduce transport energy consumption, energy of consumption and environmental impact during construction. Materials of Building use is also extremely high. In accordance with the ecological environment is currently actively promoting the sustainable development concept. It belongs to ecological building of prominent case can be used as reference for the design of future ecological construction.

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NO.112

Road Network and Crime

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Key words: Crime Prevention, Space Syntax, Road Network, Safe City

Abstract: As the anxiety of citizens is growing due to the continual occurrence of crime threatening our valuable lives and properties, the measures to prevent crimes are keenly required. In the meantime, various approaches for the prevention of crimes have been undertaken across the world. However, in view of the fact that crimes are frequently occurring on the road, this study focuses on t he relationship between the road networks and crimes. J City in Korea was selected as a cas e study and for the analysis of the road networks, this study adopted space syntax theory. Three space syntax parameters were calculated; 'Connectivity', 'Control', and 'Integration'. Then, we investigated the relationships between crimes happened along with the individual road for three years, 2008, 2011, 2012 and with the three space syntax parameters by regression analysis. The study results demonstrate that 'Integration' would have the most significant positive effect on crimes. In terms of the 'Connectivity' and 'Control', they both have positive correlations with crime occurrence too. However, 'Control' has a w eak correlation with crime. The findings suggest that the creation of a safer city from crimes would be realized depending on the careful design and development of road networks.

1. INTRODUCTION

A lot of social problems regarding the environment, traffic, safety are occurring in the process of urbanization. In particular, the anxiety of citizens is growing due to the continual occurrence of crime threatening our valuable lives or properties. Therefore, the measures to prevent crimes are keenly required. In the meantime, various approaches for the crime prevention have been undertaken across the world.

However theoretical researches on crime prevention have been approaching from the three fields; Routine Activities Theory, Situational Crime Prevention Theory, and Defensible Space. In addition, the Crime Through Environmental Design (CPTED), emphasizing improvement of urban physical environment, has been collecting researchers' concerns recently. Moreover, with the emergence of the smart Ubiquitous City (U-City) using information and communications technology (ICT), U-service as a key element of the U-City has been developed, and especially new attempts such as U-crime prevention or U-security service are rapidly developed and provided to the citizens (Moon, 2014). In the same way, a variety of approaches have been made for the creation of safer living environment, but they do not reach a satisfactory level yet. In this regard, this study focuses on the physical environment of urban space to analyze the relationship between the urban spatial structure and crimes for the creation of safer city.

From the perspectives of urban planning, major urban spatial structure is framed by land use planning, and road networks also become an essential factor to form an urban spatial structure. Therefore, the purpose of this study is to analyze the relevance of land use and road networks with crimes. There are a number of studies such as Jung et al. (2010), Heo and Moon (2011; 2012) in terms of the relation between the land use and crimes, while studies on the relation between the road networks and crime are not sufficient. Thus, this study aims to conduct an empirical analysis about the relationship between road networks and crimes targeting case area by using the space syntax which can quantify spatial structure focusing on road networks on the assumption that the different types of road networks would affect the different patterns of crime occurrence.

The study city is J City, which is one of typical medium-sized cities in Korea. However, it made an empirical analysis only on a part of the city, where residential areas and commercial areas are intermingled without special environment with a proper level of crimes happening to such an extent as to analyze. For the analysis, first of all, space syntax was applied to identify spatial structure focusing on the shape of road networks in case area. In terms of space syntax, three indicators; integration, control, and connectivity could be calculated with the axial map of road networks. Then, these indicators and numbers of crime occurrence on individual road were compared to test the assumption that there would be relationship between the form of road network and the crime occurrence.

Space syntax was utilized to explore the urban spatial structure after being developed by Hillier et al. (1984). Study cases are quite a few, but studies exploring the relationship between space syntax and crime occurrence are not so many. As a case study, Jung and Kim (1997) conducted analysis to find the relationship between the physical environment of the street structure and crimes in the case of detached housing areas. They discovered the factors to be considered in the planning of the detached housing areas. The characteristic thing is that they collected the sentencing of the court case from 1991 to 1995. The study results reveal that the crimes of housebreaking becomes higher as the connectivity of space syntax gets lower, while as i ntegration is higher, the crimes of housebreaking gets higher.

Lee et al. (2007) analyzed correlation between spatial structure and crimes targeting residential areas in the C City. The results show that higher connectivity on the roads had a positive correlation (+) with the increase in the crimes of housebreaking, while higher control and integration had a negative correlation (-) with the decline in crimes. They suggested these findings to be referred when planners decide the application sites of CPTED theory. Hong (2014) selected 54 target areas with the theory of environmental criminology, and conducted an analysis using crime data and space syntax. The study results identified that the occurrence number of night-time robbery and theft had a negative (-) correlation with integration, while the number of day-time robbery, and theft, and sex offenses had a positive correlation (+) with integration. In the case o f Nubani and Wineman (2005), they indicated that there were a correlation between integration and robbery, while Manuel (2007) argued that residential burglary and car theft would have a correlation with integration.

As mentioned above, there were a few cases of analyzing the relationship between spatial structure and crime occurrence, but those cases needs to be complemented and additional studies are required for the theoretical generalization because their results are different slightly according to the study areas.

2. ROAD NETWORKS AND CRIMES IN CASE CITY

J City has the population of 340,241 in 2014 and the road networks are characterized by Figure 1. J City is a typical medium-sized provincial city in Korea and holds stable urban characteristics without major social and urban morphological changes. Built-up area is separated naturally with the north, south, and east due to the river crossing the downtown area.

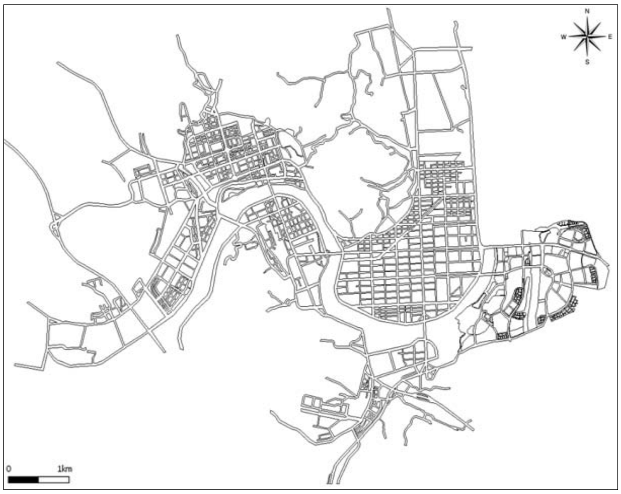

Figure 21. Road networks of J City

The crime data of J City was collected with the police department's criminal records of 2008, 2011, and 2012 (refer to TABLE 1). Theft and assault accounted for the 97~99 percents of five main violent crimes; rape, murder, robbery, theft, and assault, while the occurrence of rape, murder, robbery was relatively low.

Table 9. Crime occurrence by crime type in J City

			2008 year			
Type	Rape	Robbery	Homicide	Theft	Violence	Total
Case	25	15	2	1,308	1,007	2,357
%	1.06	0.64	0.09	55.49	42.72	100.00
			2011 year			
Type	Rape	Robbery	Homicide	Theft	Violence	Total
Case	49	16	7	1,411	1,081	2,564
%	1.91	0.64	0.26	55.03	42.16	100.00
			2012 year			
Type	Rape	Robbery	Homicide	Theft	Violence	Total
Case	21	1	0	1,484	962	2,468
%	0.85	0.04	0.00	60.03	39.98	100.00

To utilize the crime data in spatial analysis, they were converted to GIS data by geocoding via address matching (refer to Figure 2). The crime occurred frequently in commercial areas and residential areas, but less occurred within the industrial complex. Residential burglary often occurred in the back roads or allies rather than a daytime road line, while assault occurred in roads and commercial areas that hold large floating population.

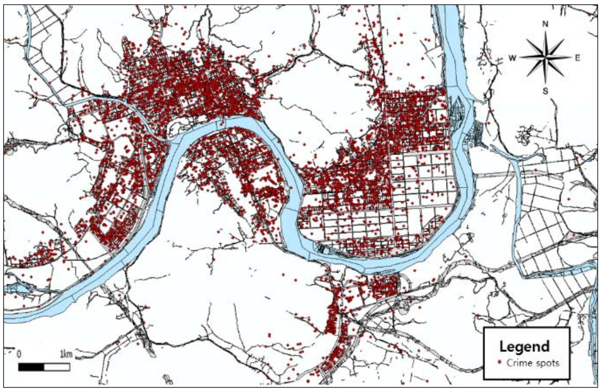

Figure2. Crime distribution in J City

The crime hot spots are shown in Figure 3. In this, 'A' zone is the built-up central business districts where commercial facilities are condensed as an old downtown, while 'B' zone is the area where the old train station is and commercial areas are distributed in surrounding areas. 'C' zone is the old residential area where traditional commercial areas are mixed in part, while residential areas account for the majority in the D zone where apartments are developed.

Meanwhile, a specific study area in J City needs to be selected to analyze the relationship between road networks and crimes occurrence. If the entire city is selected as the study area, it might not be appropriate because industrial areas and green lands are included where crimes seldom occur. Therefore, it is better to select areas where crimes occur to a certain level and are not affected by surrounding environment. In consideration of such points, this study selected area 'C' for the analysis where hold a number of crime occurrence and simple in land use.

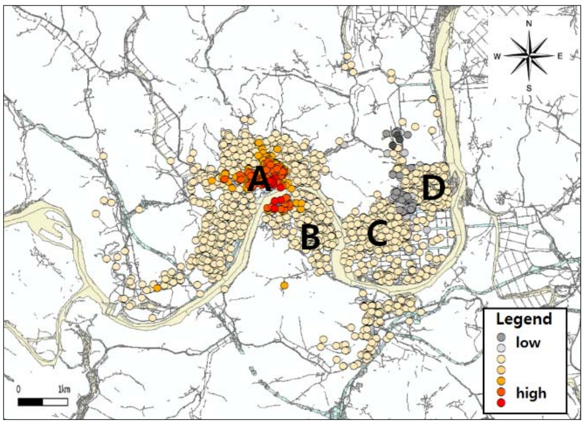

Figure3. Crime hot spots in J City

3. SPATIAL STRUCTURE

3.1 Space syntax and crime occurrence

The road networks in the case area are shown in Figure 4, and the numbers in Figure 4 are those of serial number of roads for the analysis, where one line represents one-lane road, two lines are two-lane road, and three lines are three-lane road.

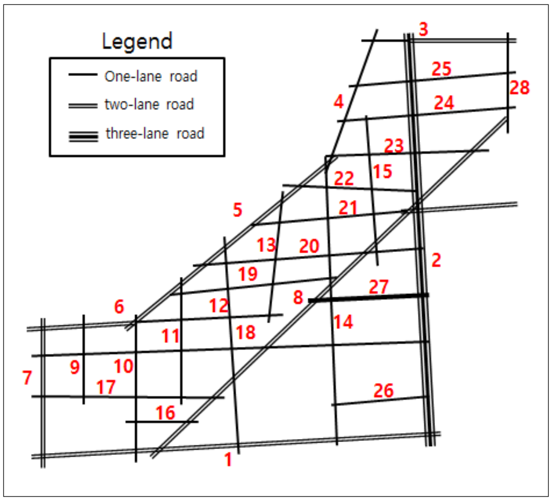

Figure4. Road networks of study area

In terms of the indicators of space syntax, 'Connectivity' represents the number of roads, directly connected to the axis (road). Accordingly, high connectivity means easy connection with another space. 'Control' is the concept, developed from connectivity, which is the value that represents a degree of control, affecting the adjacent space (Lee et al., 2004). 'Integration' is to represent relative depth for the access to another space from a specific space, so that the access to another space is easier as integration is higher. Integration is the indicator, representing the relationship between specific space and entire space (Lim, 2008).

Axial map was drawn up with the Depthmap developed by UCL around the road networks by using the digital map of the case area, and connectivity, control, and integration values according to individual road, were calculated as shown in Table 2. The connectivity was the highest, 14, of the 8th road, offered from the inside of the target area to the diagonal direction, and the lowest value of the 16th road, which is in the inside downward was 2. The highest value of the 8th road in the control was 2.488, while lowest value was 0.288 on the 26th road, which is in the lower part on the right. The highest value of the integration was 5.610 on the 8th road, while the lowest value of the 3th road and 17th road was 2.040.

Meanwhile, the number of crimes on the individual road was the highest on the 8th road as shown in Table 2, which was followed by the 1st road and the 2nd road. The roads, whose crime numbers were the least, were the 13th and 28 road, which are two cases respectively.

Table2. Results of space syntax analysis

Road No.	Crime No.	Connectivity	Control index	Integration index
1	65	6	0.959	3.366
2	50	13	2.404	4.488
3	12	4	0.334	2.040
4	8	7	1.358	3.284
5	11	11	1.698	4.643
6	16	7	1.236	2.748
7	15	4	0.880	2.321
8	68	14	2.488	5.610
9	7	3	0.772	2.362
10	10	6	1.622	3.060
11	15	5	1.164	2.927
12	25	7	1.109	3.543
13	2	5	0.726	2.693
14	22	12	1.822	4.343
15	5	6	1.685	3.131
16	3	2	0.589	2.540
17	13	4	1.150	2.040
18	34	9	1.486	4.207
19	7	5	0.890	3.284
20	22	8	1.007	3.740
21	16	7	1.073	3.543
22	6	6	0.646	2.927
23	18	7	0.836	3.366
24	9	6	0.790	2.805
25	7	4	0.584	2.362
26	7	3	0.288	2.244
27	8	4	0.447	2.640
28	2	5	1.056	2.540

3.2 Relationship between road networks and crime

To investigate the relationship between road networks and crime, crime occurrence number on the roads was set as dependent variable, while three indexes produced by space syntax, connectivity, control, and integration, were set as independent variables and regression analysis was conducted. The results are in Table 3, where the R2 of determination coefficient that represents the fitness of the regression model was 0.453, which had an explanatory power for the variance of the dependent variables, approximately 45.3%.

However, the connectivity was excluded from the independent values because connectivity was the variance inflation factor (VIF) with the value of 10.871, where multicollinearity exists, so that the regression analysis was conducted only by inputting control and integration. The standardized regression coefficient of integration was 0.591 and control 0.099, indicating that integration would have a more effect on the occurrence of the crime than control.

Table 3. Results of regression analysis

Dept. var.	Indep. var.	Unstandardized Coefficients		Standard-ized Coeffici-ents ß	t	F	R2	VIF
		B	SE					
Crime no.	Const.	-23.607	10.570		-2.233	10.348	0.453	
	Integration index	11.807	5.028	0.591	2.348*			2.892
	Control index	3.074	7.843	0.099	0.392			2.892

* $p < 0.05$

4. CONCLUSION

Understanding the processes behind the crime is significant in that it is conducive to establishing the strategies of effective crime prevention or police operation in terms of the field of criminology (Brantingham and Brantingham, 2004). This study sought for integration, control, and connectivity of road networks using space syntax in case area on the assumption that the structure of road networks would affect the crimes occurrence to analyze the relationship between crimes and above three indexes.

The study results demonstrate that integration was the most significant factor affecting the occurrence of crime, which was followed by control and connectivity. This suggests that taking measures on roads which are higher in integration is effective for crime prevention. For example, installing CCTV or intelligent street lights, giving police patrol priority to the roads of higher integration value could be effective. In addition, the creation of a safer city from crimes would be realized depending on the careful design and development of street networks. Therefore, it is required to develop a planning and design guidelines on street network, going beyond the urban planning or design which is mainly focusing on traffic management.

Despite the results mentioned above, there is a lot of work left to solve. Since the type of the road networks is not only the factor to influence on crimes, so that comprehensive approach based on a variety of analysis and case studies is required. Furthermore, analysis and review regarding a wide range of case regions are needed.

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NO.113

Prospective Living Arrangement of China's Urban Elderly and an ABS Model for Elderly Care Needs

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Key words: Agent, simulation, ageing, senior service, supply, environment, policy

Abstract: China is characterized by huge aged population, rapid ageing speed, urbanization, and social-economic transformation, the senior service issue is quite typical and urgent. To support the urban planning and decision-making of relevant policy for senior service which are significantly challenging, this research employs the MAS (multi-agents simulation) approach to simulate the complicated process of Chinese senior service provision. We define the elderly, daycare center, and RACF (residential aged care facility) as the kernel agents, determine the behavior rules of different agents, and confirm the interaction between agents, individual agent and urban environments. And 9 simulation modules were designed and integrated.

We focus on the diversifying elderly population, complexity of senior services system, and uncertainty of developing background. Senior's socio-economic attributes such as income, family structure, education and hukou status, daycare center and RACF agents' characteristics such as price, location, service standard, public /private were emphasized in a microscopic scale. With the bottom-up approach, the neighbourhood differentiation was considered as the main natures of the senior service need. Through the design of different policy-scenarios, we determine the critical parameters which have the most important influence to the senior service need and provision. The regulation of these crucial indicators will be a great scientific support to the provision planning of senior services facility, and the decision-making of the environmental improvement policy in different urban neighbourhood.

MAS approach is acknowledged as a modeling paradigm for capturing the dynamics of complex systems. This research is prominently useful to support the provision of elderly services facility and the environmental improvement of urban living neighbourhood and to promote future urban planning.

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NO.7

The State of Technology-Based Innovative Utilization in the Municipality of Kars, Turkey

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Key words: technology-based innovations, urban information systems, local governments, Kars Municipality

Abstract: The practices of technological innovations at city level had started in the early 1990s. Emergence of these innovations comprises of three mainstreams: First, local government agencies automated the records related to the city and citizens. The second one was the improvement of geographical information systems technology that allows mapping and updating database. As final one, there has been a tendency on innovative services which are fed by first two and includes the innovative services of a local government, sharing the datasets of several cities among local level government agencies and individual local agencies, etc. The focus of this research is the examination of how the technology-based innovative services of a local government can be utilized.

The innovative institutional approaches growingly take the advantage of urban information systems. Urban information systems combine improvements in information systems and urban space. Spatial analysis tools such as geographical information systems are increasingly significant parts of governments. Recent advances in geo-spatial technologies have inspired many spontaneous bottom-up municipal geographical information systems initiatives aimed at improving many aspects of urban maintenance, management or planning. (Carrera, 2004)[i] By investing in innovative technologies, local governments have the ability to create, manage and analyse their own data on land use, transportation, infrastructure, etc. effectively and up-to-date.

The empirical part of the study is based on interviews with actors in selected Turkish local governments. A case study research is made in cooperation with Kars Municipality. Selection criteria of this local government is the presence of the vision on capacity building related to urban information system of the agent. Comparative study is carried out to be able to determine the accomplishments of a successful city and to use it as a model. The major question behind this research is on the current state

of technological infrastructure, obstacles, and strengths on developing urban information systems for respondent local government.

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NO.12

Recapitulating Smart City Concepts: A New Framework for Smart City and its Evaluation in Japan

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Key words: Smart city, smart city concept, smart city indicator system, Kitakyushu city, Japanese smart city.

Abstract: Smart city (SC) concept is a new mega-trend for urban development, and is now gaining incremental popularity worldwide. Through an extensive literature review, we found that despite lacking universal consensus, there have been two major streams of SC concepts with overarching strategies for comprehensive SC developments or with specific focuses on utilizing information and communication technologies (ICT) to improve the quality of life. We then summarized the key features and components of smart city and propose a conclusive framework for smart cities that consist of double-objectives, six domains and two means for its realization. Furthermore, we have proposed customised indicator system based on our SC framework for measuring the "smartness" of the smarty cities in Japan with a case study of the city of Kitakyushu. The outcome of this paper would provide some new insights to the methodological approaches adopted to assess the on-going smart city initiatives in Japan.

1. INTRODUCTION

In recent years, the concept of "smart city" (SC) has been gaining incremental momentum particularly in the industrialized sphere. A consensus has seemingly been reached that our "business as usual" model for development is inherently not sustainable, thus alternatives of sustainable modes are desperately desired and needed. In the urban development realm, several mega-trends have emerged in the contemporary urban history. "Garden city", "Eco-city", "Low-carbon city" are some typical representations of urban development paradigms sought out though time, each addressing the needs and pursuits of urban development of their respective areas (Zou & Li, 2015). The most recent one is "smart city".

Mirroring the lack of universal accepted definition for "eco-city" and "low-carbon city" and other similar terminologies (Zou & Li, 2014), the concept of SC is neither internationally standardized nor universally defined. After thoroughly reviewing the currently available literature on smart cities including some frequently citied grey literature (conference papers, international organizational reports etc.), two streams of SC concepts and definitions can be identified. One stream focuses on developing SC to encompass broader scopes and multiple domains (such as i nfrastructures, energy, governance, economic growth and social life)(Angelidou, 2014; Lazaroiu & Roscia, 2012; Perboli, De Marco et al., 2014); another stream clusters on specific aspects of SC development such as improving the quality of life (QoL) for residents via implementing information and communication technologies (ICT) in various aspects of daily life(Chourabi, Nam et al., 2012; Cosgrave, Arbuthnot et al., 2013; Schuurman, Baccarne et al., 2012), both of which have their adherents and proponents amongst various stakeholders.

One of the early origins of the smart city concept is the "digital city", referring to the utilization of various digital undertakings of the city, such examples can be seen in Amsterdam (Digital City Amsterdam), Helsinki (Virtual Helsinki) or Kyoto (Digital City Kyoto), just to name a few(Ishida & Isbister, 2000; Schuurman, Baccarne et al., 2012). Other umbrella terms including "wired city" or "intelligent city" have all addressed the technology-oriented smart city initiatives with different focuses(Paskaleva, 2011). Another parallel concept that is analogous to the smart city is "ubiquitous city", also known as "U-city". Considered as another model for future urban development that merges the physical and virtual spaces of cities, U-city aims to foster urban innovation and improve quality of life, with the emphasis inputs from the end users (Kwon & Kim, 2007) despite facing criticism over its preferences of specific clusters of end-users (such as youngsters) instead of all age groups (Choi, 2010; Schuurman, Baccarne et al., 2012).

The literal concept of "smart city" was firstly brought up by Mahizhnan (1999) to propagate Singapore, as an resource-scared "Intelligent island" with its vision and endeavor to embrace the new information technology (IT) for both boosting the economic growth and improving the quality of life for all people. In the years to follow, the SC concept gained incremental momentum, but criticism also emerged to question the validity of the actual existing smart cities (Shelton, Zook et al., 2014) due to its lack of precise definition. Additionally, some also critically question these smart cities "urban labeling" phenomenon as merely another variation of "entrepreneurial city" argued by Hollands (2008).

A more literal interpretation of SC focuses on the applications of smart sensors embedded with smart devices under the ICT scenario, where the internet of things (IoT) is envisioned to connect numerous sensors for more efficient and effective management of resources in cities (Perera, Zaslavsky et al., 2014) given the assumed roles sensors play in making “smarter” cities (Mitton, Papavassiliou et al., 2012). In this respect, consensus seems to have been reached by the many within IT domain of the academia, where the overarching goal of SC is to improve quality of life for the people and one major instrument of which is through “smart technology” implementation (mainly ICTs).

In this paper, we will try to converge and summarize the major concepts of both the identified streams SC concepts, to have a sy stematic understanding of what SC really is, and what its defining features are. Based on the reviewed literatures, we attempt to propose an encapsulating working definition of SC, based on which, a framework of smart cities is proposed for better and more systematic assessment of smart cities. We employ the Kitakyushu city of Japan, an internationally renowned innovative city for urban sustainability, to tailor-make an indicator system based on our proposed SC framework.

2. SMART CITIES: ITS ORIGIN, CONCEPT AND INDICATORS

In this section, we have conducted an extensive review of the current literatures regarding the origin of the smart city, which is a result of the early “smart growth” movement in urban areas in the global North. Furthermore we summarize the major SC concepts and its indicators.

2.1 Smart city origins

The idea of smart city idea is neither new nor novel (Shelton, Zook et al., 2014, p. 2). Its origin could be traced back to the “New Urbanism” in 1980s’ North America, the aim of which is “improving urban environment and the quality of life in cities by promoting communitarian ideas and limiting urban sprawl…”(Vanolo, 2013, p. 887) until its ‘successor’, known as “Smart City” movement came forward in the late 1990s, wherein the U.S. government funded “smart growth” networks encapsulating a broad range of stakeholders like the Environmental Protection Agency (EPA), non-governmental groups and environmental organizations, professional associations and institutes, as well as developers of real-estate interests to revive urban America while benefiting the environment at large (Bronstein, 2009, p. 27). When the concept of “intelligent city” was applied to depict a new urban model of combining the urban sphere and techno-spheres to boost innovation, transition towards e-governance, and provide ICT infrastructure (Bronstein, 2009; Komninos, 2009). It was not long before the term “intelligent city” was embedded into “smart city” and used interchangeably sometimes thereafter.

2.2 Smart city concepts

As of now, the interpretations of what makes a city “smart” varies, the definitions of SC tend to focuses on two domains, namely “soft domains” such as education, culture, policy innovations, social inclusion, governance; as well as “hard domains”, namely, infrastructures (buildings, energy grids etc.), natural resources, water and waste management, mobility and logistics (Albino, Berardi et al., 2015, p. 8). A rather thorough list of SC definitions has been compiled by Albino, Berardi et al. (2015) which details the literatures since 2000. Here we added some more SC definitions from the available literatures and digest and group these definitions based on their core meanings for a compressed view (refer to table 1). By vertically examining these established SC concepts, we have summarized two major components of a smart city, namely the goals for a smart city and the means to realize them. Two major goals can be identified from the listed concepts, which contain double-fold parallel pursuits: to improve quality of life and to pursue sustainable urban development. The means for their realizations are mainly though the “smart” technology implementation, mainly in the form of (but not limited to) information and communication technology.

The industry sectors have also been actively riding on the forefront of this “smart city” tides. The international players like IBM, Cisco Systems. Siemens AG and Hitachi Group have all come up with their “solutions” for helping the local stakeholders to realize their smart city goals, from specific technology products to whole package of making a community smart.

In terms of what constitutes a smart city, Giffinger, Fertner et al. (2007) first identified four SC features, namely, industry, education, participation and technical infrastructure, which was later updated into six SC characters or components: smart economy, smart mobility, smart environment, smart people, smart living and smart governance (Giffinger & Gudrun, 2010). Lombardi, Giordano et al. (2012) delineated a range of urban life aspects which can be associated with the previously mentioned components in terms of industry for smart economy, education for smart people, e-democracy for smart governance, logistics & infrastructures for smart mobility, efficiency and sustainability for smart environment, security & quality for smart living. Other specific SC dimensions have been identified by literatures (Barrionuevo, Berrone et al., 2012; Chourabi, Nam et al., 2012; Eger, 2009; Giffinger, Fertner et al., 2007; Kourtit & Nijkamp, 2012; Mahizhnan, 1999; Nam & Pardo, 2011a, 2011b) which are reviewed by Albino, Berardi et al. (2015, p. 10) to share the following common grounds:

- Network connected infrastructures which enable political, social and cultural developments

- Business-led urban development to promote urban sustainable growth
- Engagement of urban stakeholders so as to develop social capitals
- Preserve natural environment for the future

As a new mega-trend that follows "eco-city" and "low-carbon city", there have been approximately 143 designated or self-proclaimed smart city projects, where Asia and Europe saw the most in numbers (50 and 47 projects respectively), followed by North America (35 projects), South America (10 projects) and Africa (10 projects) (Lee, Hancock et al., 2014). However, some of the projects have multiple titles such as the renowned example of Masdar City, which is known to the world as "eco-", "low-carbon" and "smart". Other famous smart cities include (but not limited to) Songdo smart city in South Korea, Taoyuan city in Taiwan, Barcelona, Amsterdam, Berlin in Europe, Manchester, Edinburgh and Bath in the UK, California, Dan Diego and San Francisco in the US, Ottawa and Quebec in Canada(Albino, Berardi et al., 2015, pp. 13-14).

Table 1. Concepts or definitions of smart city

Definition	Source
● Smart city as a high-tech intensive and advanced city that connects people, information and city elements using new technologies in order to create a sustainable, greener city, competitive and innovative commerce, and an increased quality of life.	Bakıcı, Almirall et al. (2012)
● Being a smart city means using all available technology and resources in an intelligent and coordinated manner to develop urban centers that are at once integrated, habitable, and sustainable.	Barrionuevo, Berrone et al. (2012)
● A city is smart when investments in human and social capital and traditional (e.g. transport) and modern (e.g. ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance.	Caragliu, Del Bo et al. (2011)
● Smart cities will take advantage of communications and sensor capabilities sewn into the cities' infrastructures to optimize electrical, transportation, and other logistical operations supporting daily life, thereby improving the quality of life for everyone.	Chen (2010)
● Two main streams of research ideas: 1) smart cities should do everything related to governance and economy using new thinking paradigms and 2) smart cities are all about networks of sensors, smart devices, real-time data, and ICT integration in every aspect of human life.	Cretu (2012)

● A city well performing in a forward-looking way in economy, people, governance, mobility, environment, and living, built on the smart combination of endowments and activities of self-determined, independent and aware citizens. Smart city generally refers to the search and identification of intelligent solutions, which allow modern cities to enhance the quality of the services provided to citizens.	Giffinger, Fertner et al. (2007)
● A smart city, according to ICLEI, is a city that is prepared to provide conditions for a healthy and happy community under the challenging conditions that global, environmental, economic and social trends may bring.	Guan (2012)
● A city that monitors and integrates conditions of all of its critical infrastructures including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens.	Hall (2000)
● A city connecting the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city.	Harrison, Eckman et al. (2010)
● (Smart) cities as territories with high capacity for learning and innovation, which is built into the creativity of their population, their institutions of knowledge creation, and their digital infrastructure for communication and knowledge management	(Komninos, 2011)
● Smart cities are the result of knowledge-intensive and creative strategies aiming at enhancing the socio-economic, ecological, logistic and competitive performance of cities. Such smart cities are based on a promising mix of human capital (e.g. skilled labor force), infrastructural capital (e.g. high-tech communication facilities), social capital (e.g. intense and open network linkages) and entrepreneurial capital (e.g. creative and risk-taking business activities).	Kourtit and Nijkamp (2012)
● Smart cities have high productivity as they have a relatively high share of highly educated people, knowledge-intensive jobs, output-oriented planning systems, creative activities and sustainability-oriented initiatives.	Kourtit, Nijkamp et al. (2012)
● Smart city [refers to] a local entity - a district, city, region or small country, which takes a holistic approach to the employ[ing] of information technologies with real-time analysis that encourages sustainable economic development.	IDA (2012)
● A community of average technology size, interconnected and sustainable, comfortable, attractive and secure.	Lazaroiu and Roscia (2012)
● The application of information and communications technology (ICT) with their effects on human capital/education, social and relational capital, and environmental issues is often indicated by the notion of smart city. Lombardi et al. (2012)	Lombardi, Giordano et al. (2012)

• A smart city infuses information into its physical infrastructure to improve conveniences, facilitate mobility, enhance efficiency, conserve energy, improve the quality of air and water, identify problems and fix them quickly, recover rapidly from disasters, collect data to make better decisions, deploy resources effectively, and share data to enable collaboration across entities and domains.	Nam and Pardo (2011a)
• Creative or smart city experiments … aimed at nurturing a creative economy through investment in quality of life, which in turn attracts knowledge workers to live and work in smart cities. The nexus of competitive advantage has … shifted to those regions that can generate, retain, and attract the best talent.	Thite (2011)
• Smart cities of the future will need sustainable urban development policies where all residents, including the poor, can live well and the attraction of the towns and cities is preserved…. Smart cities are cities that have a high quality of life; those that pursue sustainable economic development through investments in human and social capital, and traditional and modern communications infrastructure (transport and information communication technology); and manage natural resources through participatory policies. Smart cities should also be sustainable, converging economic, social, and environmental goals.	Thuzar (2011)
• A smart city is understood as a certain intellectual ability that addresses several innovative socio-technical and socio-economic aspects of growth. These aspects lead to smart city conceptions as "green" referring to urban infrastructure for environment protection and reduction of CO2 emissions, "interconnected" related to the revolution of broadband economy, "intelligent" declaring the capacity to produce added value information from the processing of city's real-time data from sensors and activators, whereas the terms "innovating", "knowledge" cities interchangeably refer to the city's ability to raise innovation based on knowledgeable and creative human capital.	Zygiaris (2012)
• The use of Smart Computing technologies to make the critical infrastructure components and services of a city, which include city administration, education, healthcare, public safety, real estate, transportation, and utilities—more intelligent, interconnected, and efficient.	Washburn, Sindhu et al. (2009)
• Smart cities are all urban settlements that make a conscious effort to capitalize on the new Information and Communication Technology (ICT) landscape in a strategic way, seeking to achieve prosperity, effectiveness and competitiveness on multiple socio-economic levels	Angelidou (2014)
• Smart cities should propose a holistic vision of future communities where new technological tools, services and applications are integrated in a unique platform, providing interoperability and coordination between these several sectors	Perboli, De Marco et al. (2014, p. 470)
Smart cities initiatives try to improve urban performance by using data, information and information technologies (IT) to provide more efficient services to citizens, to monitor and optimize existing infrastructure, to increase collaboration among different economic actors, and to encourage innovative business models in both the private and public sectors.	Marsal-Llacuna, Colomer-Llinas et al. (2015)

2.3 Smart city indicator systems

When it comes to the measurement and evaluation of smart cities, a number of methods, indicators and indices have been established or proposed. A "Smart City ranking" was conducted by Giffinger, Fertner et al. (2007) to compare medium-sized cities in Europe, the framework of which has provided useful insights to the later development of smart city measurements with an index of 6 characters consisting 31 factors with a total of 74 subsequent indicators. Another smart city model was proposed by Lazaroiu and Roscia (2012) with 4 criteria (smart economy, smart environment, smart energy and mobility, and smart governance), where fuzzy logic was applied to calculate the weights of the enlisted indicators as a supplement to indicator systems applied in "Smart City ranking". Their results indicates that the smart city is particularly influenced by sustainable, innovative and safe public transportation Lazaroiu and Roscia (2012) (pp. 330), however, they fail to illustrate the affiliating criteria where the indicators should be categorized into (refer to Table 2). Other rankings such as the Global Power City Index (created by the Japanese Institute for Urban Strategies), the Smarter Cities Ranking (conducted by the Natural Resources Defense Council of US) and a host of other organizations like the Smart Cities Council, business groups (like the aforementioned mentioned IBM, Siemens, Cisco, Hitachi etc.), and individuals have proposed different ways of measuring or evaluating cities with selected goals and targets. Idowu and Bari (2012) proposed a generic development framework that can help to develop and deploy services in smart city and more recent published report by Barranco, Aurambout et al. (2015) commissioned by EU offers a broader framework to evaluate and assess the urban developments with time series and geographical features of urban areas. Analytical models have been conducted by Lombardi, Giordano et al. (2012) to measure the performance of smart cities in general, which offers insights to policy-making with identified indicators. Individual evaluation model has been proposed by Lv (2012) for assessing the smart city development of Tianjin city as specific case study.

Table 2. Digest of smart city indicator systems

Dimensions/Criteria/Features	Structures	Sources
▪ Smart Economy (Innovative spirit, entrepreneurship, economic image & trademarks, flexibility of labor markets, international embeddedness) ▪ Smart People (Level of qualification, affinity to life long learning, social and ethnic plurality, flexibility, creativity, cosmopolitanism/open-mindedness, participation in public life) ▪ Smart Governance (Participation in decision-making, public and social services, transparent governance) ▪ Smart Mobility (Local accessibility, inter-/national accessibility, availability of ICT-infrastructure, sustainable…transport systems) ▪ Smart Environment (Attractiveness of natural conditions, pollution, environmental protection, sustainable resource management) ▪ Smart living (Cultural facilities, health conditions, individual safety, housing quality, education facilities, tourism attractiveness, social cohesion) *Note: sub-indicators not included in this table*	6 characters 31 factors 74 indicators[1]	(Giffinger, Fertner et al., 2007)
▪ Smart economy, ▪ Smart environment, ▪ Smart energy and mobility, ▪ Smart governance (Pollution, innovative spirits, CO2, transparent management, soiled waste separation, education facilities, health conditions, sustainable, innovative and safe public transportation, pedestrian areas, cycle lanes, green areas, production of municipal solid waste, GWh household, fuels, political strategies & perspectives, availability of ICT-infrastructure, flexibility of labor market)	4 criteria 18 indicators	(Lazaroiu & Roscia, 2012)

▪ Economy (Market size, market attractiveness, economic vitality, human capital, business environment, regulation & risks) ▪ Research & development (Academic resources, research background, research achievement) ▪ Cultural interaction (Trendsetting potential, cultural resources, facilitiess for visitors, attractiveness to visitors, volume of interaction) ▪ Livability (Working environment, cost of living, security & safety, living environment, living facilities) ▪ Environment (Ecology, pollution, natural environment) ▪ Accessibility (International transportation network, international transportation infrastructure, inner-city transportation services, traffic convenience)	6 functions 26 indicator groups 70 indicators[1]	Global City Power Index 2014[1]
▪ Environment (Smart buildings, resources management, sustainable urban planning) ▪ Mobility (Efficient transport, multi-modal access, technology infrastructure) ▪ Government (Online services, infrastructure, open government) ▪ Economy (Entrepreneurship & innovation, productivity, local & global connection) ▪ People (Inclusion, education, creativity) ▪ Living (Culture & well-being, safety, health)	6 dimensions 18 working areas 46 indicators[1]	Smart Cities Council[2]

Note 1: these indicators are not included in the table for the sake of space

It is, after reviewing through this literature, our opinion that to have some overarching and all-encapsulating indexes or indicator systems for smart city measurement are not viable at the current infant stage of smart city development. Assessment or evaluation would make more sense within a particular system boundary with a properly defined concept, development goals and approaches. Developing tailor-made mechanisms either for policy or framework would work better for the regional urban development in a smart manner.

[1] http://www.mori-m-foundation.or.jp/gpci/index_e.html
[2] http://smartcitiescouncil.com

2.3 Proposed smart city framework based on literature review

After thoroughly reviewing concepts, dimensions, frameworks and indicator systems of the smart cities to the best of our knowledge, we have identified dual objectives or goals manifested in most of the reviewed articles, namely, 1) to improve the quality of life of the local citizens, and 2) to pursue the sustainability for urban growths and developments. The major instruments to achieve the objectives or goals are though the innovation and implementation of "smart" technologies, such as ICT, sensors networks etc. and the involvement of the major stakeholders from the industry, academia and government (triple helix model). The main constitutions of SC entails double domains, both "soft" and "hard". Soft domain includes (but not limited to) dimensions such as "economy", "governance", "people & living"; hard domain includes (but not limited to) dimensions like "infrastructure", "energy & mobility", "environment" (refer to Figure 1).

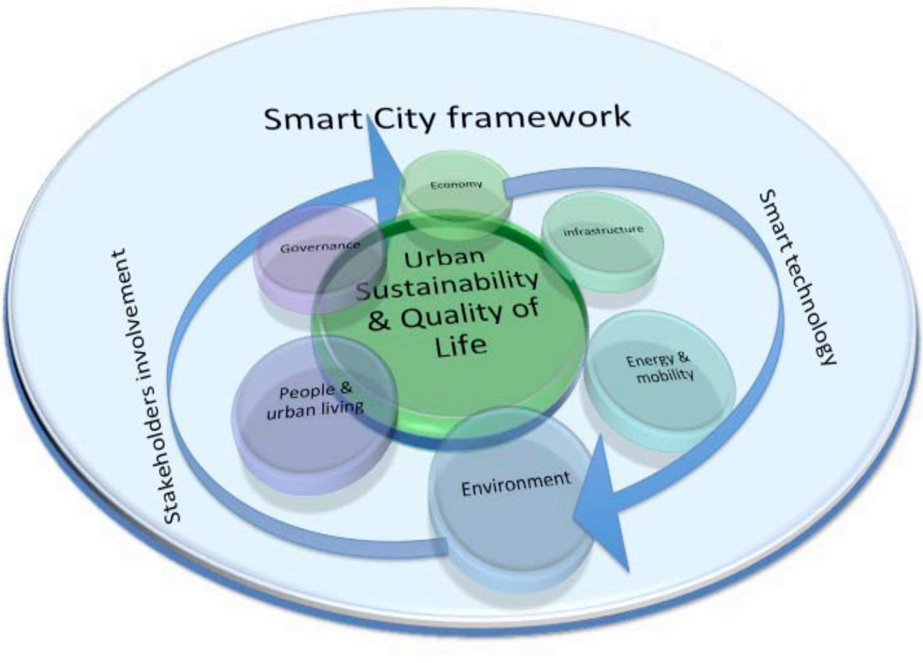

Figure 1. A conceptual framework of smart cities

In this paper, we are trying to obtain a rather digestive understanding of smart city by understanding the objectives and goals of the smart cities, the instruments for their implementation and their major contents or domains of developments. This proposed framework illustrates the reviewing outcome and is used as the theoretical foundation where the proposed indicator system is proposed for measuring the smart cities in Japan as d escribed in the following sections.

3. MEASURING THE "SMARTNESS" OF THE CITY OF LITAKYUSHU, JAPAN

3.1 General view of the smart cities in Japan

Smart cities are defined by Japan Smart City Portal3 as "a new style of city providing sustainable growth and designed to encourage healthy economic activities that reduce the burden on the environment while improving the QoL (Quality of Life) for their residents". This program was initiated by Japan's Ministry of Economy, Trade and Industry (METI) and operated by New Energy Promotion Council since 2010, to promote a next generation of energy and social system. Four project sites, namely, the City of Yokohama, Toyota City, Keihanna Science City and the City of Kitakyushu had been selected for testing smart grid- and smart city-related energy distribution and innovative social systems.

The Great East Japan Earthquake of March 2011 and the subsequent nuclear power plant crisis shocked Japan and the whole world as a "wake-up call". In a highly urbanized country like Japan, the traditional way of doing businesses and maintaining lifestyles to improve quality of life manifested some limits. Thus, the active implementation of ICT technology would enable a new generation of "smart cities" to solve those issues meanwhile continuing the improvements on QoL, such as electric vehicles (EV), which can be charged by individual smart houses, and their batteries that can be used reversibly to provide electricity to the houses in case of emergency. These four project sites are the currently cutting-edge testing beds for numerous experiments to be implemented on a large scale in the future smart cities. Moreover, the Japanese government has actively promoted the participations of various stakeholders, particularly those of the general public, to share their ideas and thoughts for translating smart cities into reality.

3.2 City of Kitakyushu and its smart city project

The city of Kitakyushu is located in the north of Kyushu island in Japan, with a territory of over 491 km2 and a population about 957,600. From the 1950s until the 1970s, this heavy industrial city of iron manufacturing was

[3] http://jscp.nepc.or.jp/en/index.shtml

severely polluted, especially in the air and water. The Dokai Bay of the city was so contaminated that it was gained the nickname of "Sea of Death", and public health suffered profoundly due to heavy pollution (refer to Table 3). Through decades of continuous and strenuous efforts in environmental protection and sustainable development, the city has restored its blue sky and clean water, and has been awarded both domestically and internationally with, for example, "Japan's Eco-model City Award", "United Nations Global 500 Role of Honor Award", "Earth Summit: UN Local Government Honors" (Maeda, 2010), just to name a few.

Table 3. Selected information of Kitakyushu City

Territory	*491.95 km2 (by April, 2015)*
Population	*957,597 (by April, 2015)*
Location	*Fukuoka Prefecture, northeast of Kyushu area, southeast of Japan.*  *Picture source: Wikipedia*
Environmental conditions of Kitakyushu's bay area (past & present)	 Smoggy sky (1960s) / Blue sky restored (present day) / Dokai Bay once called the 'Sea of Death' (1960s) / Dokai Bay regained it's original beauty (present day) *Source: (IGES, 2005)*

	Project location: The Higashida area in Yahata-Higashi ward
	Area coverage: Approximately 1.2 km2
Smart City	*Participating households: 225 (as of August 2012)*
(Eco-Town)	*Participating workplaces: 50 (as of August 2012)*
Project	*Smart meters installed: 225 (as of August 2012)*
	Technology applied: Storage batteries 800kW; Photovoltaic (PV): 400kW; Fuel cells 110 kW

The Smart City (Eco-Town) Project in Kitakyushu city encompassing the entire eastern section of the Hibiki Landfill Area was first approved by Japan's then Ministry of Industrial Trade and Industry (MITI) in 1997, which later became the Ministry of Economy, Trade and Industry (METI) in 2001. METI greatly promoted this project and offered subsidies for the constructions of infrastructure and marketing. There are two stages of the project with overall aim of promoting zero emissions though re-utilizing the waste of the local industries, contributing to the 3R (Reduce, Reuse and Recycle), society development of Japan with the first stage (1997-2002) focusing on the "Recycle" and the second stage (2002-2010) focusing on "Reuse". The overall strategy is to link together academic research, demonstrative and applied research, and the private sector of the local industries, to have jointly efforts of all these components working together. The successful outcomes of this smart city project of Kitakyushu city have made an international brand for Japan's local practices of eco-city initiatives, moreover, in terms of financial value, a total 50,200 million Japanese yen was invested, of which 7% came from the private sector; over 1000 jobs were created. An accumulated 109,300 million yen was invested from 1998 to 2003 (Zou & Li, 2015).

3.3 Proposed Framework with Indicator System for Kitakyushu City

As is seen previously, Kitakyushu has made tremendous and continuous efforts to pursue urban sustainability through government initiatives, civil participation, and technological innovation and implementation over the past decades. To fill the gap of not having a universal measurement yet for the comprehensive smart cities development in Japan, we have proposed a set of indicators based on the framework drawn up in section 2.3 for a rather holistic measurement and evaluation of such smart city programs and initiatives in Japan. Hopefully, this attempt of endeavor would bring some more clarity and insights for policy makers and city planners as well as scholars and students of the related fields of study. We advocate finding a way to select the most suitable and manageable ones within the already existing pools of indicators under our concluded framework, which we believe to have summarized the major features constituting a smart city suggested by literatures and case studies worldwide.

We have assigned six dimensions for the smart city indicator systems of Kitakyushu city with the double goals of pursuing urban sustainability and improving the quality of life (refer to Figure 1) including “Governance”, “Economy”, “People & Urban living”, “Infrastructure”, “Energy & Mobility”, “Environment”. Under each dimension, we have conducted a fine selection based on mainly the relevance, suitability and availability of indicators. The indices of existing indicators include the sustainable indicator index proposed by Dhakal (2002) of the Institute of Global Environmental Strategies (IGES), a Japanese government initiated public policy research institute, the Asian Green City Index proposed Economist Intelligence Unit (2011) and the Smart City Index established Giffinger, Fertner et al. (2007). In our opinion, sustainable cities and green cities are inherently “smart” cities; therefore major preferences are given to the first two indices for the indicator selections. We have concluded 18 aspects under the 6 dimensions with a total of 36 indicators. The detail descriptions of each aspect and its affiliated indicators are shown in the following table (refer to Table 4).

However, not all the indicators from IGES are suitable matches within the framework, and a fine selection is conducted based on the indicators reviewed in the previous section, based on content relevance, suitability and data availability.

Table 4. Proposed smart city indicator system of Kitakyushu City

Dimensions	Aspects	Indicators
Governance	Transparency & Management	• Perception of transparency of bureaucracy • Perception of fight against corruption • Monitor its environmental performances
	Civil participation	• City representatives per resident • Female city representatives • Public participation in environmental decision-making
Economy	Innovation	• % of budget of local government allocated for environment • R&D expenditure in % of GDP
	Sustainable development	• Use of electricity per GDP • Use of water per GDP
	Labor & Capital	• Gross city product per capita

People & Urban living	Human health	• Households below poverty line • Number of doctors per 1000 population • Number of hospitals per 1000 population
	Institutional & Social capacity	• Number of environmental staffs in city government per 100 thousand population • % of industries complied with emission control regulations • % of vehicles compliant with emission control regulations • Adult literacy rate
Infrastructure	Buildings	• Energy consumption of residential buildings • Energy-efficient building standards
	Land use	• Green spaces per capita
	Smart grid	• Accessibility of smart grid
Energy & Mobility	Renewable energy	• Share of renewable energy in total energy use
	Energy efficiency	• CO_2 per capita from energy use
	Sustainable transportation	• Green mobility share • E-vehicle in commercial vehicle shares
Environment	Air quality	• SO_2 concentration • TSP concentration
	Water availability	• % of population with access to adequate and clean water • Water renewable rate of the source
	Water quality	• BOD concentration of inland water bodies • COD concentration of the coastal water % of green area in the total land use
	Urban green	• % of green area in the total land use
	Waste & Waste water	• Per capital waste generation • % of total solid waste collected • % of total waste water treated

There are some limits of this study and proposed index though. Given the current on-going status of the research, we have maintained the size of indicators within a manageable 2-5 for each aspect, and 2-5 aspects for each dimension in this paper. Moreover, we have not assigned any weighting, aggregation or conduct ranking with the indicators for the time being. A follow-up updating of both indicator quality and quantity with proper weighting methodology is to be conducted in the follow-up steps of this research.

4. CONCLUSION AND DISCUSSIONS

Under the current trends of rapid and unceasing urbanization process, to cope with the various "urban ills", wide-scale urban movements such as "garden city", "green city", "eco-city", "low-carbon city" have been seen since the late 19th century onward, with the latest being "smart city" amongst others. Yet hardly any of those mega-trends has resulted in universal paradigms or models that can be applied without localization or customization based on regional features or local situations.

This paper has thoroughly reviewed the major literatures of smart cities in terms of their multi-faceted concepts, constitutions and indicator systems in an attempt to recapitulate an encapsulating and comprehensive framework that can be applied within the local context. As a result, we have proposed a paradigm with double-fold objectives (urban sustainability & improvement of QoL) with 6 constituting dimensions. Based on this diagram, we have established a framework with 18 aspects and 36 supporting indicators from the existing indexes of sustainable, green and smart cities for the up-coming measurement and evaluation of the case study Japanese city of Kitakyushu.

Discussion: Instead of focusing merely on the implementation of ICTs or the implementation of "smart" technology to make cities smarter, we have come to understand the smart cities as new approaches to solve the existing urban problems and seemingly paradoxical conflicts between people's life quality and urban sustainability. In our opinion, all the eco-cities and low-carbon cities that contribute to urban sustainability are inherently "smart" cities to some extent. Thus, holistic views of developing or measuring new smart cities shall encompass the features from the previous paradigms, to say the least. And novel sets of frameworks or indicators are sometimes less effective and pragmatic than tailor-made assessments for specific visions of smart cities at a local setting. Despite lacking universal SC definitions, common goals and features contributing to SC are indeed observable, which can offer clearer insights or references to policy makers, urban planners and stakeholders pursuing such city development paradigms.

However, there are several limits of this research, given the current stage. We have not yet conducted weighting, prioritizing, or ranking of the indicators due to the lack of convincing methodological approaches. This along would account for a separate study that needs considerable amount of resources. As another major part of our initial design of the research, a detailed evaluation and assessment of the "smartness" of Kitakyushu city is to be conducted with chronological data, and will be the major focus in our follow up research endeavors.

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NO.18

Assessment of the Process of Designing an Apartment Building through IM & VR

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Keywords: Design tool, Simulation, Computational Fluid Dynamics (CFD), Virtual Reality (VR), Cloud Computing type VR, Building Information Modeling (BIM)

Abstract: An increasing amount of attention worldwide has been diverted into using BIM tools and simulations via BIM model in the field of architecture. Using BIM modeling and the effective use of various types of numerical and quantitative simulation / analysis throughout the process, stakeholders of various parties can be informed more about the project and offer their feedback in a more effective and rapid manner, to foster better but also speedy decision-making process, hence the importance of this type of technology. In this project, various types of software and solutions based on IM (Information Modeling) & VR (Virtual Reality) are utilized in the design of a company dormitory. Simulations via BIM model are performed and a cloud-based 3D Virtual Reality is used for consensus building. This paper will examine the detailed process of this project, the effectiveness of feedbacks on the design, and the process of reaching consensus. In addition to what has been done or currently available, we would also like to suggest a summary of what we will offer in the future in terms of BIM modeling, environment simulation, and VR simulation, together.

1. INTRODUCTION

An increasing amount of attention worldwide has been diverted into using BIM tools and simulations via BIM model in the field of architecture. Using BIM modeling and the effective use of various types of numerical and quantitative simulation / analysis throughout the process, stakeholders of various parties can be informed more about the project and offer their feedback in a more effective and rapid manner, to foster better but also speedy decision-making process, hence the importance of this type of technology.

A company dormitory (FORUM8 TAKANAWA HOUSE) is planned to be constructed at Takanawa-3-Chome, Shinagawa-ku, located near Shinagawa Station which is accessible by train in approximately 10 minutes from Tokyo Station. In this project, various types of software and solutions based on IM (Information Modeling) & VR (Virtual Reality) are utilized during its designs. Simulations via BIM model are performed and a cloud-based 3D Virtual Reality is used for consensus building. This paper will examine the detailed process of this project, the effectiveness of feedbacks on the design, and the process of reaching consensus. In addition to what has been done or currently available, we would also like to suggest a summary of what we will offer in the future in terms of BIM modeling, environment simulation, and VR simulation, together.

2. DETAIL OF THE BUILDING

The site on which the company dormitory building is planned to be constructed has an area of 170.27 m2 and is located within one of the residential zones in Central Tokyo. The apartment building (company dormitory) will have a total floor space of 400m2 with 3 floors above ground, and 1 underground floor, and will accommodate 9 residents in total. In addition, some public empty spaces are currently planned to be reserved for business meetings/presentations.

In the design process, BIM modeling, wind analysis, energy analysis, construction simulation, flood/evacuation simulation, examination of the design using 3D VR, and open discussion via Cloud Computing type VR for consensus building were all planned and put into practice. In addition, the implementation of BEMS (Building Environment and Energy Management System, or Smart House) technology is also under consideration.

3. BIM MODELING

As part of BIM (Building Information Modeling), the building was constructed using an integrated BIM solution Allplan (developed by Nemetschek Allplan Deutschland GmbH) and designed by IKDS (Ikeda Kokubun Design Studio).

Figure 1 Rendered image of the appearance of the building

3.1 Creating floor plan, cutaway, and elevation view of the building

Based on the 3D BIM model, floor plan, cutaway, and elevation view were automatically created. 3D modeling can be also be performed with the same intuition derived as if drawing a floor plan. Cutaways and elevation views were created using the "Associative view" function. However, when we attempted to create the cutaway map, two technical difficulties with the software has been observed. If the associate view of a file contains another associate view, or if the scales are different, the walls on the further side of the cutaway map, as well as the windows on the wall, were not properly displayed.

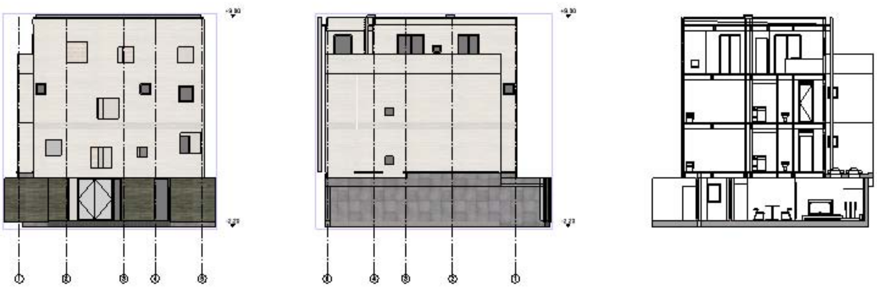


Figure 2 Elevation and cutaway views of the building that are automatically generated by Allplan

3.2 BIM Modeling

We used dedicated BIM tool, “Wall” and “Door, Window” in Allplan for the 3D modelling. In the case of windows, we also made use of the more flexible customization function SmartPart and provided the detailed information to the design studio. In SmartPart window editor, various elements such as a window’s frame, sash, direction of opening, or material, can all be customized, to create a customized design. Furthermore, by editing the scripts in SmartPart, the shape can be also altered at will. Most window design tools do not support the “double sliding window” that is more common-place in Japan. Figure 3 is an attempt at making such a window in SmartPart, complete with the direction of the opening in accordance to the standards proposed by Japan Institutes of Architects, via script editing.

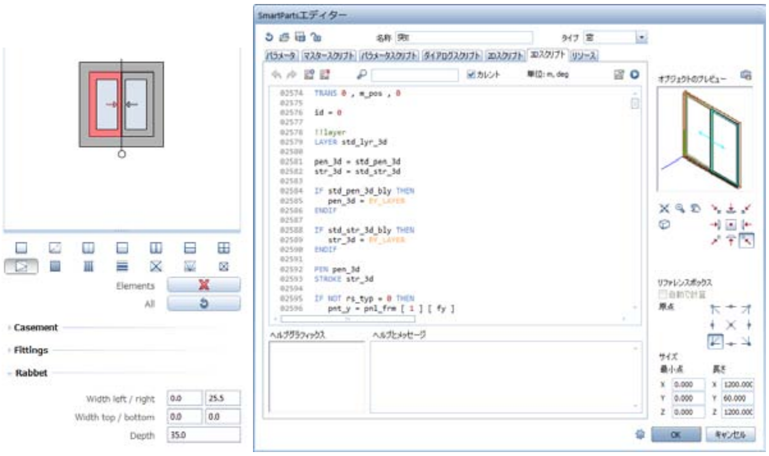
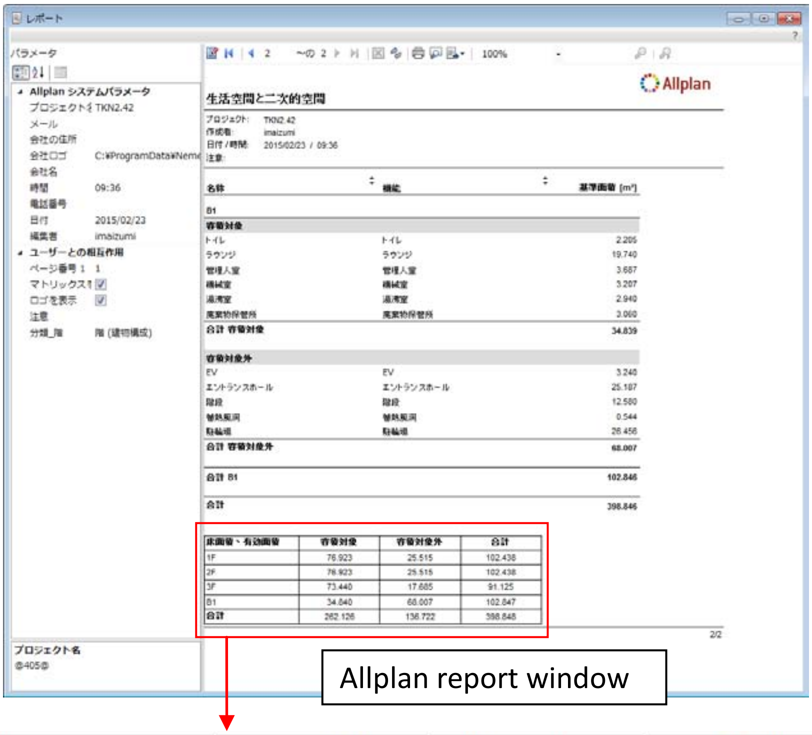


Figure 3 Editing window by changing the script in SmartPart

3.3 Calculating the legal floor space

Numerical calculations are performed by loading and customizing a client report definition file template (.rdlc) from the Microsoft Visual Studio Report Viewer, directly in Allplan. The numerical calculation is used mainly for counting or computing the number of objects placed, the volume and surface area of the 3D object. In our project, we attempted to calculate the floor area ratio to be used for calculating the legal floor space later. To do this, we made some rooms and grouped them together into different groups with Allplan’s “Room” function, and calculated the area of every group. We also had edited the report definition file so that the rentable areas and non-rentable area are both displayed. The Room function also allows room to be defined by measuring its outer frame. Using these functions, we have demonstrated that the data required for building certification application, such as the area of the firewall, net floor area, or rentable area, can be generated and effectively used for rental services.



Floor	Counted	Not Counted	Total
1F	76.923	25.515	102.438
2F	76.923	25.515	102.438
3F	73.440	17.685	91.125
B1	34.840	68.007	102.847
Total	262.126	136.722	398.848

Customized surface area (not according to the plan mentioned)

Figure 4 A customized report

3.4 Data export & coordination

The model data created in Allplan can be imported into the Real-time Interactive 3D VR Simulation and Modeling Software UC-win/Road under the following format:

Table 1 Model data coordination between Allplan and UC-win/Road

File Type	Extension	Import Method in UC-win/Road	Description
3DS	.3ds	Import 3ds	Objects' surfaces are imported as separated layers. Cannot be integrated in Allplan.
COLLADA (1.4.0 & 1.5.0)	.dae	Import fbx	Each object is imported as separated layers. If objects are made of the same materials they can be edited together in UC-win/Road, with detailed elements such as reflectance also customizable.

If an object's surface file (**.surf) or related picture files contain Japanese text in the file names, then the dae object itself or the texture may not be imported properly. Also, if using texture exported from 3DS, then the texture file name needs to be under 8 half-width letters or numbers.

However, it should be noted that it is advisable to not have surfaces intersect or placed too close with each other when creating data inside the Allplan. While in some cases when such intersections are intended to represent multiple layers in the walls, in a 3D VR setting this may cause the surfaces to either clip through each other or cause fluttering.

4. ENVIRONMENTAL SIMULATION

4.1 Wind analysis

The 3D geometry of the surrounding pieces of terrain, roads, and buildings built by the 3D VR software were loaded to OpenFOAM, an all-purpose CFD (Computational Fluid Dynamics) tool, in order to perform wind analysis. As the time required to complete the wind analysis depends on the extent of the area to be analyzed and the size of the grids, an analysis was performed on a wide area extending 400m from North to South and 250m from West to East in the first phase, and then a more detailed analysis was performed by limiting the range to the area covering the building site alone in the second phase.

In the first phase, prevailing wind in the month of July, (when the outside air can substituted for an air conditioner to be used as draft or for natural ventilation) based on the data from Japan Meteorological Agency, was analyzed to determine its wind direction and average velocity, which were northward and 3.83 (m/s), and the wind analysis was performed based on this. The results of the wind analysis were imported to 3D VR space built by UC-win/Road for visualization. There is a park north of the construction site. Since a park forms a depression amidst a group of buildings, the wind will tend to slow down as it reaches the building. This tendency was confirmed in the visualization. The second phase is planned for the near future.

Table 2 Wind speed and temperature in July, at Haneda

	All Day	Morning to Early Night (7AM-22PM)	Late Night to Dawn (23PM-6AM)
Average wind speed (m/s)	4.56	4.96	3.83
Average temperature (℃)	25.88	26.74	24.67

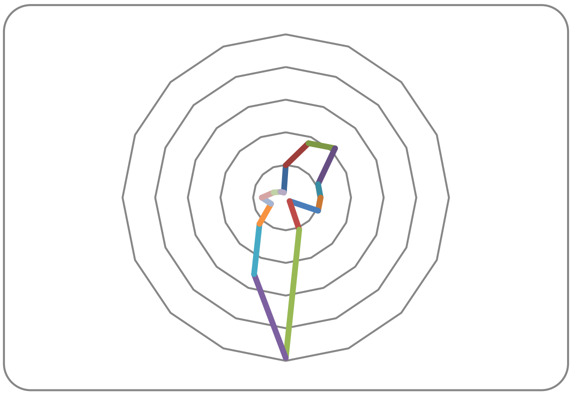


Figure 5 Frequency of occurrence during sleeping hours (23PM-6AM), in July

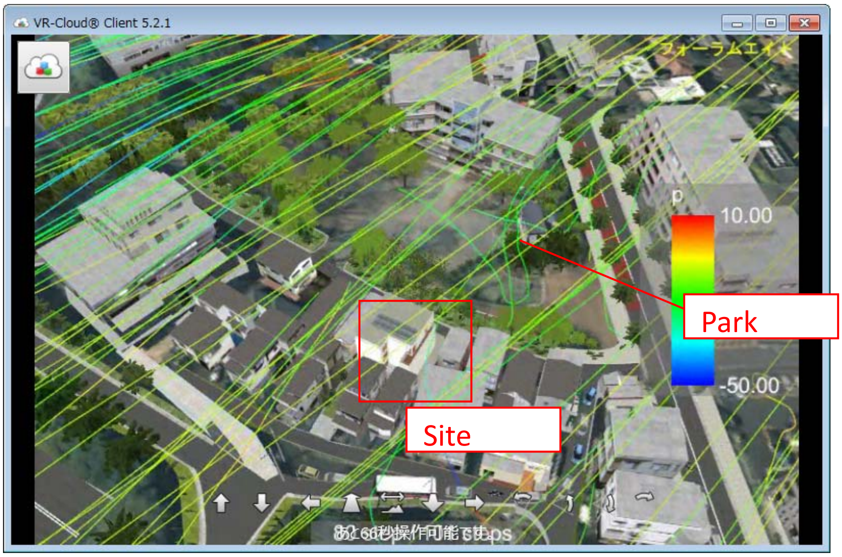


Figure 6 Phase One wind analysis (shown using VR-Cloud).

5. VR SIMULATION

5.1 Sunshine and Shadow Simulation

Before acquiring the land, a sun shadow simulation was performed to ensure the shadow of a high-rise building under construction adjacent to the dormitory would not have any detrimental effects. While on paper this was done and submitted during winter solstice, in a VR setting the date and time can be manipulated at will. This grants us the advantage of reviewing sunlight and shadow regardless of the actual date.

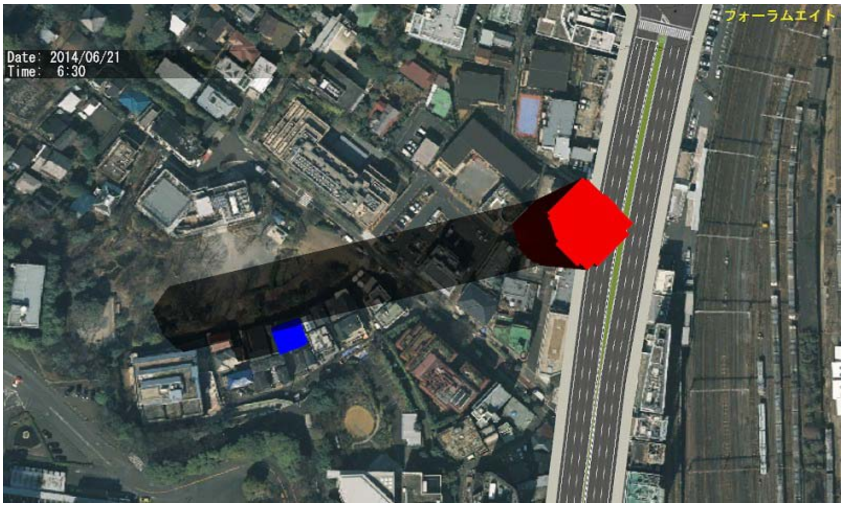


Figure 7 Evaluation of sunshine and shadow

5.2 Point-cloud Modeling

In order to further take into account other various elements inside VR, a 50m terrain mesh data was loaded into UC-win/Road, which was then used to build buildings/roads surrounding the construction site and position the surrounding trees in their correct geographic location based on onsite surveys and observations, all on top of the loaded terrain, to reproduce the surrounding environment realistically. Furthermore, point cloud data consisting of approximately 3 million points collected by 3D laser scanners from the surrounding area were loaded to UC-win/Road to be used as an accurate map on which to place models, or as a guide in understanding the terrain of the site and its surroundings as they are in the real world, as well as the detailed physical relationship between the site and the existing surrounding buildings. As for neighbor building's fence, numerical values measured using one of the functions of the 3D laser scanner which can measure the distance between any given 2 points were used as a guide in BIM modeling.

Figure 8 Neighbor building's fence height is reflected into the BIM model

5.3 Coordination via VR-Cloud

We then reflected the building model into the 3D VR cloud solution software, VR-Cloud, to achieve a higher degree of communication with the design studio over topics such as surrounding environments and wind analysis. Three different exterior design proposals to the building's was discussed and ultimately one was selected, as well as numerous variations to the internal design of the building, while editing and applying any changes or feedbacks directly into the VR-Cloud server in real-time. It is also possible to invite employees who may be living in the building to offer their opinions. Essentially, this is a case of an unprecedented new process of design project planning, information sharing, and consensus building.

Figure 9 Evaluation of the external design. Three different proposals and one selected for adoption.

CONCLUSION

With BIM software Allplan and its SmartPart script editing, as well as the customization of report templates, we were able to successfully design and recreate a Japanese-styled architecture in this case. By successfully having imported models into UC-win/Road, we were also able to create some modeling tips that can be applied to future Allplan projects. Furthermore, we have also demonstrated a hub software that is capable of providing numerous different types of simulation software data.

By having BIM aiding in the creation of a more efficient project planning process, the time saved due to this higher efficiency can be reallocated into further refinements to the original design to accomplish a project that is high in added-values. While in this case study we only ended at the design phase, we have demonstrated how it is possible to achieve numerous complicated design considerations via IM & VR solutions. It can be argued that the bigger scaled the project is, the more benefit could be gained via such a solution.

The interactive VR software UC-win/Road has performed a pivotal role in the visualization of individual simulation and analysis results. With a 3D recreation of the simulation, it is much easier for us to relate it to the reality and to have a better picture of what may happen in the reality. Furthermore, since all simulations are done in real-time without delay, it is much easier to formulate feedbacks or comments. When further combined with a cloud-based VR, in this case VR-Cloud, we have essentially accelerated the process of consensus building between various parties of stakeholders. The cloud-based VR system mentioned here will be further used during construction phase, as well as even after completion, and will have its 3D VR data updated according to new status or proposals. While a cloud-based VR allows anyone the easy navigation throughout a virtual world, finding an intuitive way to display numerical or written data has been an improvement area worth further investigation. We plan to develop newer interface and features for displaying such information in future versions of the software.

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NO.19

Construction of Urban Design Support System using Cloud Computing Type Virtual Reality and case study

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Key words: Urban Planning, Design Support System (DSS), Virtual Reality (VR), Cloud-Computing type VR (Cloud-based VR)

Abstract: In this paper we contribute a design support system of cloud-computing type virtual reality (cloud-based VR) for urban planning and urban design. A platform for Cloud-based VR technology, i.e. a VR-Cloud server, is used to open the VR dataset to public collaboration over the Internet. The digital asset representing the design scheme of design concepts includes the Land Use Zone, Building Regulation, Urban Design Style, and other Design Detail of Architectural design, landscape, Traffic/ Architectural Environment/ Sunshine/ whether/ Noise/ Inundation/ Tsunami/ Earthquake/ Evacuation Simulation. Then practice used this cloud-based VR urban design support system into 3 cases which are in different applicable category of in one room and Synchronized、 distributed synchronized、 distributed non-synchronized. Meanwhile, we evaluate the effect of this system using in urban design and urban planning process.

1. INTRODUCTION

In this paper we contribute a design support system (DSS for short) of cloud-computing type virtual reality (Cloud-based VR for short) for urban planning and urban design.

The process of urban planning and city design industries in Japan often can be divided into a series of different phases: conceptualization, detail formation, and support & maintenance plan formulization. During conceptualization there are multiple components that must be considered: it is important to examine the neighbouring environment, positioning & scale size, structural design and durability, and long-term (20-30 years) goals of the project in question. As the project moves on to detail formation phase, designers would start focusing on the numerous value-added features that is to be integrated into the project. Given that the goal or contracting partner between different phases of the project can vary, the necessity of effective consensus building before transitioning to the next stage is apparent, to successfully carry out a project.

The aforementioned issue is especially true if the project in question follows the idea of participatory planning, where the locals' or the stakeholders' opinions needed to be considered. To achieve this, numerous DSS have long been developed. However, to ensure such urban design support systems (UDSS for short) continue to properly serve its purpose in-between different phases, it is important to seek ways to extend either the reasons or chances that a system can be continually used.

Michael J.Shiffer (1995), proposes and categories the situation when DSS is used, into the following 4 c ategories: 1. the same-place same-timed "synchronized communication within the same room", 2. t he same-place differently-timed "non-synchronized communication within the same room", 3. the different-place same-timed "distributed and synchronized communication", and 4. the different-place different-timed "distributed and non-synchronized communication".

Virtual Reality (VR for short) spaces that can be navigated, as w as observed in some large scale VR software such as Second Life or Active Worlds, has the potential to be used for the purpose of consensus building. The incorporation of VR into UDSS, and features such as building reconstruction or renovation design games, urban landscape design, Geographic Information System(GIS for short) or evacuation simulation, have long been a hotly researched or developed topic due to the versatility of a VR environment. Richard K. Brail (2001) proposed an UDSS by incorporating three-dimensional computer-aided design (3D CAD for short) technologies to achieve effective communication between stakeholders and designers in his research. Nagano et al. (2008) once recreated a v irtual environment on the internet for the purpose of surveying the local residents for opinions, while publicizing all decisions and procedures of the design committee. Thea et.al (2009) attempted goods transportation inside a VR simulation [4]. Abdelhameed et al. (2012) proposed a VR microsimulation player to visualize the entire construction process of a building. Tajika et al. (2010) predicted and simulated road traffic noises inside a VR environment with interactive audio and visual playback capability. Shioi et al. (2011) attempted the construction of a 2050 future city inside a VR environment. Kawano et al. (2005) conducted surveys and examined the usefulness of a 3D VR being used as a consensus building tool. Shen et al. (2007) has created a web-based application where users can easily create their own VR designs. Shen and Kawakami (2010) proposed an online urban aesthetic design and visualization application. Shen and Lei et al. (2012-2013) proposed a UDSS based on 3DVIA and Google Earth to support urban design. Finally, with the advent of cloud computing technologies, UDSS have now been attempting to leverage on this technology.

The fundamental concepts of cloud computing can be traced back to mainframe computing era as ea rly as the 1950s. Farber, Dan. (2008) proposed the advantage of cloud computing is the elimination of the hurdle of hardware spec limitations; in theory, any user with any device would be able to access and utilize a certain application or data through the internet. Due to this, the proliferation of broadband internet has cloud computing a popular subject since 2007(Grozev N., Buyya R. (2012)).

Existing cloud computing technology researches nowadays have seen increasingly wider uses. Computer scientists of all sorts have been heavily focusing on cloud computing technologies in hopes of achieving sustainable information services (Chowdhury G. (2012)). Further, with the proliferation of smartphone devices, many mobile cloud services have been designed with these users in mind (Grover (2013) Ngai (2013) Michael (2013). Vries (2013) Ma (2012)). Due to cloud computing's expandability, accessibility, and potential for cost-cutting, it is extremely popular also in geographical researches (Huang (2013) Guan(2013) Marques (2013)). On the other hand, cloud computing easily allows big data collection while providing a service or a part of the social infrastructure (Laurila (2013) Whaiduzzaman(2013)).

As witnessed, cloud computing allows communication between different devices with more ease and can be argued to have an unrivalled amount of potential uses, hence the popularity across various parties.

Cloud-based VR, with the development of numerous simulation features, and a more customized user interface, can also have many different uses. Especially given the current mass market penetration of mobile devices, an era when devices are no longer bound space, time, or performance issues, the amount of potential and efficiency of portable computing devices being used for consensus building is unimaginable. With this in mind, Fukuda et al. (2011) examined the usability of a cloud-based VR being used as an urban planning support tool, under a distributed and synchronized communication situation for project discussion. Recognizing the potential of using cloud for the purpose of an online collaborative project service, Shen and Ma et al. (2014) compared existing technologies or products such as Google Earth, 3DVIA, and cloud-based VR, over technological feasibility.

Having introduced the existing researches, it can be argued that a cloud-based VR has the potential to bring several major changes to the urban planning processes.

This paper is categorized as the following: Chapter 2 briefly touches on the possible method used to help accelerate a cloud-based VR being used for online consensus building. Chapter 3 describes the fundamental components of a cloud-based VR. Chapter 4 gives 3 latest case studies of how a cloud-based VR has affected the urban planning & design process of each project. In this Chapter 5 this paper attempts to argue what exactly has been altered during each planning phase, based on the qualitative findings taken from the 3 cases. And finally, we will address some of the issues that will and should be addressed in the future.

2. RESEARCH APPROACH

The research method is described here. We developed a urban planning application based on cloud-based VR technologies in 2010, with the purpose of information sharing between different phases of urban planning, and have collected several use cases during these years. Due to paper limited not all the details and design content will be disclosed in this paper, but only some cases of the positive observations.

As was mentioned, we will raise 3 different cases that involve using a cloud-based VR urban planning support application and examine each of them carefully. The 3 cases are all different in category: “synchronized communication within the same room”, “distributed and synchronized communication”, and “distributed and non-synchronized communication”

Lastly, we will examine how using a cloud-based VR urban planning support application can have either positive or negative impacts on the process of urban planning and design.

3. THE FUNDAMENTALS OF A CLOUD-BASED VR UDSS

To aid effectively in urban planning, an UDSS should satisfy the following 3 fundamental characteristics: visualization of the project, information sharing between different parties, and as a means to conduct surveys to collect as many opinions as possible.

To visualize a project, we have used the 3D VR simulation software UC-win/Road®, in conjunction with VR-Cloud® that is capable of representing a UC-win/Road project through cloud computing, to achieve consensus building. Both are developed and are intellectual properties of Forum 8 Co., Ltd.

By replicating the project as a 3D VR environment through UC-win/Road, abstract information such as the design concept, future outlook, or impact to the neighbourhood area that cannot be verbally communicated convincingly, can be represented in a much more interactive and vivid fashion. Furthermore, the software provides numerous simulation features to reproduce elements such as traffic, sunlight, wind, noise, tsunami, flooding, earthquake, or emergency evacuation, as well as the incorporation and visualization of numerous BIM and CIM analysis results easily. Interactive multimedia features such as pop-up text, pictures, or sounds can also be used.

Information sharing and opinion collection is done through the

VR-Cloud®, which allows for quick and easy accessibility of information. Clients will install a client version of VR-Cloud® and access the 3D VR data stored in the server via internet. The VR data is then rendered by the server and streamed back to the users' computing device; any input commands or manipulation to the VR data is then sent back to the server and immediately reflected and sent back to the user in a real-time fashion. The compression standard of the streamed VR data is done in H.263. By using this method, even thin clients that do not possess a powerful computer can view, control or edit traditionally hardware-demanding 3D VR data without needing to replace their devices, as long as there is a sufficiently stable internet environment. Through this type of cloud computing technology, real-time information sharing of BIM/CIM data has been made possible.

To further communicate between various parties, additional features such as 3D bulletin board or annotation are also available in VR-Cloud® and can be saved and archived into the cloud server to allow distributed or unsynchronized discussion. Using these features, it can be safely argued that such technologies will greatly aid in the urban planning development processes.

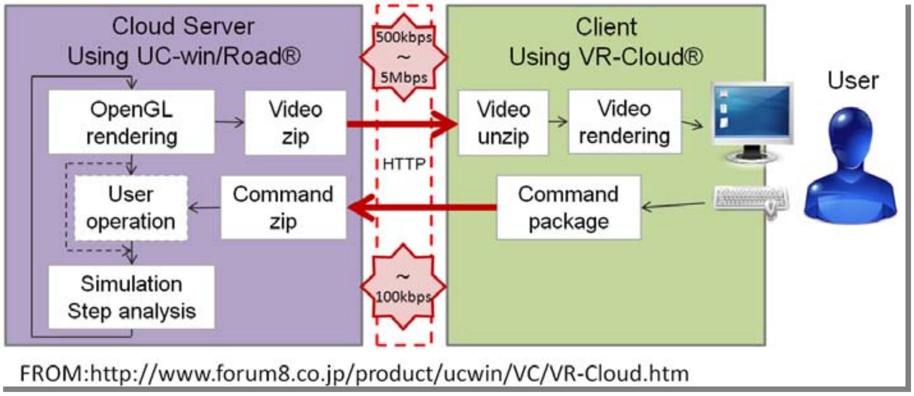

Figure 1. Composition of a cloud-based VR service

4. CASE STUDIES OF USING A CLOUD-BASED VR UDSS

In this section, we will examine 3 different cases that have made use of the type of cloud-based VR UDSS that was previously mentioned.

4.1 3D Digital City Under a DistributeD non-synchronized communication situation

By projecting and replicating an existing city inside a virtual setting, we seek to simulate or replicate situations such as either the future prospects, potential travel spots, or road work simulation. Combined with a cloud-based VR UDSS, we attempted to achieve effective sharing of information such as simulation/analysis results, aesthetical impact, even under a distributed non-synchronized communication situation and observed the effects of how it has aided in the collection of opinions or in the decision making process. The use cases date as far back as 2011, and a portion of it is represented in Table 1.

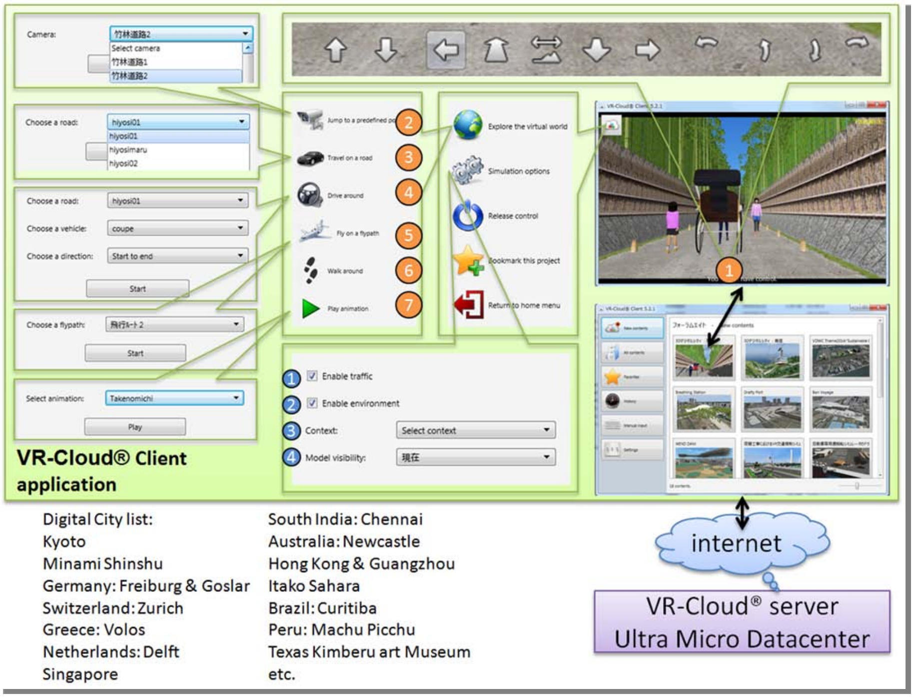

Figure 2. Composition of 3D Digital City System

The following is a description of the system's composition and control interface.

First, clients will download and install the client version of VR-Cloud®. If the client uses a PC, this is done via links that can be accessed through a web browser; if the client uses a mobile device it can be done with either a web browser or a QR-code reader. Once completed, upon accessing the link that is relevant to the project, VR-Cloud® will automatically activate and the 3D VR environments displayed. Or alternatively, upon execution of the newly installed software directly, clients will be able to connect to the contents server and can look for the project of interest. Once the VR data is properly accessed and loaded, VR-Cloud® can then be used as a distributed and non-synchronized communication system.

Initially, users are not granted controls to the VR data. By clicking on the icon on the top-left corner, users can take control of the VR environment and freely adjust the camera to their point of interest or navigate through the VR space. Additional advanced control features are introduced in the following section and shown in figure 2:

1. By using these arrow icons, users can interactively manipulate the camera or navigate inside. Depending on the system used, it is also possible to use keyboard & mouse directly.
2. Jump to a predefined position. This command jumps to a certain camera position that was designed by the creator for a specific reason.
3. Travel on road. This command makes travel on the road with limited control possible.
4. Drive around. This command puts users into a c ar which can be driven.
5. Fly on a fly path. This puts the user into flying mode that follows a predefined path.
6. Walk around. This command allows free movement inside the space with collision elements.
7. Play animation. This command allows users to see an automatic scripted event or presentation that is predetermined by the original author of the VR project. Elements such as multimedia, simulation, or text boxes/captions can be shown.

The following lists some of the elements that can be switched on or off:

1. Enable Traffic. This command enables random traffic on the road.
2. Enable environment. This command enables environmental changes such as time progression, weather effects, or wind (as well as what is affected by the wind).
3. Context. This command allows users to switch between different context and settings (such as traffic volume, environmental themes) that are predetermined by the author.
4. Model visibility. This command enables the visibility of the models, such as trees or buildings that have been placed.

To collect the voices of stakeholders, numerous communication options are also available. In VR-Cloud®, it is possible to start a new discussion or view discussions started by others, as well as u ploading screenshots. All changes can be viewed independent of each other, making it easy to determine who and what has been done to the project.

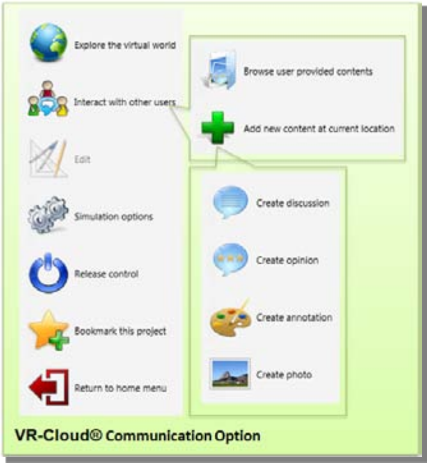

Figure 3. Communication features

Using this system, the simulation of existing cities and the joint synergy between BIM/CIM data, together with the cloud, makes it able to achieve many of the features that defines a VR system while maintaining a high degree of navigation, without any limits imposed by hardware specifications. Users can freely examine elements such as traffic, tsunami, and many other situations from anywhere (see Table 1).

Table 1. 3D Digital City content samples that are publicly available

Name	Publication Date	Description	Category
Kyoto	2015.01.21	The digital replica of the popular Arashi-yama tourist spot and the Hiyoshi-Dam located upstream. A night promenade along the roads to Nomiya Shrine is possible.	Night-view, Pedestrian Simulation
Iida, Nanshin Area	2014.10.15	The digital replica of a steep slope that is 800-1000m above sea level in Shimoguri-no-Sato, Iida. All four seasons' views of Nanshin is simulated as well. A high-speed drive through experience inside a 500 km/h Shinkansen is possible.	High-speed Vista Simulation
Freiburg and Gosler	2014.07.10	The area of Vauban and Goslar of the Green Capital Freiburg, Germany, is recreated through 3D data. Green housing designs such as roof solar panels and concepts such as collecting and redirecting rainwater directly into the soil is also properly represented.	Vista and Green Design
Kimbell Art Museum	2011.11.01	Kimbell Art Museum from Texas is recreated via VR, from the exterior into the interior.	Building and Internal Design
xpswmm Tunami Analysis	2012.04.12	Tsunami-analysis results are recreated on a VR environment using xpswmm. The model used here is the replica of a 1 km coastline inside Kamaishi-City, complete with residential buildings, road signs, and roads.	Vista and Tsunami Analysis

All VR data had scripted events or auto-navigations created by their respective authors to aid in the understanding of the project and reduce the learning curve of having to navigate through a VR project suppose the user is unfamiliar with the controls. The scripted events can be paused anywhere at any time and be switched to any other movements the user sees fit. The systems great accessibility ensures all stakeholders such as the locals can all participate online.

Looking at these distributed and non-synchronized communication use cases, it is observed that a cloud-based VR being used as visualization and communication tool is more complete than ever. Looking from the perspective of the residents, 3 major effects can be observed:

1. Ease of Building consensus

Users can view the project and its various elements visually from anywhere at any time, while communicating between different users. The various simulation and analysis results can all be viewed at will and makes the local residents' understanding of the project substantially easier. The drawbacks of an internet-based system such as latency, low resolution, input lag, are remedied by placing ordinary video files of scripted events.

2. Increase in efficiency of consensus

By having an effective communication mentioned in the previous circumstance, residents can easily provide more accurate opinions to what needs to be changed. However, one drawback here is that while opinions are shown as individual icons, there is currently no possible way to export them into the form of a graph or text.

3. Cost-cutting

Automatic presentation via scripted events lightens the burden on the system administrator to run, explain or maintain the data. All cases mentioned here were available all 24 hours, with a maintenance staff doing simple checks twice a day.

Figure 4. 3D Digital City data available on the Official HP

4.2 Junior Urban Design Seminar under a Distributed Synchronized Communication Situation

As witnessed, using VR data to ensure effective information sharing to reach consensus has increasingly becoming more important nowadays.

The same UDSS used in this paper is also used by the seminar "Junior Software Seminar 'バーチャルな 3 次元空間を作ろう！' (lit: let's make a 3D virtual space!)", which has been held since 2014. In this seminar, students from elementary to junior high school spend 1.5 days on a workshop and learn to use VR software as a form of extracurricular activity.

As seen in Figure 5, the seminar connects 6 different places into one via teleconferencing to transfer voice and visual data. A lecturer from Tokyo directs and teaches the students how to create a VR urban space remotely.

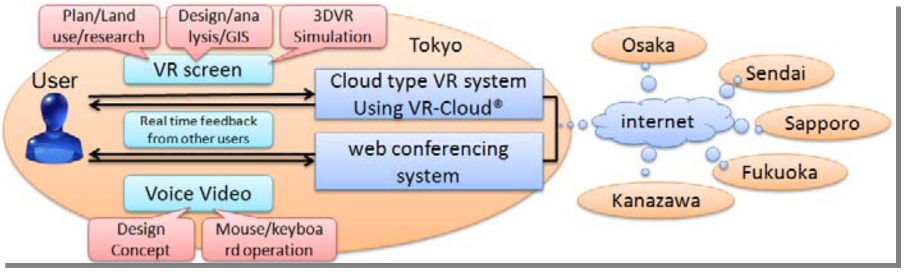

Figure 5. Composition of Distributed and synchronized presentation system

During the 1st day of the seminar, the lecturer shows to the students some basic controls and procedures on PC, which is also transferred to remote areas. Students will experience the making of roads, intersections, bridges, tunnels, trees, and positioning of building models. In the second day, students are given free control over a theme of their choice, and are free to make even exotic project such floating cities, or fictional race circuits. Students would then do a brief presentation of their project later in the day via the cloud server.

The presentation, as represented similarly to Figure 6, is done by having both the presenter and the audiences accessing the same VR data via the cloud server. Through this, all participants would look at and listen to the presenter's manipulation of the VR data; as usual, participants that are remote to the presenter can still be connected via teleconferencing methods.

As shown in Figure 7, all VR city data remain publicized on the server as a user content case and can be accessed by clients after the seminar as well. Notice that however in consideration of internet latency, instead of creating a cloud server from the PC used; it is copied to a dedicated VR data server known as Ultra Micro Data Centre.

With a cloud-based VR, students are able to view and confirm each other's work, and borrow or share ideas with each other to further refine their own designs. Eventually, this could result in some excellent urban projects that are created by teenagers or under.

Left: Tokyo. Right: Osaka, with the presenter presenting a project via a tablet remotely.

Figure 6. State of presentation

This case of undistributed and synchronized communication case also demonstrated how a cloud-based VR UDSS can also be used as a means to effectively connect the various stakeholders or designers to achieve consensus during the design phase of a project, regardless of where. In addition, since an opinion can be reflected immediately under a synchronized situation, this automatically may translate into higher efficiency in communication.

The use of uploading information to a cloud server instead of using the PC itself as a cloud server also greatly reduces internet latency or hardware related video problems. However, as internet speed and stability, as well as further improvements to hardware power over time may eventually eliminate the need to use a dedicated server.

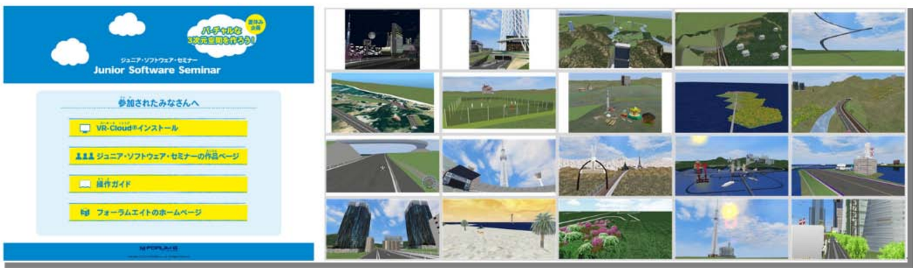

Figure 7. List of contents available and the main menu

4.3 Student BIM/VR Design Contest Judging system

In an urban planning and design project, it is arguably important to invite numerous experts or scholars to join the review and discussions. Upon realizing what the original intents or design concepts, they would be able to objectively voice their expertly opinions as well. Thus, the easier this process is the better.

A similar system has been done during the 4th "Student BIM & VR Design Contest on Cloud", in 2014. Four regular judges as well as specially invited guest judges would review, evaluate, and judge all projects submitted.

In this Design Contest, students all over the world make use of BIM/CIM and VR and compete to design advanced buildings, bridges, cities or landscape data that is relevant to a pre-determined location and theme. The judges will then perform numerous simulations that are relevant to the theme of the competition and determine a winner. The final work is composed 3 parts: VR data that set the script for automatic presentation which can explain the design concept, Design Data that created by the design software which produced by FORUM8 Co., Ltd., the concept poster.

The following is a description of the system. As seen in Figure 8, around 30 projects are made into concept posters as well as being uploaded into a VR exhibition space in the form of a poster object, accessible via cloud server. As the user navigate closer to the virtual poster object in this VR exhibition space, all expertly comments will be shown; clicking on it would load up the cloud application, in a similar fashion to section 4.1.

In this contest two judgement rounds are present, one being a distributed unsynchronized communication type for all nominated projects, while a final judgement round would take place in the state of a synchronized communication within the same room.

Figure 8. Composition of the judging system

The nomination judgment phase lasts for one week, where the 4 regular judges would access the uploaded VR data via VR-Cloud® installed devices using unique ID during their free times. They would then give points to each project panel as well as their expert comments. Students on the other hand, are given a unique ID and can also access the virtual exhibition room to evaluate and provide feedbacks to their competing teams. Once the nomination round has been closed, the top 15 teams with the most point s would advance to the synchronized communication within the same room-typed final judgement round.

During the final judgment round, all entrants would undergo through a defence presentation against the judges' questions or criticisms. All judges would share their discussion via cloud systems.

Figure 9. Final judging round and Grand Prix

In this case, we have witnessed both a distributed and non-synchronized communication typed nomination judgement round, as well as the synchronized communication within the same room-typed final round. Participants made effective use of urban planning tools, and are evaluated against different alternative submissions to select the best project possible.

Given that is the same systems has been successfully used for different categories of plan communication types, it is safe to claim that a similar system can also be used for similar situations such as during information publicizing, participatory development, or public hearings.

However, to maintain fair judgement and information transparency, anonymous reviews and feedback must considered carefully before implementation.

5. IMPACT TO THE URBAN PLANNING PROCESS DUE TO A CLOUD-BASED VR

Having examined all three cases, it is expected that a cloud-based VR UDSS can have several improvements over urban planning processes.

The visualization features can greatly involve more participants than ever; spatial, conceptual, structural, or environmental information can be more smoothly communicated to various parties to ensure that the most reasonable opinions can or are properly reflected.

Once again, since data is accessed via a cloud computing server that can be used regardless of a user's hardware specifications, time or location, all participants can freely participate and share information more easily and effectively, resulting in more opinions to refine the original design. This can lead to 2 important implications:

The first, is that consensus building during the earlier concept or design phase of a project has indeed become easier with a cloud-based VR UDSS. With a tool that effectively involves and connects more people into the project, all parties, regardless of expertise or background, can effectively communicate with each other and eliminate asymmetrical information to obtain a higher level of project understanding. Further, the involving of local residents greatly improves the transparency and fairness, is also worth considering.

A second conclusion is that such a UDSS greatly improves the speed, cost performance, and efficiency of the urban planning industry. With information parity achieved across different parties, as well as an integrated assistance and simulation package that can be used during all phases of an urban planning process, experts of different background can effectively communicate with each other and make the necessary evaluations in a much more time-efficient and cost friendly manner. Furthermore, this also allows quicker implementation or testing of opinions from numerous parties, potentially achieving a higher reliability as well as trust.

6. CONCLUSIONS

In this research, we have examined how a latest cloud-based VR urban design support system can affect a project. Three different cases have been examined and all three showed implications of how such a system can aid in the increase in quality, consensus & trust, reliability, transparency, efficiency, and cost-effectiveness.

Future prospects to refine these tool designs include elements such as further design simulation to assist in designs, a more progressive 4D VR environment that considers temporal elements, support of multiple inputs from multiple users, as well as the support of future wearable computing devices.

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Cloud-based Virtual Reality for Consensus-Building in Urban Planning and Design

A Case Study of One Foundation Disaster Prevention Park in China

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Key words: Consensus-Building, Online Discussion, Cloud-based Virtual Reality, Disaster Prevention Park, Sustainable Urban Design

Abstract: In recent years, designers have used various types of tools, such as public Participation GIS (PP GIS) and VRML, to improving consensus in the process of urban planning and design. However, these tools were frequently criticized as being too complex for the majority of potential users. Moreover, due to the limitations of data compression, hardware performance, network bandwidth and costs of current virtual reality platform, the users need to gather in the same place and at a certain scheduled time in different phases, or download the virtual environment and avatar models from the Sever through the Internet, then held on the local computer. Cloud-based virtual reality technology is acknowledged as powerful tools, which provide a communication platform for users. This paper focus on how to improving consensus in design alternatives discussion of One Foundation Disaster Prevention Park of in southwest of China, through using cloud-based virtual reality technology. We build a cloud-based virtual reality platform to proposing design alternatives, understanding and deliberating design concepts through the Internet, and examined how to share urban planning information (such as design concepts, design alternatives and planning proposal to the owners, and how to make this platform easier to comprehend and work with to improve consensus in design alternatives report meeting eventually. The application results show that the cloud-based virtual reality platform proposed in this paper not only can simplify the discussion of design alternatives without the limitation of space and time, but also can improve the efficiency of design alternatives discussion to reach a consensus without any extra expense.

1. INTRODUCTION

In this paper we contribute an application of cloud-based virtual reality technology for improving consensus in design alternatives of One Foundation Disaster Prevention Park of China. We built a cloud- based virtual reality platform to proposing design alternatives, understanding and deliberating design concepts through the Internet. We examined how to share urban planning information (such as design concepts, design alternatives and planning proposal) to the owners, and how to make this platform easier to comprehend and work with to improve consensus in design alternatives report meeting eventually.

1.1 Consensus-building in urban planning and design

In the process of urban planning and design, a consensus-building process among a variety of stakeholders like project executors, architects, residents, users, and general citizens is required (Innes, J.E., 1996). Consensus building (also known as collaborative problem solving or collaboration) is a conflict-resolution process used mainly to settle complex, multiparty disputes (Burgess, H. and Brad S., 2003). A consensus can therefore be achieved through social and technical constructions which enable unfettered dialogue for discussion (Poplin, A., 2013). An integration of geographic information systems (GISs) with public participatory tools represents one of the latest innovations in this area. Public participatory GIS (PP GIS) research discusses ways of integrating the new applications into participatory processes and considers which new functionalities and technical characteristics could offer the most benefit to users (Al-Kodmany, 1999; Carver, S. et al., 2001; Brown, G. et al., 2011). However, these technologies and other map-based applications were frequently criticized as being too complex for the majority of potential users (Steinmann, R. et al., 2005). Furthermore, different visualization tools were used in different phases of the planning process, and the participants need to gather in the same place and at a certain scheduled time in different phases.

New forms of collaboration and technical solutions emerged during the Web 2.0 era (Poplin, A., 2012). For example, Google Maps and Google Earth can be used by lay users and non-experts without intense training. As stated by Wu (2010), the Internet is undoubtedly the best way of sharing urban planning information.

Shen and Kawakami (2010) developed an online visualization tool to attain consensus on townscape design within local planning committees. In this system, participants can select design elements to visualize different alternatives in real time, and experience dynamic scenes of generated virtual townscapes in the VRML world. In their case study, this visualization tool were successful in sharing a common image, and participants were motivated to become involved in deliberation on various aspects of planning and design during committee meetings, and participants can explore from the Internet without spatial and temporal limitations.

Moreover, Gordon, E. et al (2011) proposed that new digital immersive technologies may help to achieve a consensus among different stakeholders and move the whole project towards “collaborative rationality”. In order to improve the understanding of stakeholders with respect to the planning concepts for reaching a consensus, Shen, Z.J., Kawakami, M. and Kishimoto, K. (2012) attempted to support planners in presenting their planning concepts during virtual meetings using web-based multimedia materials. Also, AlQahtany, A., Rezgui, Y., and Li, H.J. (2014) gave a comprehensive review of the current state of urban planning in Saudi Arabian cities and specifically within the capital city of Riyadh, and discussed some of the schemes that have been adopted, then proposed a consensus-based framework for the sustainable urban planning development. Additionally, Vemuri, K., Poplin, A. and Monachesi, P. (2014) developed a game that aims to support consensus building in a complex urban planning situation. Their study case was taken from India and focused on a very diverse slum area Dharavi. The complexity emerges due to the variety of different stakeholders’ interests and their specific visions about how this area could be developed and renewed.

1.2 Research objectives: improving consensus in design alternatives through cloud-based virtual reality

Despite there is a strong hierarchical administrative system in China, it is found that the city-region planning did not work well, due to a lack of actor interaction and information exchange during the top-down planning process, and the difficulties in specifying detailed planning contents. The findings echo the recent experiences in Western countries that emphasize the needs of interaction, negotiation and consensus building in the planning process (Luo, X.L. et al., 2008). Virtual reality (VR) system has been used as a tool for simulation and negotiating design alternatives, to gain consensus building (Lorentzen, T. et al, 2009), and the Internet provides informational services through various devices, it has evolved from an information distribution tool into a network for informational interaction (Deng, Z. et al., 2015). So, the combination of virtual reality (VR) technology and the Internet will become a feature of the next era, and provided a good method for consensus building. However, most online virtual reality platforms have the limitations of data compression, hardware performance, network bandwidth and costs in currently. Besides, the Clients need to download the virtual environment and avatar models from the Sever, and then held on the local computer (Smith, A. et al., 1998). Moreover, since the participants involved in online discussion have lived and evolved in physical environment, the differences between real world and virtual world may be seen as problems which are due to the limitations of current VR technology, and the real problems of design alternatives in virtual world will be difficult to identify. Thus, in order to provide a more realistic virtual environment, the virtual environment need to be compromised with several spatial entities and events , and these entities and events ought to supply a environment in which accommodate human activities such as navigation, interaction and communication.

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction (Mell, P. et al., 2011). There is no e xact definition of cloud-based virtual reality (cloud-based VR) until now. From a technical point of view, cloud-based virtual Reality (Cloud-based VR) is a new technical which combine cloud computing with virtual reality, and provide synchronous transmission and interactive services for large amounts of data, such as v ideo, 3D model data and virtual scene. In the case o f consensus building, users can employ cloud-based VR system in a participative process, and the cloud-based VR technology can serve as a software tool for planning to publish design proposals, and for stakeholders to share designs and communicate with each other to reach mutual goals through the Internet (Shen, Z.J. et al., 2014).

To address this, in this paper, we will focus on h ow to improving consensus in design alternatives discussion of One Foundation Disaster Prevention Park of in southwest of China, through using cloud-based virtual reality technology. We will build a cloud-based virtual reality platform to proposing design alternatives, understanding and deliberating design concepts through the Internet, and examine how to share urban planning information (such as design concepts, design alternatives and planning proposal) among the participants, and how to make this platform easier to comprehend and work with.

The structure of this paper is as follows. In Section 2, we will discuss the research approach in this study. In Section 3, we will present how to build a cloud-based virtual reality platform that allow owners access the virtual environment to understanding and deliberating design alternatives through the Internet. In Section 4, we will take a Disaster Prevention Park as a case study, and validate the effectiveness of cloud-based virtual reality platform in improving consensus in design alternatives discussion. Finally, in Section 5, we will complete the paper with conclusion and future work.

2. RESEARCH APPROACH

Virtual design tools such as 3D modelling and simulation are becoming increasingly sophisticated and integrated. We believe their potential is best realised when they feed into an advanced design process that brings to life the interactions between designers and between each design element. So, in order to promote the use of cloud-based virtual reality technology for consensus building in urban planning and design, we present a case study of a disaster prevention park planning project in southwest of China. Our study did not consider details on the park location; we made the detailed planning in function orientation, architectural design and infrastructure planning of the park. We created 3D object models according to the design alternatives in a virtual environment.

In this study, we build a cloud-based virtual reality platform for consensus building in design alternatives report meeting, so that the participants, including the owners and the designers, can share common virtual environment, discuss and solve planning and design problem through the Internet. The designers can easily modify the design alternatives in the virtual environment through calling 3D model database to insert 3D object models, and the owners can compare different design alternatives. Participants also can clearly understand planning and design alternatives and reach mutual understanding, or common awareness.

As previously described, we attempt to improve consensus in design alternatives. We employed SketchUp and UC-win/Road to create a virtual environment representation of the park's design alternatives in southwest of China. We also made use of cloud-based virtual reality platform to achieve consensus on design alternatives discussion eventually.

2.1 Virtual environment design

In virtual environment design, UC-win/Road is a software platform that is used to generate and present a visible and interactive 3D environment. The software can be used for various applications such as urban planning, traffic simulations, and construction demonstrations. The extensive features and visual options allow the formation of detailed virtual demonstrations can be presented and manipulated in real time.

The work of virtual environment design comprises three components. First, we will import the terrain data and street map information to create terrain for virtual environment so that the design can be carried out in this land. In this step, we will not consider details on the park location, because the owners did not get the right to use this land from the government, they are negotiating with the government by now. Second, we will use SketchUp to create 3D object models, and export to "*.3d" format that can easy be imported to UC-win/Road as the design element of 3D model database for virtual environment design. As a good 3D modelling software, SketchUp successfully unites principles of line drawing with 3D for a bare-bones program that lets designers produce surprisingly complex 3D artwork. Third, we will import the 3D object models, including building models, landscape models, infrastructure models, and adjust the visual options such as weather and sun position, and set human agents move through pre-defined routes, to design the virtual environment.

2.2 Achieving consensus in design alternatives

In a sense, the virtual environment is the virtual design alternatives. The virtual environment can be observed through the software's interface which called "VR-Cloud Client" on the desktop PC of each client. Free navigation in real-time allows the client users to observe the 3D virtual environment from any location and angle. Scripts and scenarios are designed to present the design alternatives and simulation scenarios that client users can understand the design alternatives more clearly. For basic simulations, people act as intelligent agents and obey the behavioural characteristics, and vehicles also act as the intelligent agents and obey traffic rules. When one people or one car is controlled by the mouse or keyboard of client computer, client users can walk or drive freely through a road network or scenario, and a responsive virtual environment enhances the user's sense of presence.

The heart of consensus building is discussion, debate, and deliberation (Susskind, L. et al., 1999). Thus, we will configure the cloud server that users can explore or evaluate the design alternatives via the mouse and keyboard operation, discuss and solve some planning and design problems through the Internet, and achieve consensus on design alternatives.

3. CLOUD-BASED VIRTUAL REALITY PLATFORM

Cloud-based virtual reality (Cloud-based VR) is based on UC-win/Road 7.0 (VR-Cloud Edition) and is used to share 3D virtual content over the network, whether on an office LAN or on the Internet. Clients who access the content are able to navigate through the virtual environment using basic UC-win/Road navigation modes (free, travel, driving and so on). The global parameters of the virtual environment such as the time of the day and the weather can also be configured by the clients. Cloud-based VR also provides cloud-based collaboration features. Users can create graphical annotations at any location in the virtual environment to provide better understanding of the modelled environment. Clients can also discuss using 3D forums. They can create new discussions or reply to discussion of other users.

3.1 The framework of Cloud-based Virtual Reality

The framework of Cloud-based VR Platform is shown in *Figure 1*. This platform has a cen tral "Server" which contains the data for the virtual environment, a range of avatar models and also acts as the communications hub for consensus building or online discussion. The individual participants have a "Client" on their local computer which provides the tools to view and move through the virtual environment and to also discuss or communicate via a dialogue box in which one would type comments visible to other users. "Client" software can be downloading from the website by free, and connects with the "Server" through the Internet.

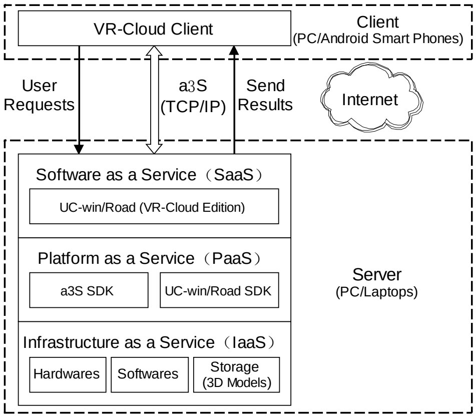


Figure 2. The framework of Cloud-based VR Platform

In this framework, anything as a Server (a3S) is FORUM8's in-house developed multimedia cloud technology that allows high quality video and audio to be supported and streamed between the server and client application, as well as the high-speed transmission of large-capacity data (Ito, Y. et al., 2013). a3S can connect the core parts controlling TCP protocols, the server and each client. It also controls commands, and manages the synchronization and authorization system.

3.2 The working process of Cloud Server

The working process of Cloud Server is shown in *Figure 2*, there are six steps in this process, including load terrain data and street map, create (or modify) and import 3D models for the design alternatives, create a virtual environment (VE), set simulation scenarios, explore or evaluate the design and configure the cloud server.

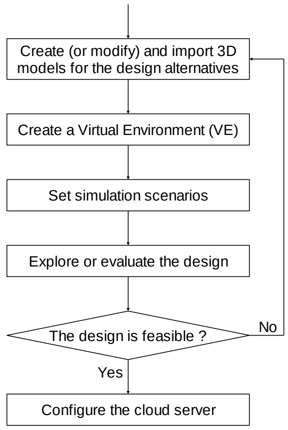


Figure 2. The working process of Cloud Server

According to the requirements of design program, One Foundation (namely the owner) wanted to construct a disaster prevention part inside the Bei San Huan Road in Chengdu city of Sichuan Province. Furthermore, some scholars have pointed out the problem of the disaster prevention park system in Chengdu city after the occurrence of the 5.12 Wenchuan earthquake, and analyzed the actual situation of Chengdu city with the urban population density distribution, transport distribution and disaster prevention park, probed into the planning and design of the city’s disaster prevention park, they believed that the new disaster prevention park can be considered inside the Bei San Huan Road (Tian Y. et al., 2010). Therefore, we load the terrain data of China and the street map of the inside of Bei San Huan Road in Chengdu city, as shown in *Figure 3.*

Figure 3. Load terrain data and street map

In order to create a virtual environment, the basic work is to creating 3D object models for the design alternatives. Currently, there are many kinds of modelling software, such as 3DS Max, SketchUp, Maya, which are often used in urban planning and design. Due to the easy operating and compatibility of SketchUp, we used SketchUp Pro 2015 to create different kinds of 3D object models and import to UC-win/Road (VR-Cloud Edition) as the 3D model database for creating the virtual environment. We created building models, landscape models, and infrastructure models, such as tents, communications facilities, water tank, photovoltaic module, which are necessary in the disaster times. Figure 4 shows one of landscape model which was created by SketchUp Pro 2015 in the disaster prevention park of One Foundation, and *Figure 5* shows the virtual environment of design alternatives after imported the 3D object models.

Figure 4. 3D modelling in SketchUp Pro 2015

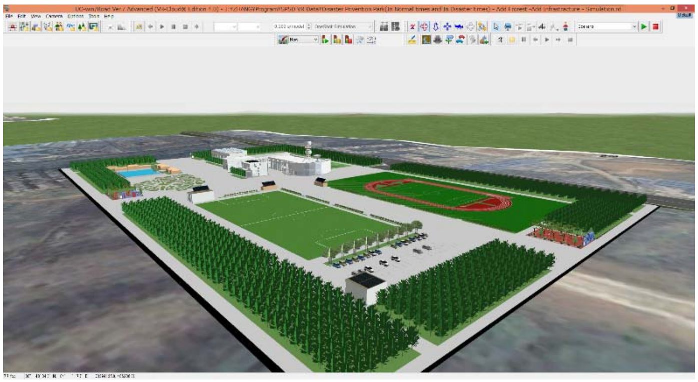


Figure 5. The virtual environment of design alternatives

Simulation scenarios will provide a dynamic virtual environment for online discussion so that users can better understand the design alternatives. In this paper, we try to set the human behaviours connected with the function of Disaster Prevention Park, in normal times and in disaster times, through setting scripts. *Figure 6* shows the simulation scenario of playground in normal times.

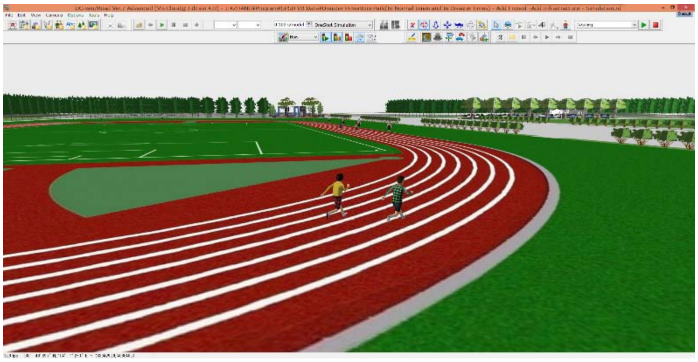


Figure 6. Simulation scenario of playground in normal times

4. CASE STUDY: PLANNING AND DESIGN OF ONE FOUNDATION DISASTER PREVENTION PARK USING CLOUD-BASED VIRTUAL REALITY

As an important part of sustainable urban development, disaster prevention and mitigation is a significant guarantee to achieve sustainable economic and social development. One Foundation is a representative of NGO (Non-Governmental Organization), which plays an important role in disaster prevention and mitigation in China. However, due to the lake of an independent command system, as w ell as a c lear disaster management system in disaster times, resulting in some problems, such as confusion of personnel management and low efficiency of relief supplies distribution, when the NGO responses to natural disasters. Moreover, there are no permanent establishments for disaster management; it is difficult for the NGO to carry out disaster prevention education and volunteer training work in normal times, as the "supplementary" of government. Therefore, One Foundation (namely the owners) wanted to build a disaster prevention park which was integrated the functions of education and training, earthquake experience, emergency command, evacuation and rescue, in Chengdu city of China.

4.1 Functional orientation of Disaster Prevention Park

One Foundation Disaster Prevention Park covers an area of 160 acres, its functional orientation drawing on the experience of International, especially the construction experience of Disaster Prevention Park in Japan. The functional orientation of Disaster Prevention Park is divided into normal times' function and disaster times' function. In normal times, the park has two main functions: social culture function and environmental protection; and social culture function including rest and recreation, spiritual civilization and disaster prevention education, such as outdoor recreation, sports, dissemination of scientific knowledge, disaster prevention training and so on; environmental protection mainly embodied in maintaining ecological balance and beautify the urban landscapes, such as erosion control, fresh air, relieve heat island effect and so on. In disaster times, due to a large area of public open space, the park can be used as emergency shelter and fire greenbelt, as well as emergency command center, rescue helicopter landing sites, relief supplies distributing center, emergency medical service location and the residence of relief workers. The functional orientation and supporting facilities of One Foundation Disaster Prevention Park were shown in *Table 1.*

Table 1. The functional orientation and supporting facilities of Disaster Prevention Park

Time	Main function	Supporting facilities
In normal times	Rest and recreation	Playground, leisure square, landscape and make green by planting trees, flowers, etc.
	Education and training	Classrooms, relief exhibition hall, disaster prevention training center, earthquake experience room, reading room, etc.
	Daily operations	The park management office, relief product exhibition hall, sales department, catering center, accommodation center, etc.
In disaster times	Emergency command center	Information summary room, commander room, lounge, office equipment, communications equipment, emergency medical service location, etc.
	Emergency Shelters	Emergency tent dormitory, emergency water supply facilities, emergency toilets and bathing facilities, emergency power supply facilities, emergency sewage system, etc.
	The residence of relief workers and relief supplies distributing center	Relief supplies reserve and distribution center, parking, rescue helicopter landing sites, accommodation center, etc.

4.2 Consensus building in design alternatives report meeting

In order to validate the effectiveness of cloud-based virtual reality platform in improving consensus, we have applied this platform to express the design alternatives and design concepts in design alternatives report meeting, and tried to convey our design intention to the owners (One

Foundation) and other people who was interested in this project. We discussed and modified the design alternatives in a virtual environment based on cloud-based virtual reality platform, and eventually reached a consensus on the design alternatives. *Figure 7* showed the working process of consensus building in design alternatives report meeting.

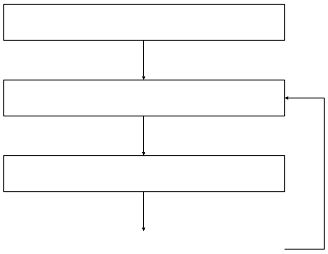


Figure 7. The working process of consensus building in design alternatives report meeting

The participants can enter the virtual environment through VR-Cloud Client which is client software that can be downloaded from the website by free, and connects with the cloud server through the Internet. Participants can input the server's IP address to connect with the cloud server, and then enter the virtual environment, as is shown in *Figure 8*.

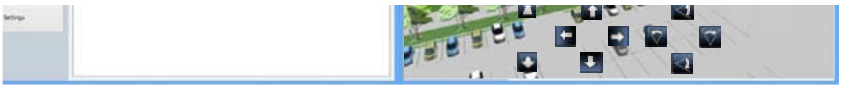


Figure 8. Enter the virtual environment

In the design alternatives report meeting, we discussed the Disaster Prevention Park from functional orientation to overall layout, to infrastructure planning with the owners. We focused on the architectural design of Disaster Management Center and the infrastructure planning of the park, and the following section will focus on these two aspects to conduct discussion.

4.2.1 Architectural design of Disaster Management Center

Based on the functional orientation of One Foundation Disaster Prevention Park, and combined with the construction experience of Disaster

Prevention Park in Japan, the Disaster Management Center responsible for disaster prevention education, training and daily operations in normal times, and in disaster times, its main function are emergency shelter and fire greenbelt, as well as emergency command center, rescue helicopter landing sites, relief supplies distributing center, emergency medical service location and the residence of relief workers and so on. According to the "Design Code of Office Building" (JGJ67-2006), the average office space per person should be not less than 4m2 (MOC, 2006), and the "Emergency shelter for earthquake disasters--site and its facilities" (GB 21734-2008) requires the construction area of Disaster Management Center of Disaster Prevention Park should be more than 2000m2 (SAC, 2008). Therefore, in the first alternatives of Disaster Management Center architectural design, we considered the building of Disaster Management Center consists of two parts: the main building and the Disaster Experience Hall, and with a total construction area of 5000m2. Since the Disaster Experience Hall needs MTS shake table to supports seismic experience, and in order to avoid affect the main building; it is important to separate the two parts, and one part as a single building; the Disaster Experience Hall has two stories, and the main building has three stories.

The owners considered about their actual needs of disaster prevention in southwest of China, and discussed the architectural design of Disaster Management Center in detail with us, and put forward some suggestions. First of all, taking into account of the reserve and distribution of relief supplies, it is best to separate the Relief Supplies Reserve and Distribution Center from the main building. What's more, the height of all buildings should not exceed 8 meters or two stories, in order to better achieve the purpose of disaster prevention. Last but not least, besides the Disaster Management Center, there are Disaster Prevention Schools in the locality, and they have the formal educations, so the Disaster Management Center should take full account the function of rescue training.

During the discussion, we modified the first alternatives in the virtual environment combined with the suggestions of the owners, and proposed the second alternatives. The functional planning of Disaster Management Center in two alternatives and the 3D effect drawing of Disaster Management Center in two alternatives were as shown in *Figure 9* and *Figure 10* respectively, and we reached a consensus on the second alternatives eventually.

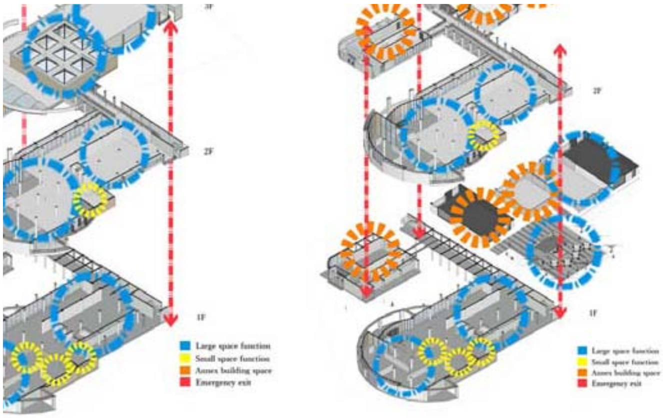


Figure 9. Functional planning of Disaster Management Center in two alternatives

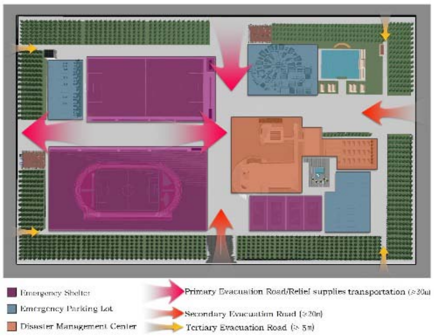
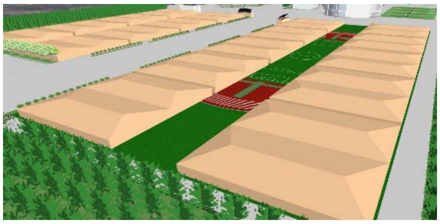
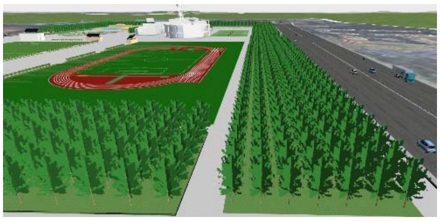
Figure 10. 3D effect drawing of Disaster Management Center in two alternatives

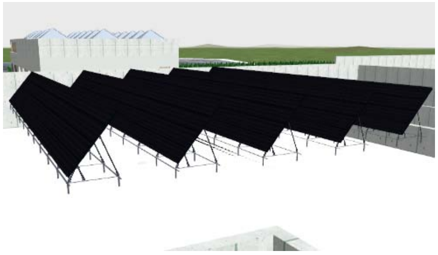
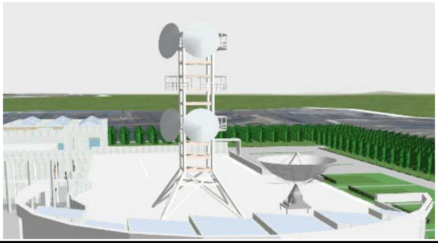
4.2.2 Infrastructures planning of Disaster Prevention Park

The infrastructures of the Disaster Prevention Park include evacuation road, emergency shelter, greenbelt, emergency water supply, emergency power supply, emergency communication and so on. We planning and design the infrastructures of One Foundation Disaster Prevention Park based on the "Emergency shelter for earthquake disasters-site and its facilities" (GB 21734-2008), as shown in *Table 2*.

Table 2. Infrastructures planning of One Foundation Disaster Prevention Park

Infrastructures	Main functions and requirements	3D presentation in virtual environment

Infrastructures	Main functions and requirements	3D presentation in virtual environment
Evacuation Road	Evacuation road connection with all emergency shelters and the Disaster Management Center, to ensure the roads unblocked and keep its effective evacuation and relief supplies transportation. The evacuation roads around the emergency shelters should be more than 2 ways, and the width should be more than 5m.	
Emergency Shelter	Emergency Shelter is the place for people to live temporarily when they cannot live in their previous residence, and the average area per person in emergency shelter should be more than 2㎡.	
Greenbelt	Greenbelt is used for isolating traffic noise, maintaining ecological balance and beautifies the urban landscapes in normal times, while used for isolating fire from the secondary disaster after earthquake. It around the park and the width is 25m.	
Emergency Water Supply	Emergency water supply including swimming pool and water tank. In disaster times, the water stored in swimming pool can be used for bathing, washing and flushing toilets, while the water tank can provide drinking water for the first period that people can survive in three days.	

Infrastructures	Main functions and requirements	3D presentation in virtual environment
Emergency Power Supply	Emergency power supply including solar photovoltaic system and minitype dynamotor, that can provide power for living, medical treatment and communication in disaster times.	
Emergency Communication	Emergency communication can be used for contact with the outside world when wireline, cell phones and other conventional means of communications fail in disaster times.	

In the virtual environment, the owners viewed the design alternatives according to our design concept, and discussed the infrastructures planning with us enthusiastically. In the beginning of this design, considered there are toilets and bathing facilities near the swimming pool, where is located in the northwest of the park, and inside the Disaster Management Center; we had not increased emergency toilets and bathing facilities. The owners believed that besides the refugees, there may be the other local people who come to use toilets and bathing facilities due to the taps run dry after earthquake. So they advised to increase emergency toilets and bathing facilities in infrastructure planning, and these facilities will not affect the park in normal times as far as possible.

Figure 11. Emergency toilets and bathing facilities

In order not to affect the landscape of park in normal times, we considered using septic tank under the ground, then covered lawn and reserved sewage covers on the ground. So it is the green lawn in normal times, and it is easy to change as the emergency toilets and bathing facilities when set up mobile house or tent in disaster times. *Figure 11* shows the planning of emergency toilets and bathing facilities in Disaster Prevention Park.

5. CONCLUSION AND FUTURE WORK

Virtual reality combine with cloud computing are an advanced information technology, and its application to urban planning and design is a challenging topic. The Cloud-based VR Platform we proposed in this paper can clearly express the design alternatives and design concepts, effectively solve the problem of miscommunication in the process of design concepts transfer and design alternatives discussion in urban planning and design, and eventually reach a consensus on the design concepts and design alternatives, so that promoting the feasibility and real-time of urban design, saving discussion time of design project, and improving design efficiency.

However, there are still some deficiencies exist in this platform. For example, although it can directly edit 3D object models in the virtual environment, its editing functions are just scaling, rotating and other simple operation; as for complex editors such as structural adjustment, material replacement, it need to be edited in SketchUp and then import to UC-win/Road. In addition, the evaluation of design alternatives only depends on the experience of participants, and lack of a quantitative method for evaluating design alternatives in virtual environment. Therefore, the future work will focus on 3D model editing and design alternatives evaluating in the virtual environment.

ACKNOWLEDGEMENTS

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A Multi-agent Based Simulator of Evacuation Activities Considering Mutual Assistance for Exploring Community-based Activities for Earthquake Disaster Mitigation

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Key words: Mutual Assistance, Multi-agent Model, Disaster Mitigation, Community-based Activities

Abstract: Japan is at great risk of being struck by huge earthquakes. When a strong earthquake occurs, various other disasters such as fire spreads, collapsing buildings, and road blockages simultaneously occur as a result. In such a situation, it is difficult to ensure that the local emergency activities by, for example, the public fire company and community volunteers are sufficient. Considering this issue, mutual assistance among residents, such as firefighting, evacuating victims, and helping those in need of assistance to designated safety sites, is extremely important. This paper proposes the development of an evacuation activities simulator, considering the capability of mutual assistance under various earthquake disasters to support exploration of community-based activities. In particular, the simulator is developed by using a multi-agent based model. The simulator calculates the time that local resident agents evacuate to the designated safety site, and the number of agents that can and cannot evacuate. Users can change the ratio of those who cannot evacuate to the designated safety site without some support and the persons who support them. Therefore, users can compare the simulation results of various outcomes. Experimental demonstration was performed to explore the using methods of the developed simulator and verify whether the simulator enables exploration of community-based activities. Confirming the simulation results of the case wherein mutual assistance activities by residents are widely performed, users can understand that human suffering is reduced by mutual assistance activities. For this, users can better grasp the importance of mutual assistance. In addition, users can distinguish when the capability of mutual assistance is high or low, and when the capability of mutual assistance is changed according to the time of day due to the presence of the commuting population. Therefore, users can explore the countermeasures used to reduce human suffering when the capability of mutual assistance is low. This developed simulator allows the possibility to explore how community-based activities are promoted.

1. INTRODUCTION

1.1 Back ground and objective

Japan is at great risk of damage from very large earthquakes. To minimize the damage caused by earthquakes, the improvement of safety in built-up areas is an urgent issue. Although the improvement of physically built-up environments is important, improving disaster response techniques by community associations is significant for the safety of those built-up areas. To improve the capability for disaster response, enhancing self-help, mutual assistance, and public help for disaster mitigation is important.

However, an issue of concern is the increasing elderly population, who cannot evacuate without assistance by others. Another concern is that of the disastrous activities that result from earthquakes. Due to these issues, it can be difficult to ensure efficient emergency responses. Thus, mutual assistance among local residents is extremely important. To improve the capability of mutual assistance among neighborhood communities, it is necessary to develop techniques to evaluate the mutual assistance capabilities of neighborhood communities for disaster mitigation, visually display the results, and support further exploration of this topic based on the results.

This paper utilizes a simulator of evacuation activities, and this simulator is developed by using a multi-agent based model. Through the simulator, this paper considers the capability of mutual assistance under various earthquake disasters in order to explore the contents of community-based activities. As resident agents take action through mutual assistance to respond to various emergencies, the simulator calculates the time that resident agents evacuate to the designated safety site, the number of agents that can evacuate, and the number of agents that cannot evacuate.

1.2 Study method

First, to understand the issues surrounding the mutual assistance of neighborhood communities in disaster mitigation activities and the required techniques to address those issues, a survey was distributed to local government staff. Second, the detailed capability of mutual assistance was explored and evaluated to better comprehend the degree of mutual assistance capabilities, and to identify areas displaying high or low capabilities of residents. Third, to explore the contents of community-based activities considering mutual assistance, a huge earthquake generation was simulated. Finally, to verify the usability of the developed simulator, experimental usage was conducted. The results of some simulations reflected scenarios in which residents performed activities related to mutual assistance, as well as cases in which they did not perform those activities. The results also showed scenarios in which mutual assistance changed according to the time of day due to the commuting population.

1.3 Related study

Very few previous studies have used the evaluation method to explore mutual assistance for disaster mitigation. Akiyama et al. (2013) suggested the evaluation method to quantitatively estimate mutual assistance as the initial response ability during huge earthquake disasters. However, the estimate value transfers mesh data to analyze large-scale such as urban scale. In other words, there is no method to evaluate the capability of mutual assistance by neighborhood communities for community-based activities. Another related study approach is model development, which simulates human behaviors such as evacuation responses to natural disaster. One of the most popular methods is using the multi-agent system (MAS). Uhrmacher and Weyns (2009) described how MAS has been used to understand the interaction among and between agents as well as their dynamic environment. For example, D'Orazio et al. (2014) proposed an innovative approach to earthquake evacuation, presenting an agent-based model to describe phases and rules of motion for pedestrians. Wagner and Agrawal (2014) presented a prototype of a computer simulation and decision support system that uses agent-based modeling to simulate crowd evacuation in the presence of a fire disaster, and provides testing of multiple disaster scenarios at virtually no cost. This current study is unique because it attempts the development simulation of evacuation activities, considering the capability of mutual assistance under various earthquake disasters. Further, this paper promotes exploring the contents of community-based activities.

2. SURVEY

To comprehend the issues related to neighborhood communities' mutual assistance in disaster mitigation activities as well as the required techniques to solve those issues, a survey distributed to local government staff was conducted. The following opinions were obtained as a result of the survey.

- If there were a map to understand the capability of mutual assistance by building units, residents would more easily understand the capability of their living area. In addition, a map may promote residents' awareness and the discussion of community-based activities for disaster mitigation.

- It is ideal that residents understand that the capability of mutual assistance is changed according to the time of day due to the commuting population.
- Local governments want to discuss urban improvement and support contents to promote the capability of mutual assistance, using methods such as those mentioned above.

Based on these responses, we think that the following two points are important for the required techniques to support issues related to mutual assistance for disaster mitigation.

1) Information in map-form to enable understanding of the capability of mutual assistance by neighborhood community

2) Information to promote the discussion of community-based activities for disaster mitigation considering mutual assistance activities

To provide this necessary information, we developed a tool to calculate the capability of mutual assistance by neighborhood community, using GIS techniques and a simulator to simulate evacuation behaviors in response to earthquake disasters, including collapsing buildings, road blockages, and fire spreads. Further, to express the human suffering resulting from these simulations, a multi-agent model was required, and we developed a support technique to address the concerns mentioned above.

3. MAP DEVELOPMENT SHOWING THE CAPABILITY OF MUTUAL ASSISTANCE

3.1 Evaluation method

To evaluate the capability of mutual assistance by neighborhood communities, we utilized the evaluation method suggested by Akiyama et al. (2013). First, the expected value for rescue of each person was calculated by using Table 1. The expected value for rescue is the numerical value showing the ability to rescue the victims (e.g., pulling a survivor from the wreckage) in accordance with gender, age, and strength. This table was organized based on the actual rescue activities in the Great Hanshin-Awaji Earthquake in 1995 in Japan. For example, the expected value of a 40-year-old man is calculated by the following formula:

strength (0.93) * executing rate (0.298) * activity rate (0.72) = 0.1995

Strength: This value is calculated in accordance with age and gender on the basis of the strength value of a man in his teens through his twenties set at one.

Executing rate: This value is set in accordance with the condition of actual rescue activities in the Great Hanshin-Awaji Earthquake.

Activity rate: This value is the ratio showing residents can perform rescue activities considering the degree of daily activities.

The expected value *Rrj* of building *j* is calculated as the total of residents' expected value at building *j*. However, in this paper, elementary school students and junior high school students have no capability for rescue. Second, the expected value is weighted by distance because of the assumption that residents take some time to discover (recognize) the person who cannot evacuate without some assistance in accordance with the distance. Therefore, the range limit in which residents can discover a person who cannot evacuate the building *i* is set at 100m. The resident's expected value is decreased with the increasing distance from building *i*. The weighted value *dwi* of building *j*, having *dj* [m] distance from building *i*, is calculated by formula (1). The evaluation unit of the mutual assistance capability is the building unit, based on the assumption that it is easy for residents to understand the capability.

$$dwj = \frac{1.502}{\log(1+dj)+1} \quad (0 \leqq dj \leqq 100) \quad (1)$$

$$\text{The capavility of mutual assistance} = \frac{\Sigma Rrj \times dwj}{5} \quad (2)$$

Table 1. The expected value in accordance with age and gender

Age	Men's strength	Women's strength	Executing rate	Men's activity rate	Women's activity rate	Men's expected value	Women's expected value
10	1	0.85	0.228	0.76	0.24	0.1733	0.0465
20	1	0.76	0.228	0.76	0.24	0.1733	0.0416
30	0.96	0.76	0.229	0.72	0.28	0.1583	0.0487
40	0.93	0.73	0.298	0.72	0.28	0.1995	0.0609
50	0.9	0.72	0.228	0.63	0.37	0.1293	0.0607
60	0.84	0.7	0.191	0.74	0.26	0.1187	0.0348
70-	0.78	0.65	0.129	0.75	0.25	0.0755	0.021

3.2 Creating a mutual assistance map

To evaluate the capability of mutual assistance by using the evaluation method, detailed population data such as the family structure of each building and the age and gender of each resident was necessary. To obtain such detailed data, cooperation from local government and residents was also necessary. To experimentally develop a mutual assistance map, a v irtual space was created.

The concept of the virtual space is as follows. Each building had one household. Young generations and elderly persons were uniformly distributed in the entire space. Residents' living space was changed according to the time of day in order to represent the commuting population.

Thus, evaluating the capability of mutual assistance was conducted for each case. When calculating the capability of mutual assistance of the building at the edge of the virtual space, the buildings located outside of the virtual space were not considered. The mutual assistance value of commercial facilities was set at 0 because mutual assistance activities by commercial facility users were not anticipated as the local residents' activities were. The age structure of the whole virtual space was set based on the result of national population census by MIAC (2011). There were five types of households (one-person household, married-couple household, and two-generation households with one, two, or three unmarried children). The ratio of two-generation households with over four children is under 10 pe rcent. In this study, therefore, the limit of unmarried children in each two-generation household was set at three.

3.3 Evaluation of the capability of mutual assistance

The capability of mutual assistance was calculated following three cases considering commuting times: 1) the morning hours, 2) afternoon, and 3) early evening. In the morning hours, all household members were in each of their buildings. In the afternoon, almost all residents in the virtual space were stay-at-home wives and elderly persons. Almost all students and workers were outside of the virtual space (commuting).The commuting rate of each age was set based on the result of national population census. In the early evening, almost all students came back home. Almost all residents in the virtual space were stay-at-home wives, students, and elderly persons.

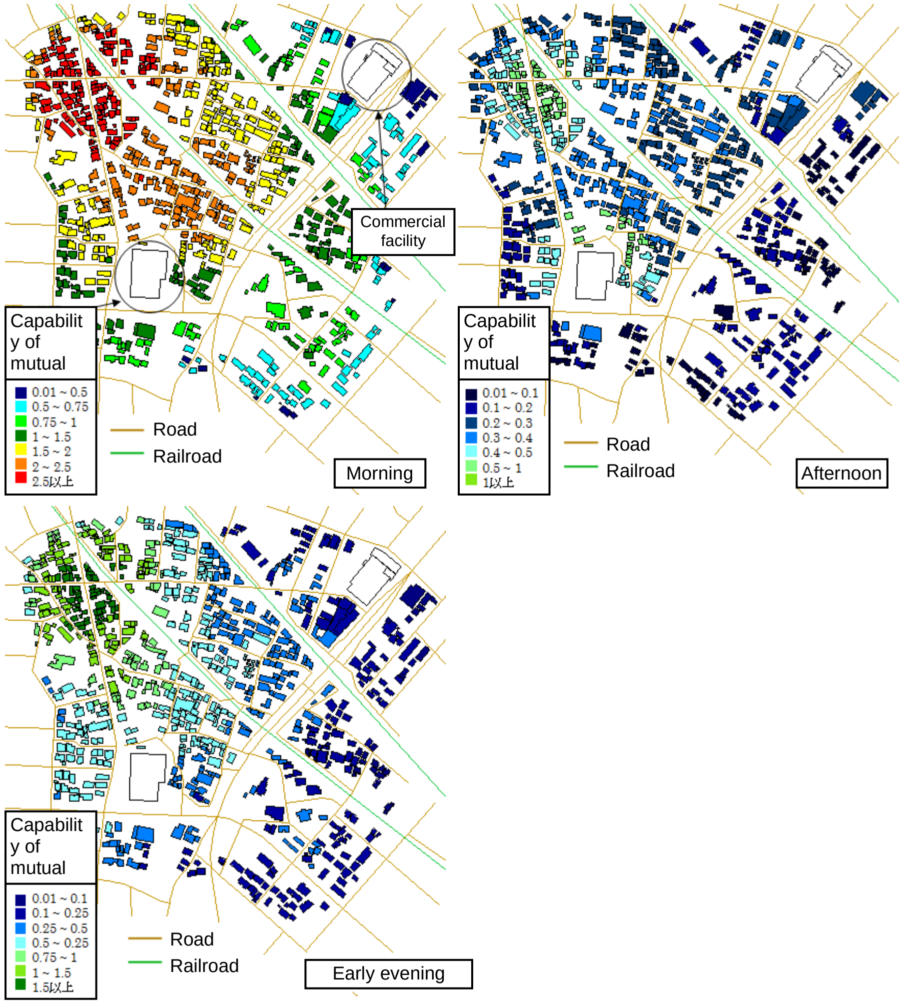

Figure 1. The map showing the capability of mutual assistance in each time zone

Figure 1 shows the evaluation results. By using this map, users can distinguish the areas with low capability of mutual assistance by neighborhood community, as well as the change of capability in accordance with the time change. Thus, by using this map, residents may better understand the capability for initial response to earthquake disasters, the issues surrounding mutual assistance activities, and the necessity of mutual assistance.

4. MODEL DEVELOPMENT

Utilizing a multi-agent model, this study executed an experimental evacuation behavior simulator under the condition of huge earthquake disaster.

4.1 Model structure in virtual space

The model was set to simulate a huge earthquake (intensity 6 upp er). Collapsing buildings, road blockages, and fire spreads were generated. Residents evacuated to the designated evacuation site. Therefore, following six agents as the components of a simplified virtual urban area (urban area, roads, fire origins, fire extinguishers, rubble, and the designated evacuation site) and resident agents were generated. The virtual urban space consisted of 3m by 3m grid cells.

4.2 Resident agents

One resident agent represented one person. Each agent was given an age, gender, and expected value as the initial setting for beginning the simulation. The age structure, household distribution, and expected value were set according to the mutual assistance map.

4.3 Road blockage model

For the road blockage model, the model proposed by Gohnai et al. (2007) was incorporated. After setting the probability of building collapse for each building based on structure, floor number, and year of construction, collapsed buildings were generated by using random numbers. When the rubble was spread on a road with a width under 0.6m, resident agents could not go through the road.

4.4 Fire spread model

The model proposed by Ohgai et al. (2007) was incorporated as the fire spread model. Fire origins were set by using random numbers. Users could set the wind velocity and wind direction. According to the condition, a fire spread simulation was conducted.

4.5 Behavior of resident agents

The resident agents performed the following 7 actions.

4.5.1 Evacuation

Each resident agent evacuated from each building to the designated evacuation site. In this model, middle-class children above elementary-school age (8 and older) could evacuate alone. Children less than 8 years old evacuated with his/her parent.

4.5.2 Firefighting at initial period of fire

When there was a fire origin within 100m from a r esident agent, the resident agent battled the fire with fire extinguishers. After firefighting, the resident agent reinitiated evacuation.

4.5.3 Waiting rescue

The resident agent who was buried under a collapsed building would wait for help. The resident agent who was in a burning building had no support from other resident agents because in the real world, it is difficult for residents to rescue someone who delays escape from a fire.

4.5.4 Rescue victims

When resident agents discovered a victim in need of help within 100m from him/ her during evacuation, he/she took part in the rescue activity. However, the resident agent with an agent older than 65 years old or a child less than 8 years old (early elementary school years) was given priority in evacuation. When the total expected value of resident agents participating in rescue activities exceeded 1, they could rescue a victim. When the total expected value was not greater than 1 after a lapse of 5 minutes from earthquake generation, the resident agent gave up rescue and restarted evacuation.

4.5.5 Those in need of evacuation support

According to the Ministry of Health, Labour and Welfare (2014), 5% of the agents from 65 to 74 years old and 34% of the agents over 74 years old were set as the agents who were in need of evacuation assistance.

4.5.6 Those supporting evacuation

When resident agents discovered a resident in need of evacuation support within 100m of the evacuation site, he/she provided evacuation support. However, the resident agent with an agent older than 65 years old or a child less than 8 years old (early elementary school years) was given priority.

4.5.7 Awaiting public support

In the following three situations, resident agents could evacuate, even when performing mutual assistance activities. Therefore, when residents are in the following situations, they should wait on support from public institutions such as the local fire or rescue teams:

1) A resident agent in a burning building; 2) A resident agent who cannot be rescued by another in situations where the total expected value is not greater than 1 (see section 3.1); 3) A resident agent who cannot reach the designated evacuation site due to road blockage.

4.6 Simulation flow

Figure 2 shows the simulation flow. First, the virtual space was generated, and then resident agents were generated under certain conditions. Second, a huge earthquake occurred with an intensity of 6 upper, followed by the simulation of a road blockage caused by simulated collapsed buildings and fire spread. Third, resident agents judged the actions (evacuation, firefighting, rescue and support for evacuation). In this phase, initial firefighting by residents was simulated up to ten minutes after the fire simulation was initiated. Fourth, resident agents went to the destination he/she chose from the aforementioned options. In the case of firefighting, resident agents went to the fire origin with an extinguisher. In the case of supporting evacuation, resident agents went to the individual in need of evacuation assistance. In the case of rescue, resident agents went to assist a victim. In the case of evacuation, resident agents went to the designated evacuation site. Fifth, after finishing each mutual assistance activity, resident agents restarted the evacuation process. Finally, resident agents reached the evacuation site.

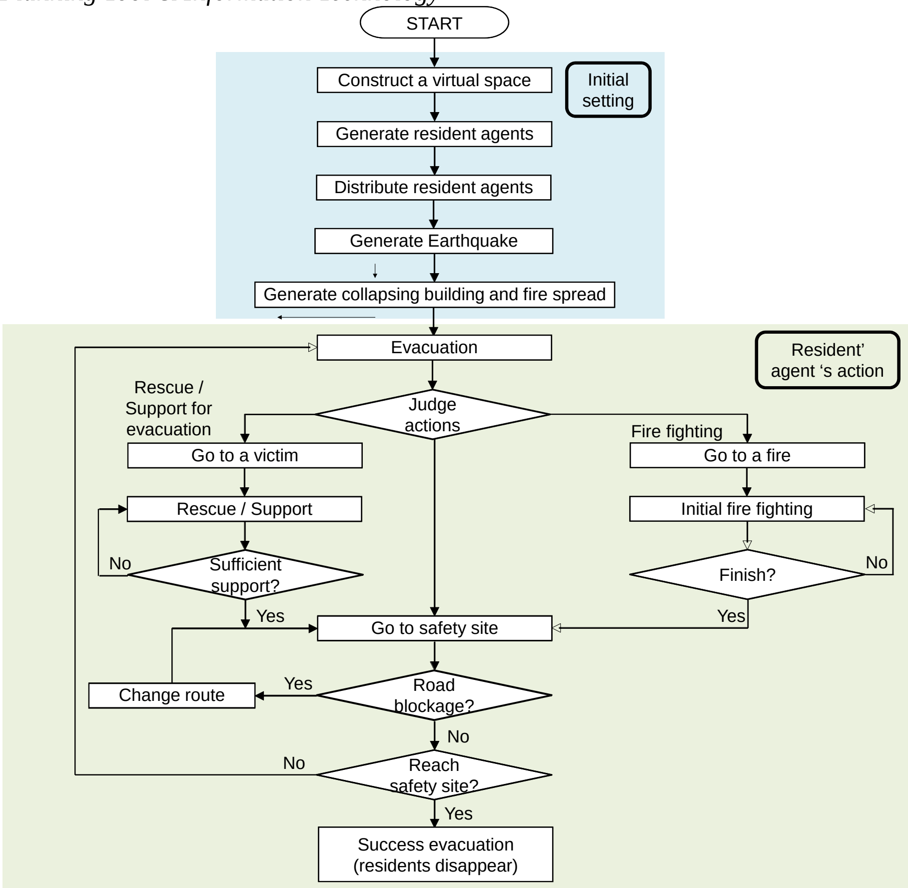

Figure 2. Simulation flow

4.7 Change of simulation conditions

As this simulator observes community-based activities for disaster mitigation, the function to change some of the simulation conditions was added. Figure 3 shows the pane to change the conditions.

1. Fire origin: The users of this simulator can set the number of fire origins in the virtual urban space.
2. Wind velocity and direction: The users can set the wind velocity from 0 m/s to 9 m/s, and the wind direction in 8 directions.
3. Waiting time: The users can set the time from earthquake generation to starting evacuation.
4. The ratio of resident agents who need some help for evacuation: The users can set the ratio of resident agents who need some evacuation assistance in the 65-year-old to 74–year-old range and the range of over 75 years old.

5. The ratio of residents who perform mutual assistance activity: The users can set the ratio of residents who perform mutual assistance activity.
6. The age limit of residents who perform mutual assistance activities: The users can set a limit that designates whether residents over 65 years old can perform mutual assistance activities or not.

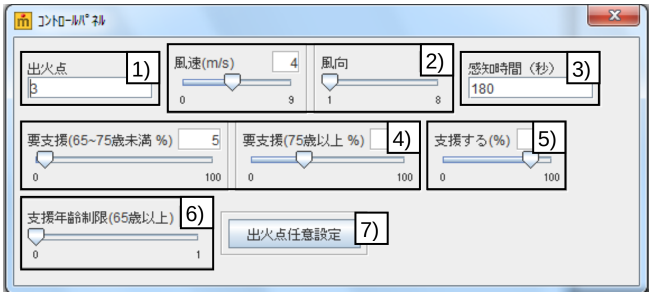

Figure 3. The pane to change simulation conditions

7. Setting the point of fire origin: The users can set the point of fire origin freely.

5. ERIMENTAL USE OF DEVELOPED SIMULATOR

5.1 Perspective of evaluation

In the experimental use of the developed simulator, the following three scenarios were set: 1) The presence or absence of mutual assistance activities during evacuation; 2) The altering of the ratio of resident agents in need of evacuation assistance (this suggests the promotion of the declining birth rate and a growing population of elderly people in the future); 3) The capability of mutual assistance was changed according to the time of day caused by the commuting population.

The simulation results reflecting each scenario were evaluated following three points:

1. The time that all residents who could evacuate reached the designated evacuation site.
2. The number of residents who could reach the evacuation site.
3. The number of residents who could reach the evacuation site. This number refers to the number of residents who were waiting for help from a fire or rescue team in a collapsed or burning building on the blocked road.

The simulations reflecting each scenario were conducted ten times. After that, the average values were calculated and compared. The time it took to pull a survivor from the wreckage was not considered. The basic setting values for simulating are shown in Table 1.The simulation results are shown in Figure 3 and Table 3.

Table 2. Setting value for simulation

Item	Setting value	Item		Setting value
Population	850	Wind direction		North
Household number	333	Wind velocity		0 m/s
Fire origin	3	Ratio of residents who support		80%
Walking speed	1.5 m/s	Ratio of resident who could not evacuate	65-74	3%
Waiting time	180s		Over 75	34%

5.2 The presence or absence of mutual assistance activities during evacuation

Comparing the results of the case, considering the case o f mutual assistance with not considering mutual assistance activities during evacuation (the ratio of residents to perform mutual assistance activity was set as 0%), the evacuation time of all residents who could reach the evacuation site was longer in the former case than in the latter case. However, 20 resident agents who needed evacuation assistance (about 2% of the number of all residents in the virtual space) could reach the evacuation site by mutual assistance activities. According to these results, the users (local residents) can easily understand the effects of the mutual assistance activities. In addition, users can understand where to locate residents who cannot evacuate, as well as the disasters that cause entrapment such as collapsed buildings, road blockages, fire spreads, and a lack of neighborhood support. From these effects, users can better comprehend areas in need of improvement such as urban infrastructure or lacking mutual assistance activities. Furthermore, these results seem to promote the discussion of community-based, mutual assistance activities.

Table 3. The numerical value of simulation results

	Without mutual assistance	With mutual assistance	Over 75 years old	Over 65 years old	Morning	Afternoon	Early evening
Time [s]	574	657	621	635	657	607	630
Number of those reached	651	675	662	631	675	231	396
Number of those who could not evacuate	199	175	188	219	175	66	108

5.3 Changing the ratio of resident agents who needed evacuation assistance

Comparing the results of the residents over 75 years old who could not evacuate with the residents over 65 years old who could not evacuate, the former showed 31 more residents (about 4% of the number of all residents in the virtual space) who could reach the evacuation site by mutual assistance activities than the latter. An increase of the residents who could not evacuate shows that rescuing all neighborhood residents who cannot evacuate by mutual assistance activities is impossible. In the future, when the declining birth rate and a growing population of elderly people are promoted, some countermeasures are needed. In addition, this result reveals the risk of the district with a high ratio of elderly people such as the local city and rural area. Therefore, users can understand the necessity for promoting mutual assistance activities. Further, it seems that the discussion for exploring some countermeasures of community-based activities is promoted through this simulation.

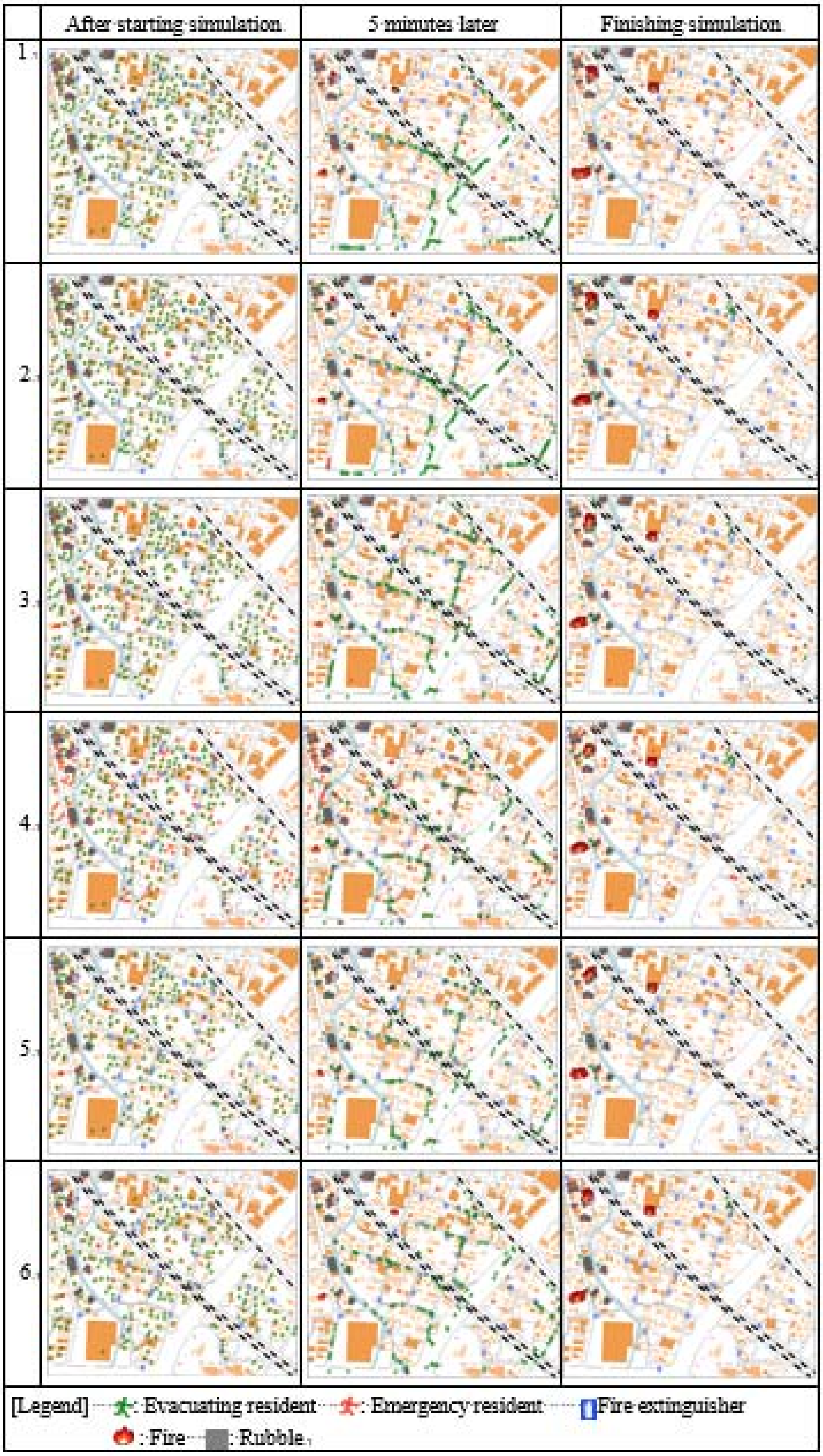

Figure 4. Simulation results

5.4 Changing the timeframe

As mentioned in section 3.3, in the morning hours, all household members are in their respective buildings. In the afternoon, almost all residents in the virtual space were stay-at-home wives and elderly persons. Almost all students and workers were outside of the virtual space (commuting). The total population was 297 residents. In the early evening hours, almost all students came back home. Almost all residents in the virtual space are stay-at-home wives, students, and elderly persons. The total population was 504 residents.

Comparing the results of morning, afternoon, and early evening hours, in the afternoon, mutual assistance activities become poor because students and workers who could contribute to the promotion of mutual assistance activities were commuting. Therefore, the ratio of the residents who could not reach the evacuation site was higher in the afternoon than in the morning hours.

In the case of early evening, the residents who could contribute to the promotion of mutual assistance activities increased because students went back home. Therefore, the ratio of the residents who could not reach the evacuation site was lower in the early evening than in the afternoon. In this way, the capability of mutual assistance activities by neighborhood was changed in accordance with timeframe. Users can thus understand the need for countermeasures such as the promotion of mutual assistance activities for timeframes when the capability is low.

6. CONCLUSION

In this paper, a simulator of evacuation activities considering mutual assistance under various earthquake disasters to support exploring the contents of community-based activities was developed by using a multi-agent based model. To verify the usability of the developed simulator to support the discussion for exploring community-based activities and mutual assistance, experimental usage was conducted. The results of some simulations reflected scenarios such as whether the residents performed the activities related to mutual assistance or not, and cases wherein mutual assistance was changed according to the time of day due to the commuting population.

The following results were obtained from this study:

- Confirming the simulation results of the case wherein mutual assistance activities by residents were not performed, users can understand the number of people that cannot evacuate to the designated safety site and the areas where there are many people that cannot evacuate.

- Confirming the simulation results of the case wherein mutual assistance activities by residents were widely performed, users can understand that human suffering is reduced by mutual assistance activities even whether evacuation times are longer. In addition, users can distinguish between neighborhoods with high and low mutual assistance capabilities. Further, users can more fully comprehend the importance of mutual assistance. Therefore, users can explore the countermeasures to ensure the sufficient mutual assistance activities for areas where the mutual assistance capability is low .
- Users can understand that the capability of mutual assistance is changed according to the time of day caused by the commuting population. Therefore, users can explore the countermeasure to reduce human suffering at the case that the capability of mutual assistance is low.
- Users can simulate cases where the ratio of those unable to evacuate the designated safety site without some support will be increased by aging in the future. Therefore, users can explore the short- and long-term countermeasures to ensure sufficient mutual assistance activities.

The developed simulator provides users with information for exploring the countermeasures to ensure sufficient mutual assistance activities. Therefore, the simulator is useful to explore different community-based activities considering mutual assistance activities. The improvement of the simulation model is required to reproduce more accurate mutual assistance activities, and some demonstrations in a full-scale model district is required to verify the usability of the developed tool.

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The Influence of ICT on social networks of urban residents in Nanjing China

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Key words: ICT, social networks, Chinese context, Nanjing

Abstract: In the past decades, there have been increasing concerns about the influence of ICT on individual's social networks. However, existing scientific literature has drawn disproportionally from data of North America, North-western Europe and Australia, and Japan and South Korean in Asia. Very little is known about the influence of ICT on Chinese people. Since it has widely acknowledged that social ties are highly cultural, geographical and social constructed, the influence of ICT on urban residents' social networks in urban China might show a different picture compared to the West, given the large differences in social, cultural and urban contexts. Based on the Behavior Survey of Urban Residents in the Information Era which is conducted in Nanjing in 2012, this paper therefore attempts to investigate how internet and telephone affect urban residents' social ties. It was found that the use of ICT tend to decrease local social ties while increase the contact of colleagues and friends of common interests in distant places. The extent and direction of the influence are highly dependent on socio-demographics as well as the built environments in which urban residents live.

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Automatic Generation of 3D Buildings Models with Effient Solar Photovoltaic Generation

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Keywords: 3D building model, automatic generation, solar photovoltaic generation, 3D city model

Abstract: To facilitate public involvement for sustainable development, 3D models simulating a real or near future cities by a 3D CG (Computer Graphics) can be of great use. 3D city models are important in environmentally friendly urban planning that will use solar photovoltaic (PV) generation. However, enormous time and labour has to be consumed to create these 3D models, using 3D modelling software such as 3ds Max or SketchUp. In order to automate laborious steps, we proposed a GIS (Geographic Information System) and CG integrated system that automatically generates 3D building models, based on building polygons or building footprints on digital maps, which show most building polygons' edges meet at right angles (orthogonal polygon). A complicated orthogonal polygon can be partitioned into a set of rectangles. The proposed integrated system partitions orthogonal building polygons into a set of rectangles and places rectangular roofs and box-shaped building bodies on these rectangles. In this paper, for placing solar panels on the hipped roof, we clarify the structure of an ordinary hipped roof that is made up of two triangular roof boards and two trapezoidal ones. To implement efficient PV generation, we propose to automatically generate 3D building models topped with double shed roofs attached by PV arrays. The sizes and positions, slopes of roof boards and main under roof constructions are made clear by designing the top view and side view of a double shed roof house. For the application example of the developed system, we simulate the solar photovoltaic generation change of a city block by performing land readjustment and changing shape of buildings, that is, ordinary roof house or double shed roof house suitable for efficient PV generation. Our simulation reveals that double shed roof houses have greatly improved the solar photovoltaic generation.

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Protection and restoration of traditional building in Guifeng village based on BIM

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Key words: Protection, restoration, Traditional building, Building information model, Guifeng village

Abstract: Under the background of urbanization, traditional buildings are disappearing. The protection of traditional buildings requires large quantities of manpower and financial resources. The past way of using CAD to record the two-dimensional information of traditional buildings was not easy to count and arrange. With the development of technology, there are some smart soft wares including BIM that can bring a better future for the protection of traditional buildings. Taking Qing Dynasty tea house in Guifeng village as an example, this paper creates information model with Revit Architecture to analyse the application of BIM in the protection and restoration of traditional buildings. It focuses on the information collection, sorting out, saving in, and the advantages of 3D virtual models of tea house, in order to provide a new way for the protection and restoration of traditional buildings.

1. INTRODUCTION

Building Information Model (BIM) is a digital representation of physical and functional characteristics of a facility. As such it serves as a sh ared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle from inception onward. A basic premise of BIM is collaboration by different stakeholders at different phases of the life cycle of a facility to insert, extract, update or modify information in the BIM process to support and reflect the roles of that stakeholder (Li Weiping, Xia Qing (2012)). BIM contains geometry information, performance and function etc. of all components in the model. All information throughout the project life cycle is included into a single model which includes not only the components of the model itself, including the construction schedule, the construction process, maintenance management information (H Edward Goldberg, (2004)).

According to Voice of China "News" reported and the relevant departments of the latest statistics show that there were 3.6 million villages 10 years ago, now only 2.7 million, an average of one day disappearing villages about 80-100 , which contained a large number of traditional villages. At present there are 2.3 million villages, traditional villages with high conservation value of the remaining less than 5000, accounting for only 1.9% of the national total administrative villages（MOHURD.2013）. Traditional buildings are the important component of traditional villages, so there are a huge number of existed traditional buildings. In the context of China's rapid urbanization, large quantities of traditional buildings are disappearing, and their protection requires a lot of manpower and financial resources.

How to efficiently and intuitively protect these traditional buildings? The protection in the past was recording the two-dimensional information of traditional buildings with CAD, which was not easy to count and arrange. The introduction of BIM technology can improve the efficiency of the traditional buildings' protection, and the protection work will be more scientific and reasonable. This paper taking Qing Dynasty tea house in Guifeng village as an example and creating model with Revit Architecture analyse the advantage in traditional buildings' protection and regeneration with BIM.

2. ITERATURE REVIEW

BIM was introduced to China in 2003, although late, the concepts, technologies and related software in the country have been recognized by people in the construction industry. In the near future, it will replace the current mainstream to become the next generation of mainstream software system in construction industry (Yang Fuhua, Zou Huifen, et al. (2013)). During this period, many scholars have done a lot of research on the application of BIM in traditional buildings. Combining with "Xi'an residential protection project," Wang Chao discussed and summarized the protection of traditional buildings in new technologies, new methods, especially the application of three-dimensional laser scanning technology and BIM (Wang Chao, Xue Ye. (2007)). Some advantages of applying BIM to traditional buildings surveying are put forward including the aspect of data record 、 sharing data model and the data counting(Sun WeiChao, Wang WenBo, et al. (2014)). Wang Ru designed index performance function to extract quantified and call in the ancient building information model of critical information with the information reuse technology based on BIM, seeking the economic evaluation index(Wang Ru, Zhang Xiang, et al.(2014)). Zhu Lei selected a number of different structural forms of the early extant examples of wooden architecture as a case study, to make a preliminary inquiry of information model building ideas and methods based on BIM technology, and he tried to set its analysis BIM family planning of building elements (Zhu Lei, Wu Cong. (2012)). There are also some scholars analysed parameter models from the Revit Architecture, the core software of BIM. Sun WeiChao from model elements, annotation symbol entity, view the database elements in four areas made the overall appearance of the ancient building information model to show, focusing on t he subject of the information model - model elements (Sun WeiChao, Xu Zhen. (2012)). Luo Xiang described the elementary methods in parametric modelling of Chinese traditional architecture based on family component, including the setting of parameter、the modelling of main structure and the roof with the sample of Cuanjian pavilion(Luo Xiang, JI Guohua. (2009)). In addition to the application of BIM in single building, Li Weiping expanded the scope of the study, proposed for the study of historic district City Information Model (CIM), to solve the shortage of existed BIM software when applied to urban scale (Li Weiping, Xia Qing. (2012)).

3. GUIFENG VILLAGE AND THE TEA HOUSE

3.1 The introduction of location

Guifeng Village is located in the northeast of Yangzhong Town, Youxi County, Sanming City, Fujian Province, China. The village government is only 500m away from Bejing-Fuzhou expressway in straight line (Figure 1).The weather is mainly rainy and humid, and the village is at a high altitude and this factor increases the moisture conditions of the area. There is a large presence of springs and streams and the mountains around north south east creating a barrier to the wind (*Figure 2*).

The village streets are pedestrian only and follow the trends of soil morphological intertwining and creating tunnels between the picturesque stone houses, earth and wood. The access to the village is a road under construction and currently in clay from which you reach the square/parking area, and the tea house is located in the middle of the village, close to the main stream(*Figure 3*).

Figure 3.The position of Guifeng village

Figure 4.GuiFeng village is at a high altitude

Figure 5.The position of tea house in Guifeng village

3.2 Historical evolution

Guifeng village has a long history, which has been more than 760 years. Because of the main surname is Cai, Guifeng once was called "Cai Ling." Later, there was an official road from Youxi to Fuzhou through here, and it was the only transit station and accommodation for Youxi dignitaries, merchants and hawkers to and from Fuzhou. Then, Guifeng quickly flourished, also known as the "Little Fuzhou"(JIN Fenghua, (2012)).

The project house belonged to Cai family, and there was a time in Qing Dynasty, the front house was used for teahouse. It was a teahouse mainly for people passing by. They would buy a cup of tea to drink, or mainly bring the homemade local tea back home. They were rich people when the house was built, but not so rich after 60s to nowadays. There used to be 5 families lived there at most. This house has never collapsed or been burnt. It has been repaired twice, once was in late of Qing Dynasty and the other was in 70s or 80s. After that, it began to be ruined. In 2000, village government organized a repairing for this building for tourism, but it was interrupted because of lacking of money.

The tea house is more representative of traditional buildings in GuiFeng village, and it had the way of building in the past (*Figure 4*). The shape of the roof, the position of the stair, the structural composition and so on was due only to the ability of craftsmen and builders. It consisted of two rectangular building, which are not in the same horizontal position and the rooms besides the road were shops (*Figure 5*).

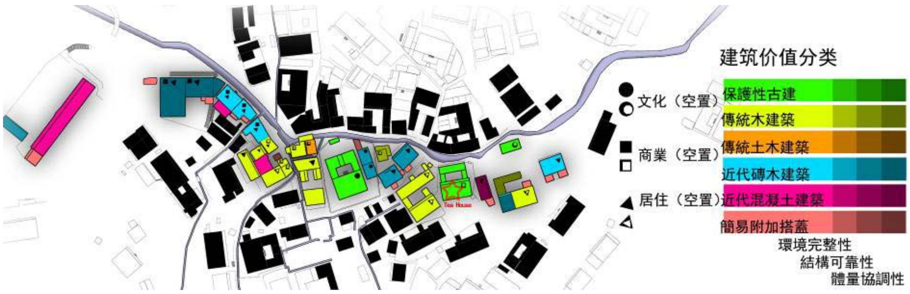


Figure 6.Building types along the ShenGui creek

*Figure 7.*Photos of tea house

4. THE PROTECTION OF TEA HOUSE

Protection means protect the practical situation of traditional buildings. The approach of traditional buildings' protection has two steps. Firstly, we should know the real situation of the building and classify it according to the type and present situation. Secondly, we should follow the principle "first rescue those important traditional buildings which have endangered structural and hidden safety trouble", then diagnose structure, develop programs about restoration and renovation (Zhang Ying, Shen Shaojie, et al. (2008)). So the present situation investigation of traditional buildings is very important.

4.1 The protection of data information

We often make the first surveying to better understand the data information of this building. Because the three-dimensional scanner is expensive, and it isn't suitable for the size and weight to carry, generally it used for the valuable heritage buildings. So manual surveying is the most commonly used methods of surveying, and it always needs the help of some tools, such as the hand-held laser rangefinder. No matter which way we survey the traditional buildings, we are ultimately drawing the surveying.

In the past, drawing the surveying of tea house with CAD means drawing projection of the building each side. In this way, we first draw two-dimensional projection of the tea house each side, then mark the measurement data on draft. Since the recording of the data is more, different projection is generally different persons drawing, finally form a set of drawings (Figure 6).Because different people process the surveying data in different ways, so it is prone to problems that different drawings data cannot connect. Elevation and profile contains a large number of components, such as brackets, pillars, beams and others, so it is very tedious and easy to make mistakes when drawing the elevation and profile. When we want to know the specific circumstances of a component, we have to refer to its plane, elevation and profile, perhaps in the end we still do not know its problems.

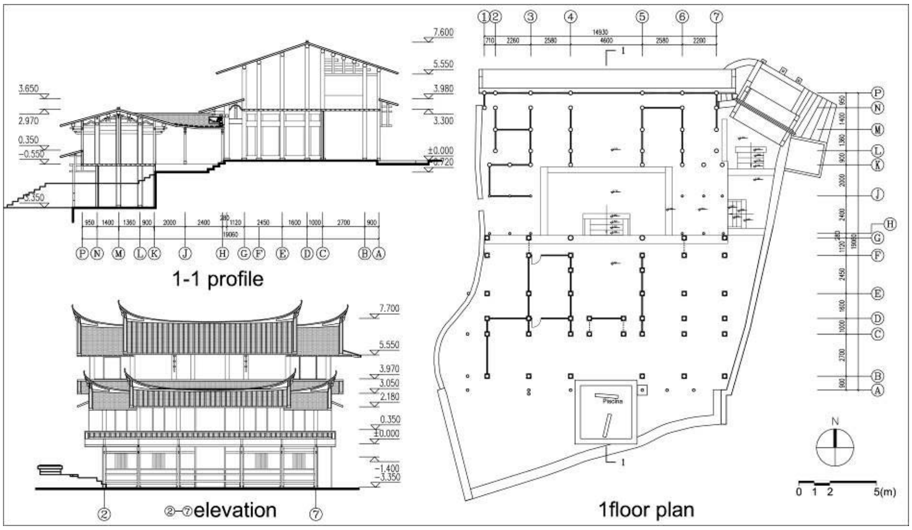


*Figure 8.*The CAD drawings of tea house

Now there is a new software system that can solve the above problem, and the data information of traditional buildings Data can be more intuitively displayed in front of us. BIM is based on the three-dimensional graphics, and it eliminates the process of drawing two-dimensional projection, in order to avoid drawing erroneous projection and bringing inconvenience for the paradigm shift of mapping personnel between two-dimensional and three-dimensional. It accords to the division of the building components. For example, when we draw the beams and pillars structure of tea house, first of all we draw a beam and a pillar, then we define each of the major data for the corresponding length, width and height attributes, finally, these data will appear in the list of family type. Other beams and pillars can directly quote from component family in the repository, and record information by directly entering the property value. With some simple operations in the plane and elevation, it builds 3D models directly from the data information (Figure 7).

We can better protect the present situation of traditional buildings with BIM. If we want to receive a two-dimensional view, we only need a few simple operations such as marking elevation, sectioning and so on, then it will automatically generate the desired view (Sun WeiChao, Wang WenBO, et al. (2014)).

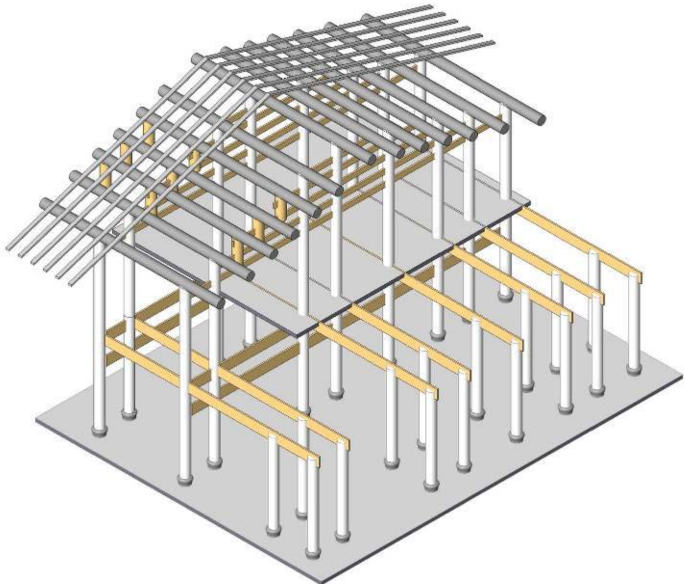


*Figure 9.*The 3D models of tea house's beams and pillars structure

4.2 The protection of non-data information

For traditional buildings, they carry a lot of information. In addition to the size of the data, a great deal of non-data information is also very important, such as the background of the relevant building, damaged components, and the cultural information of the building. BIM's system of information input is completely dependent the model, and process modeling is the process of information input (Sun WeiChao, Xu Zhen. (2012)).

We can achieve visualization of non-data information based on B IM. When building the models of tea house's beams and pillars, we input structural degradation, alteration and degradation of the material at the same time (*Figure 8*). First, we can sort out the current situation issues table of tea house's pillars and beams through field research (*Table 1*).The family model comes with system contains perfect parameter mechanism for designers inputting, but the family model that we build ourselves can add the needed information to the properties dialog box of components. According to the classification of the current situation issues table, we input the specific attribute of each beam and pillar, and then the system will automatically generate the current situation attribute table of beams and pillars. Because the text description is not intuitive, so we transformed the text into graphics *(Figure 9*), at last we can get this attribute table (*Figure 10).*

We can easily know the current situation of beams and pillars through the above tables and graphics. In order to protect these components of tea house, we make the intervention proposals for wood structure corresponding to the current situation issues (*Table 2*),and then we can get the appropriate disposal measures for the pillars in 1 floor, such as cleaning and maintenance, partial substitution and reinforce or entire substitution (*Figure 11)*.

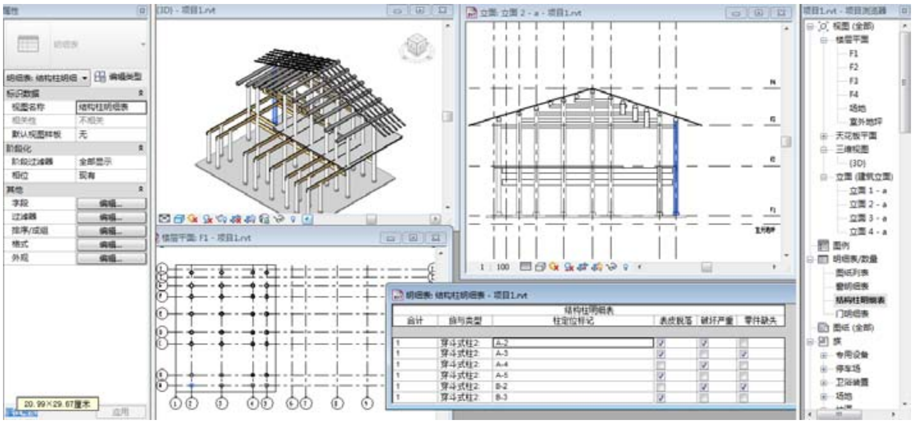
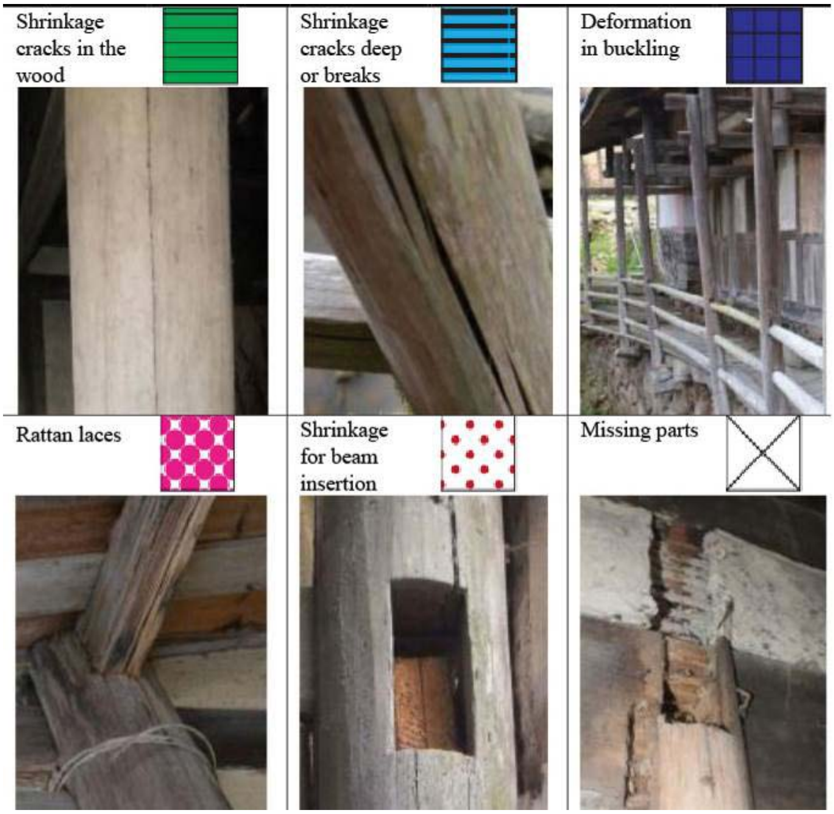


*Figure 10.*The interface of revit model

*Table 2.*current situation issues table of pillars and beams

Issues	Description
Shrinkage cracks in the wood	The shrinkage cracks do not give structural problems naturally occur in the wood when it is dehydrated after the implementation, the change in temperature as in this case may enhance this phenomenon.
Shrinkage cracks deep or breaks	In the case of continuous and rapid changes in temperature and / or when the column is subjected to excessive weight loads are created deep fissures in the party till the break of the carrier. Rupture normal stress for axial load.
Deformation in buckling	The deformation of the load-bearing column is due to natural factors, the wood put in work presents axial deformations in Y. Or is deformed due to the load. Other deformations and / or swelling can be caused by moisture.
Rattan laces	The connection with rattan is used to reinforce the pillar in the intersection with one or more beams. Most of this laces are destroyed by insect and they had no more function.
Shrinkage for beam insertion	Fractures and vertical slits are to be attributed to the adaptation of the wood for the insertion of the vertical element. With moisture, permanent load and other factors such as xylophagous insects can accentuate the problem up to the need to create new support within the column to support the beam.
Missing parts	The lack of parts or elements entire column can be attributed to two factors, anthropological have been removed to be replaced or due to erosion by fungi and insects. In both cases, the replenishing of these elements should be implemented.
New wood/new addiction	The replacement of whole carriers was accomplished without paying attention to the study of the existing case-pillar prospectus South Regarding the restoration of contact between column and base in the case of failures, the operation was carried out in an approximate way without solving the underlying problems.

Decay fungus white/brown	(Synonyms: rot) Degraded wood caused by fungi that cause progressive loss of mass, mechanical strength, hardness and generally also variations in color and appearance. These mushrooms can be active only if the wood has higher moisture of (18-20)%. The type of decay is found you type white fibrous appearance and bleached wood and brown rot or cubic.
Holes flicker of wood eating insect	Animal or vegetable organism that portrays their nourishment from the wood. The holes in these insects are particularly common when they can give rise to structural problems and missing parts.
Gallery of insects on the surface	Gallery built by insects (usually by termites) with different material (dirt, excrement, etc.). Attached to the out-side of the building to move from one area to another.
Mold	This term is used generically to indicate superficial mycelial growth of fungi imperfect, typically in environmental conditions of high humidity.
Moss	They occur when there is plenty of water and may become black when there is poor lighting, and otherwise turn green. They have the behaviour similar to other plant species, as procure physical degradation when the root system penetrates deep into the cracks and producing a chemical degradation by substances secreted from the roots.
Smoke and carbonization	The presence of smoke and carbonization is due to rituals that were using smoke for the ancestral hall, and is also found in areas used for food preparation. The phenomenon is manifested by the blackening for overlap of smoke particles. The focus if this was too close to the structures has resulted in a superficial carbonization of wood.
Metal element	Presence of metal elements such as nails inconsistent and unnecessary from the structural point of view for the functional building. Their position is probably due to the necessity of hanging candle lamps or furniture.
Surface erosion	Disruption surface due to removal of small fragments from the wood surface, by various factors, such as rubbing of solid bodies, or impact of particles carried by the wind or liquid streams. Sometimes it is differentiated between those areas of spring wood and late wood, according to their relative hardness.
Humidity	Amount of water contained in the wood, expressed as a percentage by mass dry weight of the wood itself. Being highly hygroscopic, the wood can exchange moisture with the surrounding air, and can also absorb water, which may be in contact.
Exposure UV rays	Factor of degradation of the wood surface, which if exposed for long periods has surface discoloration (graying) and micro-cracked by ultraviolet radiation (through photo-oxidation processes and depolymerisation), and infrared radiation (by heating it produces).
Efflorescence	Training superficial appearance of crystalline or powdery or stringy, usually whitish in color.


Shrinkage cracks in the wood
Shrinkage cracks deep or breaks
Deformation in buckling
Rattan laces
Shrinkage for beam insertion
Missing parts

New wood/new addiction	Decay fungus white/brown	Holes flicker of wood eating insect
		
Gallery of insects on the surface	Mold	Moss
		
Smoke and carbonizatio n	Metal element	Surface erosion
		
Humidity	Exposure UV rays	Efflorescence
		

*Figure 11.*The pictures of current situation issues

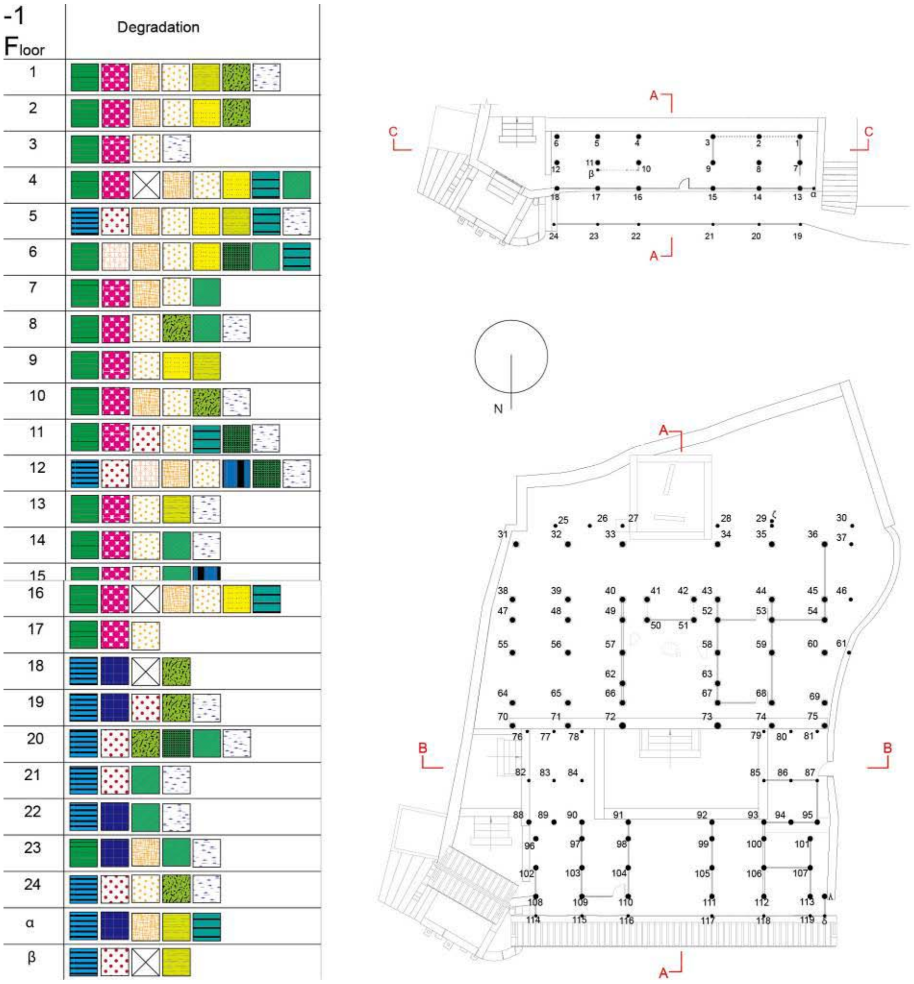


*Figure 12.*Attribute graphics of the pillars in tea house's 1 floor

*Table 3.*The intervention proposals

Metallic elements incoherent	Mechanical removal of the elements that damage by oxidation the woody parts, cleaning solvents with surfactants.
Solution for the glue on wooden elements	Removal with hot steam and scrape off the glue and paper with a plastic spatula if necessary with sandpaper.
Removing paint from plaster and graffiti	Hydroxide sodium or hydroxide potassio. Pack with absorbing substances such as talc.
Solution for black smoke on wood elements	Clean the stained surface with a cloth dampened with a mild solution of soapy water, rinse well with clean water and dry immediately passing the oil.
Moss	Remove with a rubber spatula and water, if it were not enough you need to use chemical biocides.
Intervention for white	Eliminate or reduce the problem of moisture through the drying or

or brown fungus	forced ventilation, remove the contaminated area and two coats of fungicide spray at a distance of at least 2 meters for destroy any spores in the air.
Intervention for xylophagous insects	Treatment micronode, natural, is based on heating at 55 ° C of the entire trunk, allowing the killing for dehydration and hyperthermia woodworm. The most severely damaged parts should be removed and replaced with wood previously treated against insect attack. Treatment with permethrin-based solvent. Preventive treatments will be carried out with boron salts.
Molds	Do not cause structural damage but create aesthetic problems, can be removed with simple cleaning bleach and water or any antiseptic treatment such as chlorine. For the most affected areas is okay to use sanding or sandblasting.
Salinity and efflorescence	Ascent or descent by capillarity is formed by salts. Remove steam with muriatic acid 1 to 12 of distilled water. You can also use the wraps with solutions to dissolve the salts, packs of paper. Give hand protection with natural oils or acrylics. Done every 2 years every 4 natural acrylics.
Weathering and UV protection	Sandpaper and remove dust. Dealing previously wood with a coat of water-repellent treatment to protect it better. Use of oils such as linseed oil or oils in the acrylic latex.

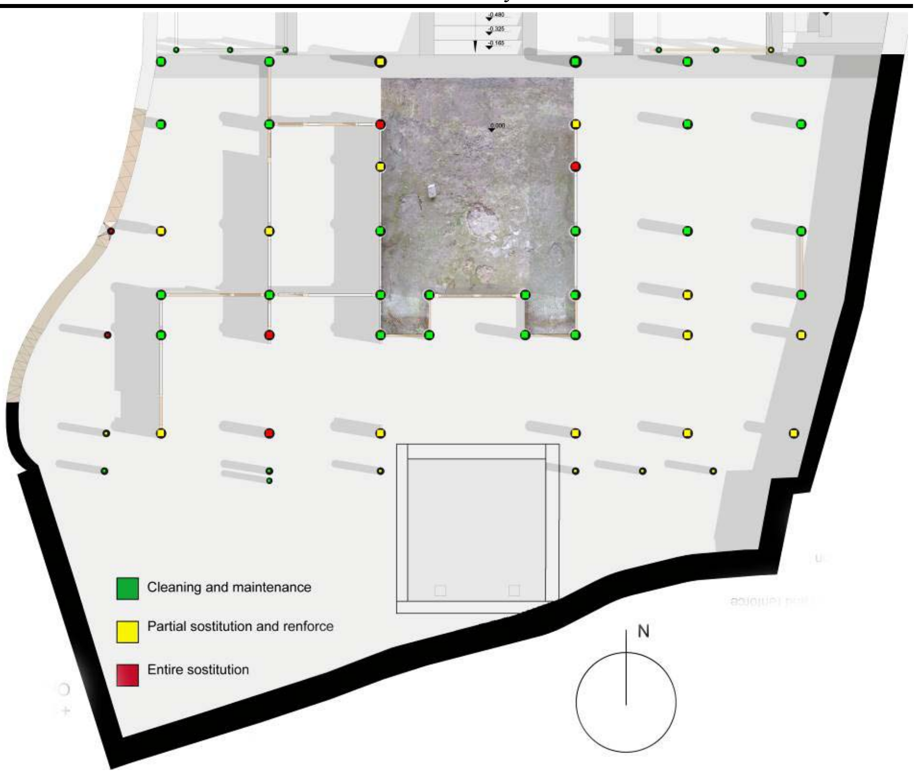


*Figure 13.*The appropriate disposal measures of the pillars in tea house's 1 floor

4.3 Other functions of BIM in the protection of traditional buildings

There are other functions of BIM in the protection of traditional buildings, such as the economic evaluation of protection project, information sharing of traditional buildings, data docking with the three-dimensional laser scanner and so on.

Extracting key information in the information model, we can build the index system of protection project's economic evaluation with the use of correlation function. When the lack of protection funds, we should be preferred to the rescue project, if there are sufficient funds, we can choose the project that the repair effect and technology level has reached the level of specification requires while the cost is minimum(Wang Ru, Zhang Xiang, et al.(2014)).

Traditional buildings have a certain similarity, when surveying other buildings, we can directly use the family file if we had previously surveyed and stored the same or even similar family style. If the size is different, we just simply modify the predefined parameters to complete the drawing of components. Information sharing not only saves modelling time but also contributes to the sorting and archiving of traditional buildings' components. So that these families are like "gene" being stored in the traditional buildings' "gene library", and continue to be enriched and improved.

The accuracy of 3D laser scanner has been improved compared to manual surveying, and achieved the unity of the measurement accuracy. BIM operating systems Revit series of software since 2012 the new version adds a point cloud tool that can be used as the reference point cloud which is embedded into the file and extracts the plane reference from cloud data, for components position and achieving a direct link of BIM and 3D laser scanner. This new feature of BIM provides a strong technical support for introducing new technology instruments into the collection of traditional buildings' information model.

5. THE RESTORATION OF TEA HOUSE

5.1 The design scheme

The purpose of the regeneration of the tea house is due to the importance and strategic location of this within the village for tourism purposes and for the promotion of local products of the village. The intent is to make this house a home manifesto for the protection and restoration for the better of the old buildings of wood around the village. Being a predominantly agricultural village and having experienced first-hand the dishes of the place there is no doubt that the tea house should have the function of restaurant but most of all it should regain its original function as a tea house and a meeting place of passage.

The following is my design scheme. The floor below ground will be used as shops selling local crafts and tea. On the ground floor underside of the tea rooms will be used as exhibition space, the topics will vary from the history of Chinese tea to the beautiful landscape paintings of the personalities in the history of the village from the same village, the space in front is clear of furniture and seating to observe the village overlooking the ShenGui creek. On the second floor there will then function as the tea rooms are more and divisions intact (*Figure 12).*It is from this desire to want to reopen to the public house shops swap space par excellence, could not find better location if you do not in direct contact with the road along the creek. I inserted a new block with new structure and walls that would allow the integration of the new plant floor level on the ground floor with the first floor being a volume that occupies two rooms with no beams will not need to destroy anything and will be incorporated within the new box one of the pillars. The box is divided in two horizontally on the ground floor services wc and upstairs kitchen facilities bulkier doing so will be incorporated in new walls (*Figure 13).*

The owners of tea house can easily know the design ideas of the project by 3D virtual model of BIM, the partition function, the restoration of structure, the roof and so on. Except the overall isometric drawings of the buildings, BIM also can provide any corner of the virtual reality scene of the traditional buildings (*Figure 14*). BIM can create an immersive visual, and it automatically generates an image from the height of human sight (*Figure 15*).

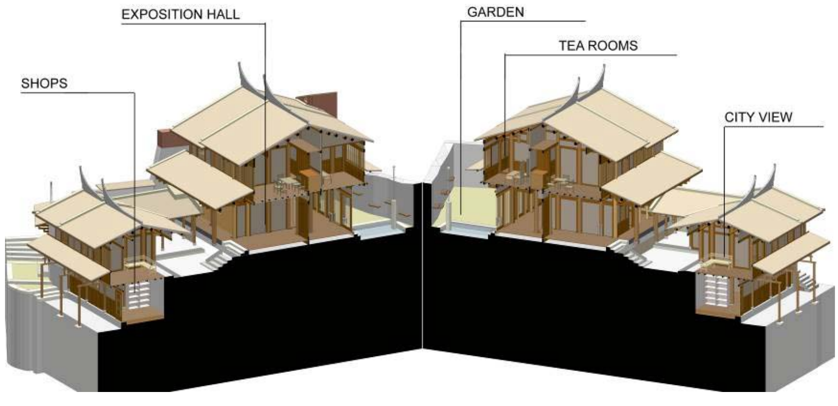


*Figure 14.*The 3D virtual model of tea house

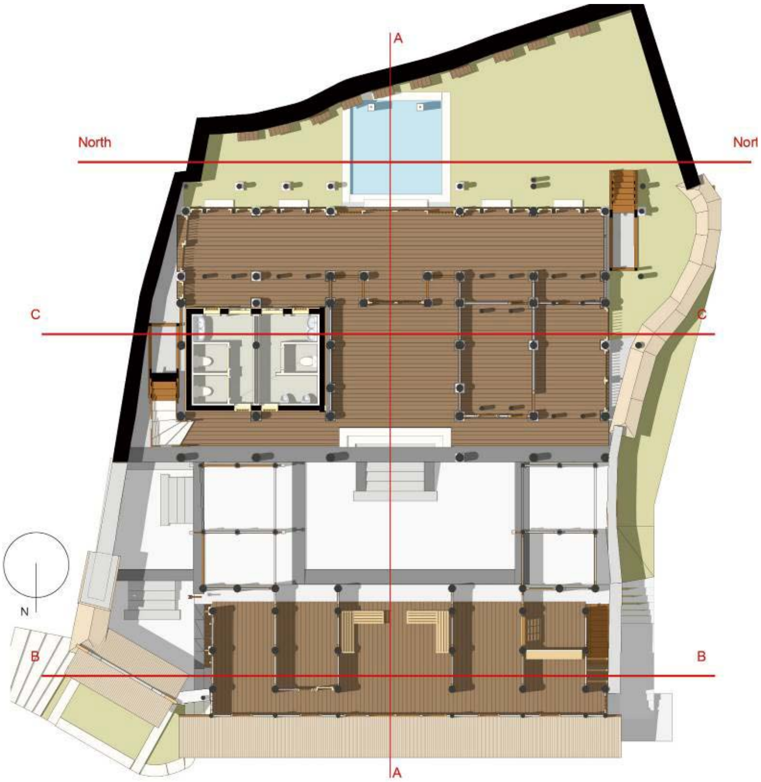


Figure 15. The 1 floor plan of tea house

*Figure 16.*The virtual scene of tearoom

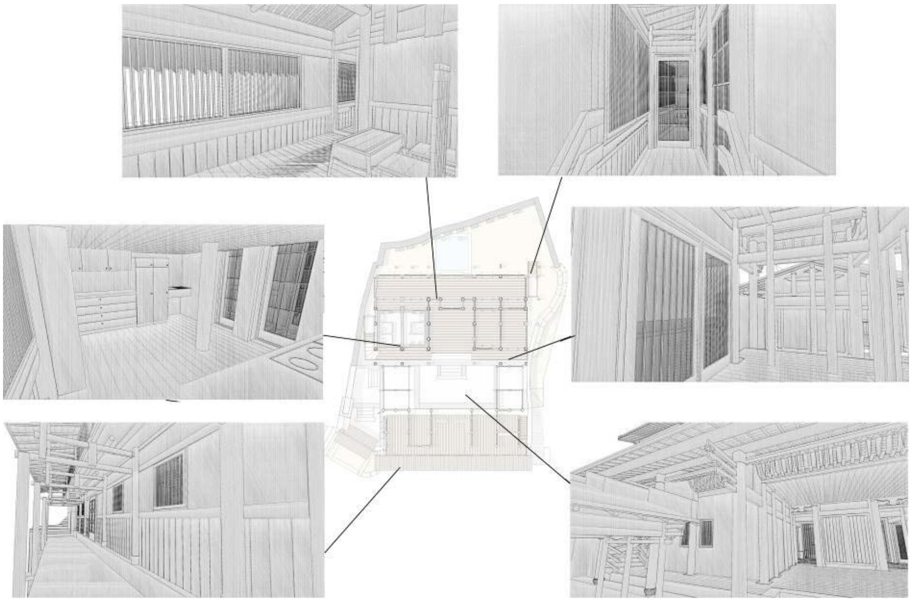


*Figure 17.*The interior scene model of tea house

5.2 The restoration of components

Traditional buildings consist of a variety of components, and the regeneration of tea house means the restoration of the components in tea house. First, considering the integration of partial pillars, problem more interested in the base of the pillar is proposed integration with removal of the damaged part, using a new steel structure. Some cases of strong deformation and cracking will be heated with the creation of new unions and increasing the cohesion of the element itself, can hoop with root or for more severe cases of carbon fibber. Second, we replace entire bearing elements. Due to the severe cracking the case will fully replace the item, the replacement of the central elements also because there are no unions masonry preventing its removal. Finally, we do t he new structure for beams. Some rooms at the second floor present resistance fragile, with the support of two new beams and pillars that depart from the floor below, we will be able to keep the beams excessively not consumed by degradation to lay new flooring (Figure 16).We can understand the construction steps of traditional buildings from the station base to the roof, and it is easy to know the changes of the pillars and beams in the tea house through above figure, the new floor, old pillars, and new pillars etc.

When designing a small exquisite component, the CAD draws the plane, elevation and profile, and we have to imagine its shape through the brain. BIM overcomes this problem, and it expresses the approach of components more intuitive. As the new steel of pillar for example, we cut the decaying wood of the pillar and temporarily hold it stable with media that anchor the pillar at the upper end below the slab interstory, then we weld the base plate with the L profiles, place it below the stone plinth, bolt the plate above the L profiles previously welded to the supports and spike the pillar ancient elements arranged below the upper plate. At last we glue the supports for the glass to L and the glass glue on supports. L-shaped elements and glasses will be previously dimensioned to fit the corrupted part of the pillar (*Figure 17*).

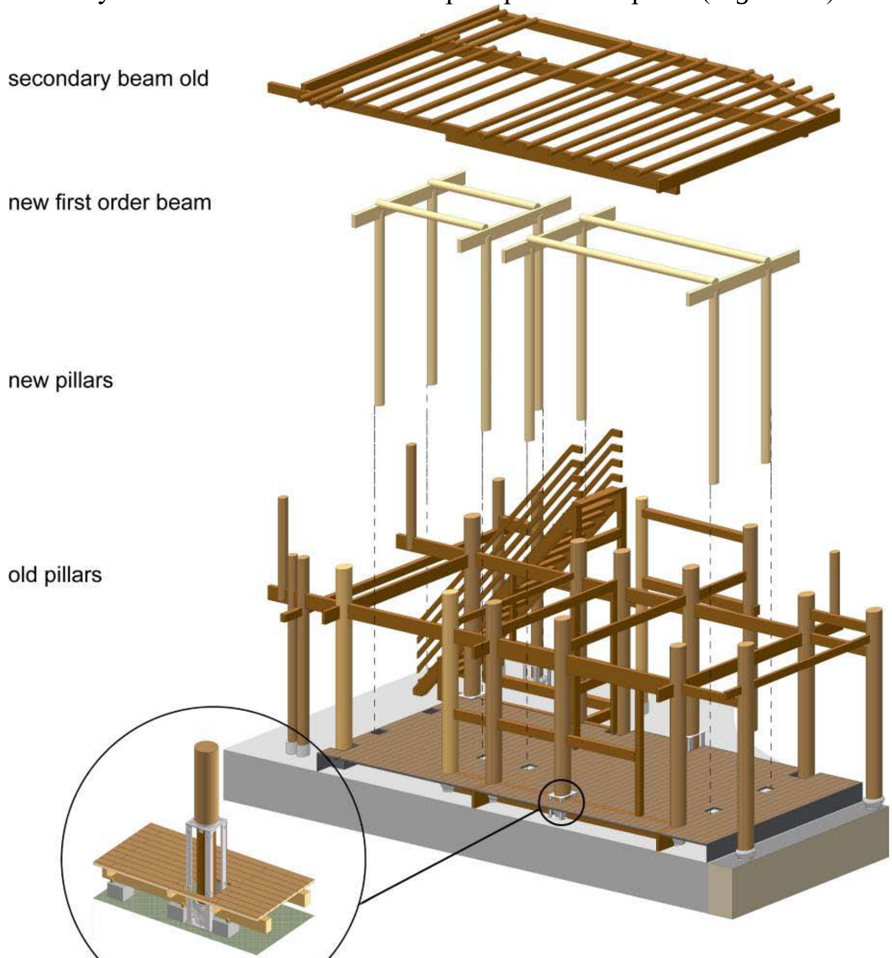


Figure 18.The specific practices of components in tea house

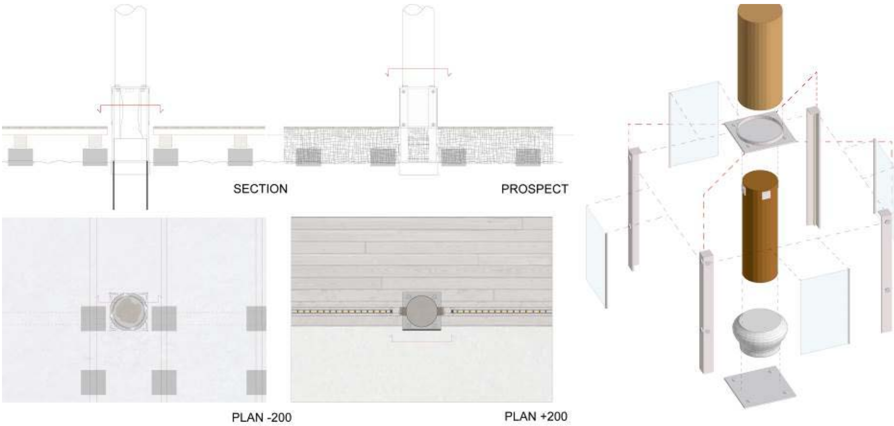


*Figure 19.*The new steel of pillar in tea house

5.3 Other related analysis of traditional buildings

In addition to enhancing the visualization of traditional buildings, there are some of the features very important for the protection of traditional buildings with the 3D model of BIM, such as the simulation of disaster response, virtual construction and docking with ecological software, etc.

With the use of BIM and the corresponding disaster analysis and simulation software, we can simulate the process of disaster before the disaster, so that we can develop measures to avoid it. When a disaster occurring, the BIM model can clearly show the location of the emergency situation inside the building, or even provide the most suitable route for rescuing.

BIM can link the 3D model with the progress of project, so that the spatial information and time information will be integrated in a visual 4D (3D + Time) model, which can intuitively and accurately reflect the whole regeneration process of traditional buildings (Zhao JingXue, Jiang Li, et al.(2012)) . We can clearly get the difficulties and points in the restoration process, and also the original program can be further optimized and improved in order to improve the safety and efficiency of the project.

Ecotect (Autodesk Ecotect Analysisi) is the important software of BIM system, and it can make the simulation analysis of light environment, thermal environment, sight, acoustics and sunshine, etc. Today, except the architecture, Ecotect is also widely used analysis of neighbourhoods and urban planning.

6. ONCLUSION

Facing with large wide range of traditional buildings in china, we cannot use the previous method of protection, so the introduction of BIM is very meaningful. It can completely replace the traditional surveying drawings as design and construction data been archived for the inspection at the time of the traditional building repairing in the future. Relying on the recording of components size and process data of traditional building information modelling, we can make the residual components repaired or replaced. Basing on the record of components size and material data of information model, we can also make the missing components deployed with the original. The parametric qualities of BIM provide a wide range of convenience and variety of ideas to the study and research of traditional buildings. No matter from the perspective of cultural exchange, the economic point of view, or from the management point of view, it will be a breakthrough, and will get more and more extensive application, prospects. Basing on the core concept of BIM technology, there will be new software called CIM (City Information Modelling) if the study expands from the buildings to the cities and settlements. It is the BIM model upper system, and it can longitudinally connect with BIM software platform.

The protection of traditional buildings is very difficult, and it requires a variety of different departments with each other, for example, the government, the villagers, experts, community groups and so on. This paper from the designers point of view, and the use of a new software system for the protection and restoration of the process, only to provides a new technical support for the protection of traditional buildings. In this paper, I explore the applications of BIM in traditional buildings as an example of the Qing Dynasty tea house in Guifeng village. There are still many shortcomings in the building information modelling because of the time and technology. Focusing on the application of BIM in traditional buildings' surveying and 3D virtual model, there will be a more in-depth study following up.

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NO.69

Design of Land Use Planning Model of Green TOD

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Key words: Transit-oriented Development, land use planning model, mathematical programming.i6

Abstract: Transit-oriented development (TOD) has become a main concept of urban planning as the advocacy of sustainable development. Previous studies, though, have explored the benefit of TOD which features of compact development and mixed land use, excessive density will also accelerate the resources consumption in inner city and decrease the quality of living environment. To solve the aforementioned problems, studies have proposed the concept of "Green Transit-oriented Development (Green TOD)", which combines the concept of "TOD" and "Green Urbanism" in anticipation of shaping an environmentally friendly urban form further. However, most of the studies about Green TOD mainly focus on defining the planning concept or establishing the evaluation framework and criteria of it, it still lacks a land use planning model for Green TOD which aims to generate planning alternatives objectively for planners. As regard to the land use planning model, prior studies seldom took the current zoning and rezoning restriction into consideration during the model formulation, which not only made the formulated model fail to represent the real planning problem but also decrease the application value.

This study, therefore, develops a multi-objective land use planning model for Green TOD from the aspect of overall review of urban planning. The objectives of the model include "maximizing the development density", "maximizing the mix land use degree", "maximizing the biophilic open space", "maximizing the accessibility of non-motorized vehicle", "minimizing the parking demand", "maximizing the benefit of resource allocation" and "minimizing the rezoning scale of available land". The constrains of the model include "the rezoning feasibility of overall review", "the restriction of allocated location", "the allocated restriction of minimum scale and maximum volume", "budget limitation", "identification of transit station area" and "connectivity of bikeway network". The revised minimum deviation method with different weight settings are used to search the non-inferior solutions set for the simulated case to verify the applicability of the developed model and sensitivity analysis was used to explore the model characteristic.

The result found that some of the objectives, which cannot be integrated due to the difference of planning concept, assessing aspect and decision contents, feature of non-trade-off relationship due to the same pursuing direction. The application of the model can therefore apply this characteristic to pursue the integrated benefit accordingly and focus on the planning approach of high density development. Besides, the sensitivity analysis shows that budget amount influence the planning flexibility and trade-off degree significantly. Budgeting should therefore be dealt appropriately after analyzing the current zoning to ensure the achievement of planning preference. The land use planning model developed by this study can be applied to generate planning alternatives under the planning concept of Green TOD and support the authorities for land use allocation, bikeway design and water resource allocation.

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NO.74

A LUTI Model for Beijing Metropolitan Area

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Keywords: LUTI; Beijing; Urban Activity; Accessibility; Evolution

Abstract: We develop a LUTI model to simulate urban spatial evolution in terms of urban activity spatial distribution with a practical implementation. The LUTI model proposed consists of a transport sub-model, a residential location model, an employment location model, and an implicit estate rent adjusting model. The model proposed is applied to Beijing China to forecast the urban development trend under the land use policies of recent years. Urban expansion in terms of residential distribution in Beijing mainly happens along or outside 5th ring road, but urban expansion in terms of employment distribution mainly appears outside 5th ring road and is much more dispersed with only a few zones with high increase in density, from which we could conclude that there is abundant labor in Beijing, and companies concentrate mainly on the cost instead of destination accessibility to enhance their location utility. Future research subjects are also discussed.

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NO.75

The Urban Sustainable Development Path Under the New Normal Background

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Key words: New Normal, Homo Urbanicus, People-Orientation, Sustainable Development

Abstract: China's economy has entered into the New Normal Era. The economic development form of this period will be significantly different from the extensive economy of the last thirty-five-year rapid economic growth. The rate of economic growth would turn from high speed into intermediate speed. The lower the amplification goes, the smaller the resource consumption. The new urbanization would be the biggest development potential and power of the New Normal Era, which emphasizes the self-positioning of cities from urban planning and construction industry aspects, and promote the core of people-oriented ecological civilization and sustainable development concept. Hu Jintao's report at 18th Party Congress put forward the new urbanization strategy, which stresses that urban development is going to focus on people themselves, rather than merely focus on economic construction. In the current era, it is urgently required that China's urban development has to base on people-oriented urban living space, instead of taking economic construction as the centre of development concept, which will only make cities turn into economic growth of production space. According to the Homo Urbanicus planning theory proposed by Hok-lin Leung, homo urbanicus are people who make rational choice of settlements to pursue spatial contact opportunities, which can rationally understand and match different contact opportunities offered by different human settlements. Homo Urbanicus are the masters of the city, the ultimately service targets of urban construction activities, economic development and ecological protection. This theory can provide accurate supply and demand information to urban planning workers, that can meet the needs of homo urbanicus, to balance the production and distribution efficiency; which can also provide operation and management information to the local government, to promote the living condition and quality of homo urbanicus, and balance the self-existence and coexistence at the same time; which advocates grassroots level democracy planning system, with higher level commands can made known to lower levels, and the individuals could express their views which can reach higher authorities, to identify the pursuant of representative homo urbanicus. Thus, we urban planning workers

can design and practice democracy planning, to provide the representative human settlements with better living space condition, where the self-existence and coexistence have reach the optimum balance. It is in this light that we combine the people-oriented new urbanization and homo urbanicus planning theory together, make a discussion on three aspects, social change, people-orientation change and behaviour change, which breaks through the traditional urban planning method, changes planning direction from land and economic activity-based to individual and daily living-based, changes planning development from static and blueprinted to dynamic and procedural. Thus, we put forward a further discussion on the urban sustainable development path under the background of new normal era, to make urban planning more scientific, accuracy and efficiency.

1. RESEARCH BACKGROUND AND SIGNIFICANCE

American geologist, Ray. M. Northam put forward a curve theory in 1975, in which the progress of global urbanization presents a r everse flattening S-shaped curve. Urbanization process has entered the phase of rapid lifting stage when the urbanization rate is more than 30%; and entered mature stage while the rate is reaching 70%, manifest the stagnation or slight declination of urbanization. From the developing trend of cities across China, according to statistics in 2013, the urbanization rate of Shanghai, Beijing and Tianjin have already exceed 70%; the urbanization rate of coastal provinces such as Guangdong, Liaoning, Zhejiang, Jiangsu, Jiangsu has overtaken 60%, which will beyond the threshold of 70% in succession in the following years. This implies that those leading development districts' urbanization have entered or approach to enter the mature stage in the process of national modernization drive. A new normal of China's economy emerges. This period will be significantly different from the past thirty-five years high-speed but extensive economic development.

On November 9, 2014, P resident Xi Jinping made the remarks when addressing the Asia-Pacific Economic Cooperation (APEC) CEO Summit, that the new normal of China's economy is characterized by having still registered considerable increment albeit the slowdown, growth having become more stable and been driven by more diverse forces, structure having been improved and upgraded, and the government having vigorously streamlined administration and delegated power. The social and economic development of China has appeared the situation of the new normal, the new feature of urban and rural development pattern and tendency will be emerged. Thus, it can be seen that the economic foundation supporting ultra-high speed urban development is no longer exist. The practical situation leaves China no choice but to look for new driving forces for growth. Is consistent with the new normal economic development, urban development is bound to enter into the new normal stage of advancing quality and efficiency gradually.

Urban sustainable development would be the biggest development potential and power of the new normal era, which takes the coming 13th Five Year Plan of national economic and social development as an opportunity, stresses the new urbanization strategy put forward by Hu Jintao's report at 18th Party Congress, emphasizes the self-positioning of cities from urban planning and construction industry aspects, and promotes the core of people-oriented ecological civilization and sustainable development concept. In the current era, it is urgently required that China's urban development has to base on people-oriented urban living space, instead of taking economic construction as the center of development concept, which will only make cities turn into economic growth of production space. Deep understanding and positive adaption of the new normal era would be the key point of China's urban and rural planning and development during current and future.

The ideology and methodology of China's urban research and planning come through the premonition of revolution. With the establishment of China's economic superpower status, urban sustainable development, new urbanization, harmonious society construction and the like would be the main objective during the future multi-decades of urban development. Western humanistic city construction exploration would gradually be recommended, applied and innovated in China. Homo urbanicus theory focuses on people-orientation but function-orientation, on people's physical needs but capital's efficiency needs. When we planning cities based on homo urbanicus theory, we can finally embody people-oriented cities.

2. URBAN PLANNING THEORETICAL RESEARCH BASED ON HOMO URBANICUS

Starting from 1970s, under the influence of Humanism and Post-modernism views, social change, people-orientation change and behaviour change appear in western urban research. Structuralism, humanism, behaviourism methodology etc. generated by urban social structure, individual initiative and time-space behavior, are becoming the theoretical basis of modern urban research and planning. ‘Better city, better life' will be the main theme of the era.

2.1 Connotation of Homo Urbanicus

‘The Science of Human Settlements’ proposed by Greek architect and town planner Constantinos A Doxiadis, according to the idea of human settlements, describes habitation as a spatial phenomenon, constituted by five ‘Ekistic Elements’, ‘nature, man, society, shell and network’. Enlightened by the economic 'Homo Economicus' assumption and 'Science of Human Settlements', Hok-lin Leung put forward the theory of 'Homo Urbanicus'. He considered that city is a phenomenon of people settlement. Furthermore, both of man and habitation are indispensable. Homo Urbanicus are people who make rational choice of settlements to pursue spatial contact opportunities, which can rationally understand and match different contact opportunities offered by different human settlements. Homo Urbanicus are the masters of the city, the ultimately service targets of urban construction activities, economic development and ecological protection.

Constantinos A Doxiadis put forward that human beings comply with five principles to shape their residence. To pursue the greatest opportunities for contact with other people, natural and artificial environment; to minimize the effort to fight for real contact or contact opportunity, and to build habitation structure shape and road network layout based on the above; to create an optimum living space, with appropriate distance to avoid sensory or psychological discomfort and uneasiness while maintain the contact with people and object; to create an optimal order of the relationship between human and its surroundings; to organize human settlements optimization by optimize contact opportunities, and to pursue the greatest opportunities for contact, with minimal effort and a certain life and environmental quality underscore.

According to Hok-lin Leung, rational Homo Urbanicus have the following characteristics. They can rational distinguish positive and negative contact opportunities, likes and dislikes clearly; they pursue contact opportunities rationally, and use 'optimization equation' ---

Spatial Contact Opportunities = ∫ (Settlements Variables)

--- to design the most efficient pursuit method, with distinct motivation; they make rational choice of finding ideal accommodation by measuring the amount of contact opportunities of the certain area.

Based on "the Basic Need Hierarchy" put forward by Abraham H Maslow， Homo Urbanicus possess two characteristics: They pursue spatial contact opportunities, to chase for a sense of belonging and respect, and the possibility of self-realization through the interpersonal space contacts; also, they are rational inhabitants who have safe distance limit, settlement by rational pursuit of physical and psychological sense of security brought within a certain safe distance. Therefore, the author believes that Homo Urbanicus are the people who can make rational choice of settlements, and who can make a balance between spatial contact opportunities and sense of safety. Although Homo Urbanicus can sometimes be short-sighted, focus only on their self-interests and short-term interests.

2.2 Means and Methods of Homo Urbanicus Research

The problem urban planning has to deal with is a trade-off of matching land and the land use. Urban planners have to identify the appropriate accessibility and bearing capacity, although some of the determinants are subjective, some based on the conflict of interest, some based on the ideological differences. At present, the handling method to solve the problem is mainly through politics, including public participation. However, the final result of compromise is often full of anger and tension. Through in-depth study of homo urbanicus theory, we can break through the dilemma from excessive pessimism of human nature. By restoring the human nature original appearance of the self-existence and coexistence, we can exploit a set of urban planning orientation with animation and innovation, to create a harmonious and happy habitation.

The homo urbanicus theory aims to create a people-oriented habitation to match what homo urbanicus pursue, and what space opportunity can provide. It can provide accurate information of supply and demand to satisfy homo urbanicus needs to urban planners, in terms of measure the production and distribution efficiency. It can also furnish supporting information of operation and management to the government, to promote the homo urbanicus' life quality, in terms of balance the self-existence and coexistence. Homo urbanicus are the people who chase space opportunity by living in a community, whose identity are qualitative by synthesize four factors, which are human being, matter, situation and space.

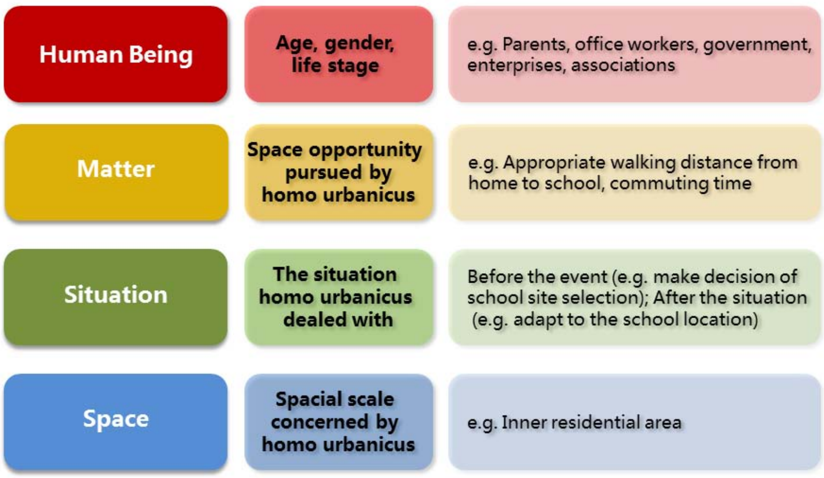


Figure 20. Qualitative factors of homo urbanicus identity

Take walking distance of school site selection as an example. Parents' self-existence consciousness makes him/her pursue the minimum distance from home to school. Their coexistence consciousness make him/her acknowledge and accept that the site selection of the school authority may have other consideration of other education works, from which the children get relatively further distance is acceptable. Therefore, parents' balance of self-existence and coexistence consciousness makes him/her accept the fact that children may go further distance to go to school, as long as the distance is no more than children's physical limits. School authorities' self-existence consciousness make them hope to cover most source of students correspond with school's scale. They want to select the center of the maximum range of student source. School authorities' coexistence consciousness makes them acknowledge and accept that parents concerned about the distance and safety of their children walking to go to school. Hence, their balance of self-existence and coexistence consciousness make them tend to select school location according to the farthest distance on foot, but no more than children's physical limits.

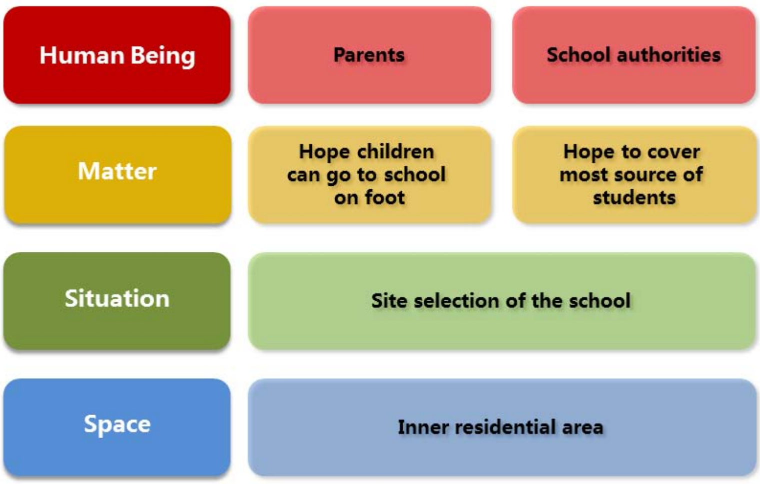


Figure 2. Qualitative factors of school site selection

The divergence of school site selection within parents and school authorities comes from their estimation difference of children's physical limits. School authorities may overestimate the limit; on the contrary, parents may underestimate the limit. The top and bottom limitation can be found through investigation from both sides' opinions of walking limits and school site selection, or through comparison between the parents and school authorities of actual walking distance satisfaction degree. The homo urbanicus theory emphasizes that both parents and school authorities acknowledge and accept that the rational walking distance between the top and bottom limitation. In case that there is a planning mechanism which help them exchange their places to take other's needs into account, the two sides could reach consensus to a large extent, which reaches the optimum balance of self-existence and coexistence.

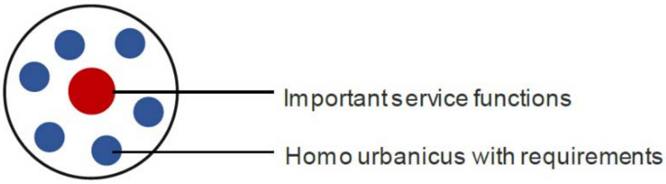
2.3 Urban Planning Theoretical Model based on Homo Urbanicus

On the basis of existing urban physical entity, we can speculate the optimum proportion of public service design through homo urbanicus' related data information, and make planning management according to the research mentioned above. Along with time passed, exploitation and construction brought about homo urbanicus' property change, including the requirement change caused by age growth, and style change caused by removal. Thus we could take the combination of gentle and force methods, in which the gentle method namely the internal unit of public service facility and service personnel scheduling, and the force method namely the supplement and removal of relevant service facility. Therefore, urban planning is not only make from the material space, but also make from the effective management of function. To put it simply, the problem we have to solve is that people follow the facilities, or both the people and facilities are given consideration and cooperation.

For instance, the price of school district housing around excellent school resources is extremely high, though its service effect only exists certain years. The time of children studying in this school may only take three to nine years; moreover, the whole family may live here more than ten years even a lifetime for the sake of children's study opportunity, including the process of various kinds of formalities. Thus it can be seen that the time for children receive education and the whole family dwelling at the certain place are non-equivalence. A couple may need to provide their children such education opportunity between the ages of twenty-five and thirty-five, while after the ages of forty; they might need more other service facilities. The contact opportunity, which is the original advantage of typical habitation, is no longer highlighted. In this case, it will not only caused the waste of education resources, but also not meet the different life stages needs of homo urbanicus, furthermore, it may also causes problem such as excessive housing price.

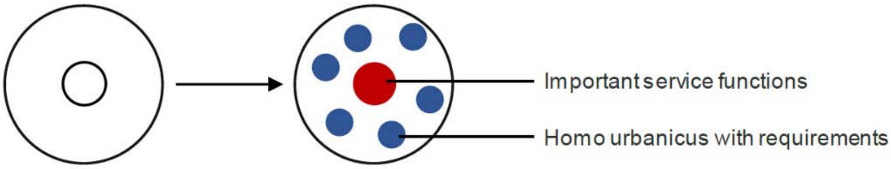
Take one of the public service facilities --- school as an example; we can build a spatial linkage management time-space urban model by using big data.

Stage I, New (existing) residential groups --- Original model.

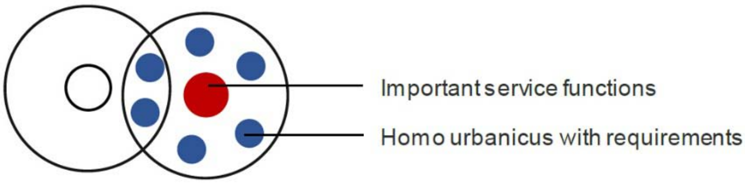


Stage II, as time goes on --- Homo urbanicus' requirements change --- The core services change --- The original resources transfer to the direction more needed.

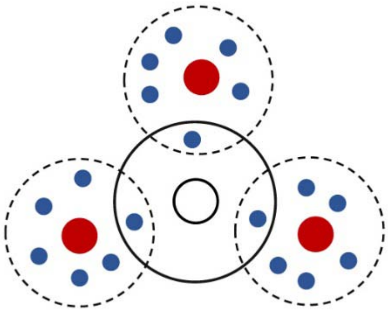
Case 1: Regional distribution of homo urbanicus with requirements changes --- Functions directly migrate and change in residential groups.



Case 2: Unilateral deviation of homo urbanicus with requirements --- Functional groups recombination --- Function directed migration.



Case 3: The demand intensity of homo urbanicus with requirements reduced --- Distribution scattered --- Functional zone recombination.



All kinds of homo urbanicus pursue different space opportunity, but their requirement quality for space opportunity may most often be likeness and trade-off. The quality contains security, convenient, comfortable and aesthetic. On condition that we admit and encourage homo urbanicus who have consistent request on space quality to gather together, then the urban land use efficiency would be improved, and the harmonious coexistence of urban residents would be promoted. We can imagine a performance partition planning normal form, which divide different living area and production area according to the index of security, convenience, comfort and aesthetics, to replace the functional partition.

Other than different function of economic, engineering, industrial needs, urban planning based on homo urbanicus focus on living and production needs from different age, gender and life stage; Other than function efficiency, urban planning based on homo urbanicus focus on living and production space quality; Other than function division of mutual nonaggression and lack of coordination, urban planning based on homo urbanicus focus on making self-existence and coexistence reach the optimum balance; Other than shackle urban land use and exploit sole and standardized, urban planning based on homo urbanicus focus on induce blended and synthetically use and development by performance index.

3. THE PEOPLE-ORIENTED URBAN SUSTAINABLE DEVELOPMENT PATH

The concrete meaning of people-oriented urbanization is to design and implement a set of planning control index including security, convenient, comfortable and aesthetic space opportunity, according to the principle of self-existence and coexistence reaching optimum balance, to let the space opportunity various habitation provided by satisfy and promote the pursuance of all kinds of homo urbanicus, and make them live a better life. Facing the new circumstances of human-oriented city construction in China, proposing the new urban sustainable development path focused on homo urbanicus is urgently required. On the one hand, based on the individual behavior, optimal adjust the urban spatial structure planning path and urban life time planning path, to provide homo urbanicus the basic guarantee of urban physical environment. On the other hand, oriented to the individual behavior, put direct behavior guide into effect, assist homo urbanicus' behavior decision-making in daily life via soft policy and information method, and lead homo urbanicus to form wisdom, healthy and mild behavior model and life-style. Hence, the people-oriented urban sustainable development incorporates space opportunity pursuance based on the individual behavior, and homo urbanicus behavior guidance oriented to the individual behavior.

3.1 The People-Oriented Urban Spatial Structure Planning Path

At present, China's urban planning always determine the urban space development direction, new growth pole of the city, major development area, industrial spatial distribution and so on according to the city's economic development strategy, by means of population overall dimensions prediction, residential and facilities land distribution on the basis of land proportion standard ration, and combination the land to form urban spatial structure. This planning pattern gradually forms the economic growth as the goal, space supply as the orientation, industrial space as the priority during the practice, so far as to leave inhabitants living space as matching function. Whereas, in recent years, land development of central urban area reaches a saturation value, accompanied with urban residents' mobility needs progressively increased, their demand is also increasingly diversified. Related urban planning cannot effectively cope with the growing complex urban disease, for instance, job housing unbalance, urban social space differentiation, residents reducing accessibility, declining residents' health and living quality, urban air environment deterioration, etc..

In this context, China's urban planning is necessary to break through the existing urban spatial structure planning pattern, emphasize the synergy between macro urban development and micro homo urbanicus' daily life in the planning. Turn the urban planning thinking mode from "make industrial area as the node, make economic relation as the axis cord", to "make homo urbanicus' vitasphere as the node, make homo urbanicus' movement path as the axis cord". In addition, to propose the sustainable development as the goal of social and environment, and orient by homo urbanicus' demand, to form the new urban spatial structure planning path which regards residents living space system as the core concept.

Urban living space reflects the interactive relationship of homo urbanicus' activities such as commuting, shopping, relaxation, and the urban entity space. On the foundation of urban entity space, we can establish a homo urbanicus' living space system, composed of "daily vitasphere --- commuting vitasphere --- urban vitasphere" hierarchical structure, as the core of urban spatial structure planning oriented by living space, according to homo urbanicus' various types, different frequency, and different time-space scale activities. Thereinto, the daily vitasphere mainly include day-to-day living affairs, for instance, dwelling activity, daily shopping, community communication, physical education and so on, the characteristic of this level is relatively irregular, multiple production, meet the needs at any time, and in most cases the activities are occurred in the form of a family. Just as its name implies, the commuting vitasphere mainly includes commuter activities, supplemented with higher level of shopping and social entertainment activities. In general, the time scale is working days with the unit of one day, with activities of personal mobility and public transportation. The urban vitasphere primarily covers transactional activities and high level leisure activities, the frequency of occurrence is once a week or even longer, which shows long-periodic rule.

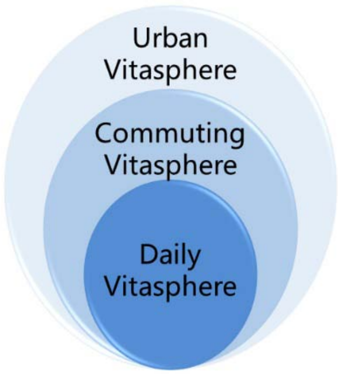


Figure 3. Hierarchical structure sketch map

The homo urbanicus' living space system based on "daily vitasphere --- commuting vitasphere --- urban vitasphere" hierarchical structure, can implement urban spatial structure planning oriented by living space. It uses urban space regionalization organizational strategy such as western edge city for reference, on the basis of homeostatic and self-support homo urbanicus' vitasphere development, construct suburban activity center, and let compact multi-center drive compact cluster. In addition, to perfect protection facilities of people's well-being planning, and develop micro-circulation transportation inside the cluster, to shape the "multi-level, relatively independence, organic organization, network association" central system, and construct the "vitasphere, cell cluster, multi center" urban space and social formation.

3.2 The People-Oriented Urban Life Time Planning Path

The existing urban community planning in China mainly regard residential land development and residential quarter construction as the main content, the land development intensity, community function layout and the amount of public facilities are settled according to the homo urbanicus' population size, which only consider to meet the quantitative needs of community residents. This type of community planning only lay emphasis on completion of service facilities construction during the residential development phase, while less considered comparatively the feedback utilize situation of related supporting facilities, public service and public space of homo urbanicus in daily life after the development is completed, which especially neglect the matching relation between the spatial arrangement of public service, public space, and homo urbanicus' mobility, the service time of public service, public space, and homo urbanicus' pace of life. In this case, homo urbanicus cannot share favourable space-time accessibility.

The planning objective of people-oriented city should change from traditional residential district development with economic efficiency as the goal and space supply orientation, to community and social planning with homo urbanicus' living condition enhancement and living practice regulation orientation. We urban planners should satisfy their usage requirements on both sides, the quantity of community public facilities and public service, and also the service time of relevant facilities and services should match homo urbanicus' daily life and movement demand. To realise the co-ordination of supply and demand on c ommunity resources time, so that the time-space accessibility and living quality of homo urbanicus' daily life can be enhanced. Such time-oriented planning path has been preliminary practiced in western countries these years.

Individual space-time accessibility can be measured by the amount of activity opportunities in potential activity space during the whole day.

Thereinto, the potential activity space depends on the following factors, personal activity space-time path, personal free time distribution, personal mobility, etc. Besides, activity opportunities lie on the facilities amount and running time of the potential activity space. On the basis of temporal and spatial regularity of homo urbanicus' daily life, regulate and control the opening hours of community public facilities and public service, adjust the public facilities' function in different time period, which can effective balance the community public service space-time supply and homo urbanicus' space-time requirement, can enhance their time-space accessibility and living quality, can increase the opportunity of activities participation and neighborhood social interaction. Furthermore, in accordance with homo urbanicus' time distribution regularity of activity demand, dynamic regulate the function of the community public facilities, make the related facilities used for other activities at certain time when the activity is in off-peak, to increase the utilization rate of facilities, to act according to circumstances to meet homo urbanicus' needs of all kinds of activities. For instance, adjust the after-school sports venues of elementary and secondary schools into public sports facilities, and open to the community, or adjust the after-hours office land parking lot into common parking area, to ease community parking pressure.

Based on the city life planning practice measures discussed above, we can increase the community residents' accessibility opportunity of community public facilities and public services, to improve the living quality of community residents. Through optimize community living organization, we can effectively increase the use of community public space, enhance community neighborhood interaction, increase community construction and management of the resident participation, to create a harmonious community atmosphere, promote the residents' sense of community identity, cultivate social capital, and realize the basic goal of community planning.

4. CONCLUDING REMARKS

The urban sustainable development path based on people-orientation advocates grassroots level democracy planning system, with higher level commands can made known to lower levels, and the individuals could express their views which can reach higher authorities, to identify the pursuant of representative homo urbanicus. Thus, we urban planning workers can design and practice democracy planning, to provide the representative human settlements with better living space condition, where the self-existence and coexistence have reach the optimum balance.

People-orientation has become the important guiding ideology of urban development, it is in this light that we combine the people-oriented new urbanization and homo urbanicus planning theory together, make a discussion on three aspects, social change, people-orientation change and behaviour change, which breaks through the traditional urban planning method, changes planning direction from land and economic activity-based to individual and daily living-based, changes planning development from static and blueprinted to dynamic and procedural. Thus, we put forward a further discussion on t he urban sustainable development path under the background of new normal era, to make urban planning more scientific, accuracy and efficiency.

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NO.80

Capturing Local Environmental Units for Natural Disasters Avoidance

Using Historical Land Use Assessment and Natural Condition Assessment

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Key words: Natural disasters, Environmental evaluation, Resilience, Data Usability, People Perception, GIS

Abstract: We have to think sustainability and resilience for future regional planning, and preventing risk of natural disasters are essential. Many studies have shown frameworks for restoring post-disaster areas. However, few studies have reported on the landscape evaluation processes that lead to risk prediction before natural disasters. In this study, we focused on showing frameworks, which can capture local environmental features for natural disasters' risk prevention, and which also can understand easily for local residents. We used two simple and holistic frameworks: Historic Land Use Assessment (HLA) and Natural Condition Assessment (NCA). HLA tried to show disaster risk from historical continuity, while NCA showed from natural environmental character. We captured relationship between each methods (HLA and NCA) and natural disasters, which actually happened. As the result, HLA could explain more in flat disasters, such as flood disasters than NCA, but NCA could explain in steric disasters, such as debris flows. In addition, we overlaid the results of environmental classification from this research and the present aerial photos of two study fields. The photo turned out to be able to understand instinctively why the areas are vulnerable to natural disasters. In conclusion, this study showed that by using two simple and holistic frameworks, we will be able to make sustainable regional plan for natural disasters risk prevention.

1. INTRODUCTION

Many people recognize that natural disasters have strong relationship to create sustainable cities. Nowadays, natural disasters are becoming extreme all over the world, and they are affecting human safety and property (Steiner,

F. (2014)). For example, the Tohoku Earthquake and Tsunami (2011), occurred in Japan, killed more than ten thousands of people and destroyed more than a hundred thousands of houses (Zare, M. and Afrouz, S.G. (2012)). The Christchurch Earthquake (2011), occurred in New Zealand, killed 185 people and destroyed many heritage buildings including famous Anglican Christchurch Cathedral (New Zealand History (2011)). And Hurricane Katrina (2005), occurred in USA, damaged considerably the Ninth Ward of New Orleans (Steiner, F. (2014)). These severe natural disasters are becoming a big issue in many places around the globe. Thus, we need to deal with natural disasters in terms of preventing people from suffering.

Many studies have shown frameworks for restoring post-disaster areas. Chang, E.S. (2010) proposed a framework to create empirical (1995 Kobe earthquake, Japan) pattern in urban disaster recovery of population, economy, and business. Uehara, M. and Inoue, T., et al. (2015) evaluated two different settlement relocation processes after the 2011 Earthquake and Tsunami Disaster in Japan, using a Semantic Differential Method and comparison of accessibility. However, few studies have reported on the landscape evaluation processes that lead to risk prediction before natural disasters (Uehara, M. (2012)).

At the same time in present, people often use uniformed provision to prevent disasters (ex. high seawalls and shore protection work) (Photo 1), but this easy provision might work or might not work in some places since every land has different environmental features.

Photo 1. Seawall reconstruction on the same site is easy way

In addition, Japan and some other countries have maps called hazard maps, which shows potential disaster areas for local residents, but these maps are made based on bias academic simulation. In addition, hazard maps are informed separately in each natural disaster (e.g. floods, earthquakes, and debris flows), and this makes more complicate for residents.

Thus, many previous studies on disaster simulations showed individual natural disaster results. Unfortunately, these simulations could not prevent thousands of kills by the Tohoku Earthquake and Tsunami (2011), and following accidents at the nuclear power plant. The reason of this is that simulations are not always succeeded and people thought these simulations done by experts are absolutely correct. This residents' blind faith of academic evaluation made a tragedy of Ohkawa elementary school during the Tohoku Earthquake and Tsunami (2011). On March 11th of 2011, 70% of students and 90% of teachers in Ohkawa elementary school were killed by the tsunami attack (Koketsu, K. (2014)). Teachers in the school could not instruct students to move to hill when the earthquake occurred because the hazard map shows that the school is safe (Figure 1). If the teachers understand natural environment of the area on their own, they could evacuate to the hill and many lives could be saved. In fact, students and teachers were killed by the tsunami after 40 minutes discussion on the playground (Yomiuri Newspaper (2011)).

Therefore, we need frameworks, which can capture local environmental features for natural disasters' risk prevention, and which also can understand easily for local residents. And suggesting these frameworks is the purpose of this study.

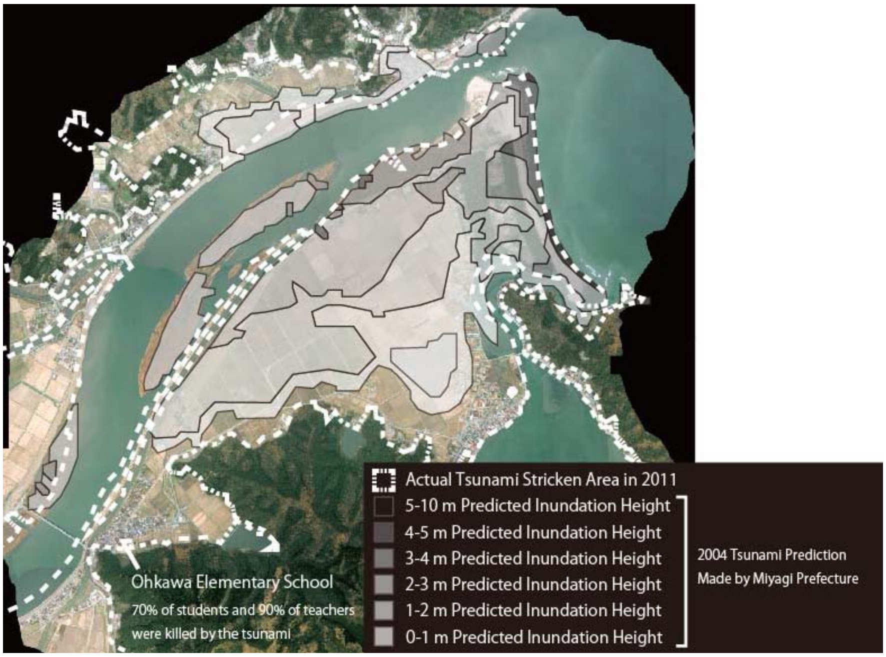

Figure 1. Ohkawa elementary school students and teachers (Miyagi prefecture) were killed by blind faith of academic evaluation

2. METHOD

2.1 Study Methods

In this study, we used two simple and holistic frameworks that can capture local environmental features: Historical Land Use Assessment (HLA) and Natural Condition Assessment (NCA). These two frameworks enable to categorize lands using only two environmental information.

HLA integrates land use patterns of two different periods (past and present) to assess the environmental features (Figure 2). Before the economic growth in Japan, land use was made to adapt local environmental features, such as geography and topography, thus simple environmental evaluation can be conducted when we see land use in the past. In addition, by overlaying the present land use and past land use, it can show unreasonable development (e.g. land reclamation). Arc GIS and topographic maps were used to make two different periods' land use maps (100 years ago and near before disaster happened).

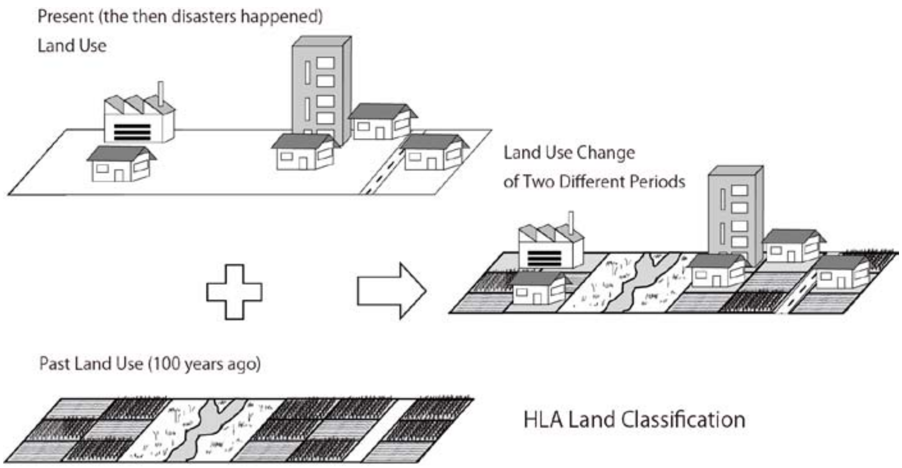

Figure 2. Land classification process of HLA (Historic Land use Assessment)

NCA integrates potential natural vegetation division and topography division, and it can assess the environmental features (Figure 3). The potential natural vegetation is a climax-vegetation, which shows holistic natural condition. It integrates many natural indexes, such as temperature, ground moisture condition, and precipitation. Also, the potential natural vegetation maps are used for phytosociology, forestry, agriculture, nature and landscape protection, range management, and land use planning across the world (Brzeziecki (1993)). The maps started to be equipped in Japan in 1970's, however, it is not maintained in nationwide but in limited regions.

Arc GIS, potential natural vegetation maps, and terrain classification maps are used to conduct this method.

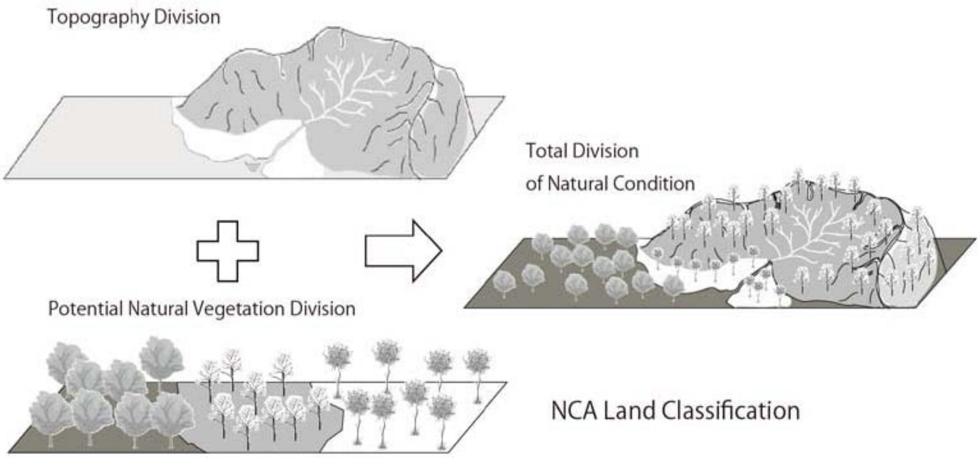

Figure 3. Land classification process of NCA (Natural Condition Assessment)

Afterwards, we captured relationship between each methods (HLA and NCA) and natural disasters, which actually happened. In this experiment, we compared area ratio of environmental features, which received damage. In other words, we tried to show disaster risk from historical continuity and natural environmental character. We assume that these frameworks have advantages on using only two layers, and also local residents can easily understand visually.

2.2 Study Fields

Two study fields were chosen for this study (Figure 4). First study field is a complex disaster (floods and debris flows) occurred in Matsukawa-Machi, Nagano Prefecture, Japan (Saburoku disaster, 1961), and the second study field is a debris flow disaster occurred in Nagiso-Machi, Nagano Prefecture, Japan (Nagiso debris flow, 2014).

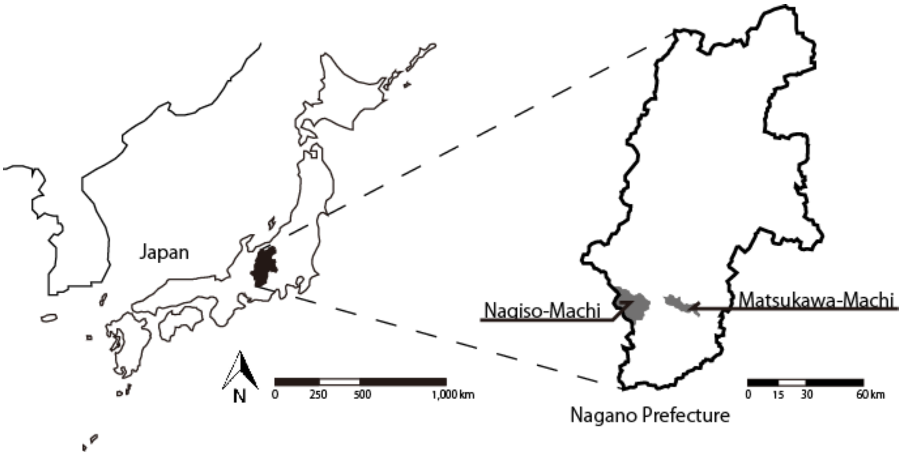

Figure 4. Location of Matsukawa-Machi and Nagiso-Machi as study

Matsukawa-Machi, located in Southern Nagano, has 72.9 square kilometer and has 13,530 in population (2012). Tenryu River flows in middle of the town, and it made broad flat area around it, and undulate areas are located at the edge of the town. Matsukawa-Machi experienced severe rain in 1961 June, and it caused floods and debris flow (Figure 5 top). The disaster destroyed 2.99 square kilometer by the flood and destroyed 0.04 square kilometer by the debris flow (3.03 square kilometer in total), and it killed 7 people and injured 41 people in this town. 82 houses were destroyed by the disasters, and flooded houses were 995 houses according to Matsukawa-Machi (Matsukawa-Machi (2008, 2010)).

Nagiso-Machi, located in Middle Nagano, has 215.96 square kilometer and has 4,810 in population (2012). Steep slopes and valleys are dominated most part of the town, and settlements are gathered in small flat areas around the Kiso River, which flows in the middle of the town (Nagiso-Machi (1982)). On July 9th, 2014, the town experienced severe rain caused by typhoon, and it caused debris flows (Figure 5 bottom). The debris flow disaster destroyed 0.34 square kilometer, and it killed one child. It also damaged local infrastructures, such as major roads and railroads. 13 houses were destroyed by the debris flow, and flooded houses were 9 houses (Hiramatsu, S., Fukuyama, T., et al. (2014)).

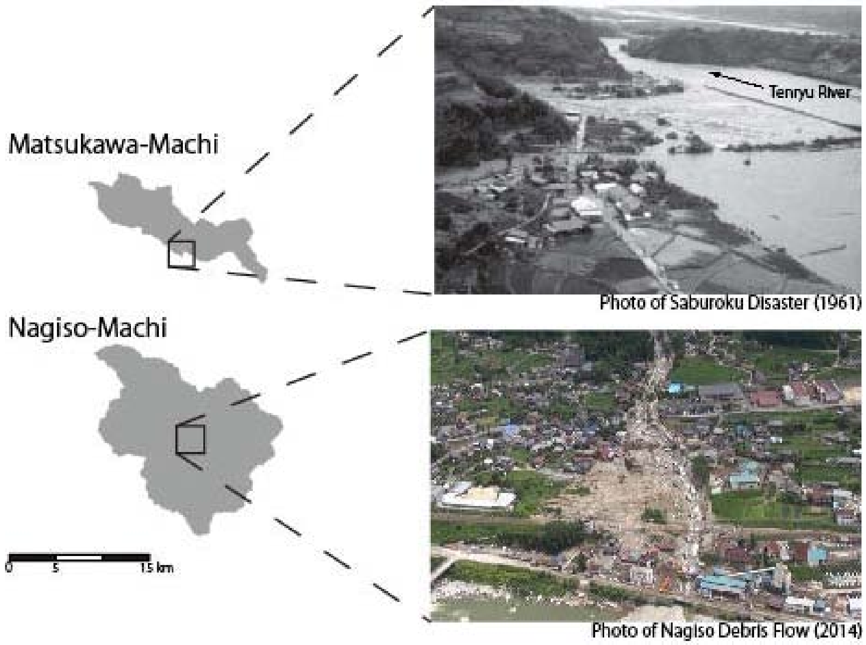

Figure 5. Photos of Saburoku disaster (top) and Nagiso debris flow (bottom)

Photos derived from

Compared to major disasters, such as the Tohoku Earthquake and Tsunami (2011), these disasters are relatively small, however, they occur frequently, and might occur in many places. Thus, these disasters can be applicable to disasters all over the world. And a reason to choose these two sites is because Japan, especially Nagano Prefecture, is abundant in vegetation and topology. Also, a reason to choose these two disasters is that they are different kinds (complex disaster and debris flow) of disasters and different period (1961 and 2014) of disasters.

3. RESULTS

3.1 Vulnerable Environmental Features

3.1.1 Result of HLA

HLA analysis in Matsukawa-Machi was conducted using 1911 and 1959 land use maps. And Nagiso-Machi was conducted using 1911 and 2008 land use maps. Table 1 shows HLA result of flood disaster in Matsukawa-Machi, and Table 2 shows analysis result of debris flows in Matsukawa-Machi (Table 2 top) and Nagiso-Machi (Table 2 bottom).

As the result, Table 1 shows water related land use: paddy field and river had high percentage in stricken area by the floods. Also the table shows that historical paddy field and historical river (paddy field and river in 100 years ago) corresponded to 46.4%, and 1959’s paddy field and river corresponded to 42.4%. This means flood disaster stricken areas are concentrated on water related land use, and also whatever changed from water related land use (paddy field and river), the disasters are concentrated to these areas. Also, we found that damage of forest in 1959, which changed from paddy field and mulberry field (in other words, abandoned cultivated areas) is large (10.7%). In addition, we found that damage of continuous housings and roads were relatively small. Moreover, continuous forest (23.7%) was large because land use maps did not show narrow rivers, and these rivers had serious damage.

However, this method could not explain the debris flows (Saburoku disaster and Nagiso debris flow) enough (Table 2 top and bottom). Damage of continuous forest was 83.7% and 82.7%, respectively. Reasons are most part of the debris flows occurred in forests, and most part of these two towns are dominated by forest (Approximately 80% in Matsukawa-Machi and 90% in Nagiso-Machi). And unshown rivers are also one plausible explanation for this, as well as flood disasters. Thus, we confirmed that HLA could explain flood disasters, but could not explain debris flow disasters enough.

3.1.2 Result of NCA

NCA was conducted by overlaying potential natural vegetation (PNV) maps and terrain classification maps. Table 3 shows NCA analysis result of flood disaster in Matsukawa-Machi, and Table 4 shows analysis result of debris flows in Matsukawa-Machi (Table 4 top) and Nagiso-Machi (Table 4 bottom).

As the result, Table 3 shows the environmental combinations, which has wetland PNV (e.g. Alnus japonica) and also river topography (alluvial fan and gravel plateau) and low relief mountains, which locates in low elevation, marked high percentage in stricken area by the floods (Saburoku disaster). These categories damaged 45.1% by the flood. And remained 54.9% scattered different potential natural vegetation and topology, as Table 3 shows.

Regarding to the debris flows (Saburoku disaster and Nagiso debris flow), the environmental combination, which has foothills/montane vegetation (e.g. Quercus glauca) and also middle/high relief mountain, which locates in high elevation, marked high percentage in striking area. 40.7% of Saburoku disaster (debris flow) had an inclination as mentioned above, and 79.9% of Nagiso debris flow had this inclination as well (Table 4 top and bottom). Nagiso-Machi was not damaged foothill PNV/ high relief mountain areas by the debris flow, but this is because Nagiso-Machi has small areas of foothill vegetation, originally. Two remained percentages (59.3% and 20.1%, respectively) scattered different potential natural vegetation and topology, as Table 4 top and bottom shows. Thus, we confirmed that NCA could explain both flood disasters and debris flow disasters, but in low accuracy.

Table 1. HLA Results of Flood Disasters in Matsukawa-Machi

Flood Disasters (Matsukawa-Machi)			Land Use of Before the Saburoku Disaster (1959)								Total of 100 Years Ago Land Use (%)
			Paddy Field	River	Forest	Bamboo Forest	Bushland	Mulberry Field	Resident	Road	
Land Use of 100 Years Ago (1911)	Water Related	Paddy Field	19.3	0.7	7.3	0.3	0.1	0.1	0.1	1.1	46.4
		River	0.9	10.6	5.0		0.2	0.6		0.0	
	Open Land	Forest	4.5	1.8	23.7	0.2	0.0	0.7		0.3	31.3
		Bushland	0.6	2.8	5.1		4.0	0.2		0.1	12.7
	Dry Field	Mulberry Field	0.3	0.2	3.3		0.3	2.9	0.0	0.0	7.1
	Artificial	Resident							0.2	0.1	0.3
		Road	0.2	0.1	0.5			0.0		1.3	2.1
Total of Before the Saburoku Disaster Land Use (%)			42.4		44.9	0.5	4.6	4.6	0.3	2.9	100

Table 2. HLA Results of Debris Flows in Matsukawa-Machi (top) and Nagiso-Machi (bottom)

Debris Flow (Matsukawa-Machi)			Land Use of Before the Saburoku Disaster (1959)								Total of 100 Years Ago Land Use (%)
			Paddy Field	River	Forest	Bamboo Forest	Bushland	Mulberry Field	Resident	Road	
Land Use of 100 Years Ago (1911)	Water Related	Paddy Field									12.9
		River		9.3	3.6						
	Open Land	Forest		4.4	82.7						87.1
		Bushland									0
	Dry Field	Mulberry Field									0
	Artificial	Resident									0
		Road									0
Total of Before the Saburoku Disaster Land Use (%)			13.7		86.3	0	0	0	0	0	100

Debris Flows (Nagiso-Machi)			Land Use of Before the Nagiso Debris Flow (2008)								Total of 100 Years Ago Land Use (%)
			Paddy Field	River	Forest	Bushland	Mulberry Field	Resident	Road	Railway	
Land Use of 100 Years Ago (1911)	Water Related	Paddy Field	0.5	0.3	0.1	0.2		1.0	1.2		3.2
		River						0.1			0.1
	Open Land	Forest	0.8		83.7			0.2			84.7
		Bushland				0.0		0.9	0.6		1.5
	Dry Field	Mulberry Field	1.3					0.5		0.3	2.0
	Artificial	Resident	1.0	1.0	1.7			1.4	0.0	0.7	5.9
		Road	0.1		0.5			0.5	0.2		1.2
		Railway						1.2		0.1	1.3
Total of Before the Nagiso Debris Flow Land Use (%)			3.6		86.0	0.2	0	5.8	2.0	1.0	100

Table 3. NCA Results of Flood Disasters in Matsukawa-Machi

Flood Disaster (Matsukawa-Machi)		Alluvial Fan	Gravel Plateau	Low Relief Mountains	Middle Relief Mountains	High Relief Mountains	High Relief Hills	Foothills	Total	Vegetation Type Total (%)
Wetland PNV	I	9.0	0.0	4.9	0.3	3.3			17.5	51.8
	II								0	
	III	7.4	1.4	8.0	0.7		0.6	0.0	18.2	
	IV	7.1	0.2	7.1			1.5		15.8	
	V				0.3				0.3	
Foothills PNV	VI	2.9	9.0		7.2		0.4		19.6	35.4
	VII					0.3			0.3	
	VIII		4.3	7.0		1.3	0.0	2.9	15.5	
Montane PNV	IX					0.1			0.1	12.8
	X			4.9	2.8	0.9			8.6	
	XI			1.8	0.8	1.6			4.1	
Bare Land PNV	XII					0.0			0.0	0.0
Topology Type Total (%)		26.4	14.9	33.6	12.0	7.5	2.6	3.0	100	

Table 4. NCA Results of Debris Flows in Matsukawa-Machi (top) and Nagiso-Machi (bottom)

Debris Flow (Matsukawa-Machi)		Alluvial Fan	Gravel Plateau	Low Relief Mountains	Middle Relief Mountains	High Relief Mountains	High Relief Hills	Foothills	Total	Vegetation Type Total (%)
Wetland PNV	I					0.3			0.3	4.1
	II								0	
	III								0	
	IV	3.8							3.8	
	V								0	
Foothills PNV	VI	21.0	6.1	2.5					29.5	43.7
	VII					2.4			2.4	
	VIII		1.4	10.4					11.8	
Montane PNV	IX					20.7			20.7	41.2
	X			2.9	12.2	2.6			17.6	
	XI					3.0			3.0	
Bare Land PNV	XII					10.9			10.9	10.9
Topology Type Total (%)		24.8	7.4	15.8	12.2	39.8	0	0	100	

Debris Flow (Nagiso-Machi)		Alluvial Fan	Gravel Plateau	Low Relief Mountains	Middle Relief Mountains	High Relief Mountains	High Relief Hills	Foothills	Total	Vegetation Type Total (%)
Wetland PNV	I								0	8.6
	II					5.4			5.4	
	III		2.7		0.5				3.2	
	IV								0	
	V								0	
Foothills PNV	VI		6.4						6.4	14.5
	VII								0	
	VIII		0.1		8.1				8.2	
Montane PNV	IX				2.1	64.3			66.3	72.0
	X		0.2		2.3	3.1			5.7	
	XI								0	
Bare Land PNV	XII				0.0	4.9			4.9	4.9
Topology Type Total (%)		0	9.4	0	13.0	77.6	0	0	100	

PNV: Potential Natural Vegetation

I: Lindera praecox-Zelkova serrata Community

II: Larix kaempferi Pioneer Community

III: Carex biwensis-Alnus japonica Community

IV: Riverside Herbaceous Community

V: Dryopteris polylepis-Fraxinus platypoda Community, Hydrangea involucrata-Euptelea polyandra Community

VI: Quercus glauca Community

VII: Castanea crenata-Quercus serrata Community

VIII: Illicium anisatum-Abies firma Community

IX: Carex reinii-Tsuga sieboldii Community, Rhododendron nudipes-Tsuga sieboldii Community

X: Sasa borealis-Fagus crenata Community

XI: Sasa borealis-Quercus crispula Community

XII: Natural Bare Land

3.2 Comparison of HLA and NCA

In this research, we found that different local environmental features caused different vulnerability to different kinds of disasters (floods and debris flows). Also, we found that two simple and holistic frameworks, HLA and NCA, have different accuracy of predicting local environmental features which vulnerable to different kinds of natural disasters. HLA could explain more in flat disasters, such as flood disasters, than NCA, but NCA could explain in steric disasters, such as debris flows, while HLA could not. It is confirmed that these two frameworks could simply explain potential disaster areas while hazard maps are difficult to explain because they use disaster simulations in limited supposition (e.g. 5m inundation height in X mm/h precipitation).

Most of the base maps used in HLA and NCA was drown to a scale of 1/50,000. Maps in HLA are easy to buy, but maps in NCA are difficult to obtain. Thus, we will need to examine the replacement from potential natural vegetation maps and terrain classification maps to other indexes, such as soil maps.

3.3 Possibilities for Regional Planning and Residents' Education

In this research, we focused on c omprehensibility of environmental information. We continue to focus on this, and we piled layers of actual aerial maps and environmental classification. We overlaid the results of environmental classification that we obtained in this study and present aerial photos of Matsukawa-Machi and Nagiso-Machi. After overlaying the aerial photos, we compared the photos and hazard maps in the same area. The Aerial photos are made using Agisoft and free download aerial photo.

As the result, the photo turned out to be able to understand instinctively why the areas are vulnerable to natural disasters (Figure 6). Especially from the classification result of HLA (Figure 6 top-left), you will see that much new housing are built on the historical paddy field areas, which are vulnerable to floods. Also the results of NCA (Figure 6 top-right), you can also see new housing on the vulnerable area to floods, and it allows people to instinctively understand what vegetation will be in potential disaster areas, compared to geological maps. Thus, these photos will be easy for local residents to understand and useful in case of natural disasters.

If you look at the hazard map in Figure 6 bottom-right, it only shows potential disaster areas in limited suppositions made by experts. Some natural disasters might more extreme than the supposition, and the hazard map will not work in this occasion. Also, local residents who live in non-classified areas (white areas) of the hazard map might think the areas are safe, and some might die in case of the disasters exceed the supposition, same as the Ohkawa elementary school, Miyagi prefecture. Indeed, Matsukawa-Machi's hazard map indicated only 9% of the Saburoku disaster stricken area as potential disaster area: recall our HLA and NCA analysis results indicated 46.4% and 45.1%, respectively as potential disaster areas.

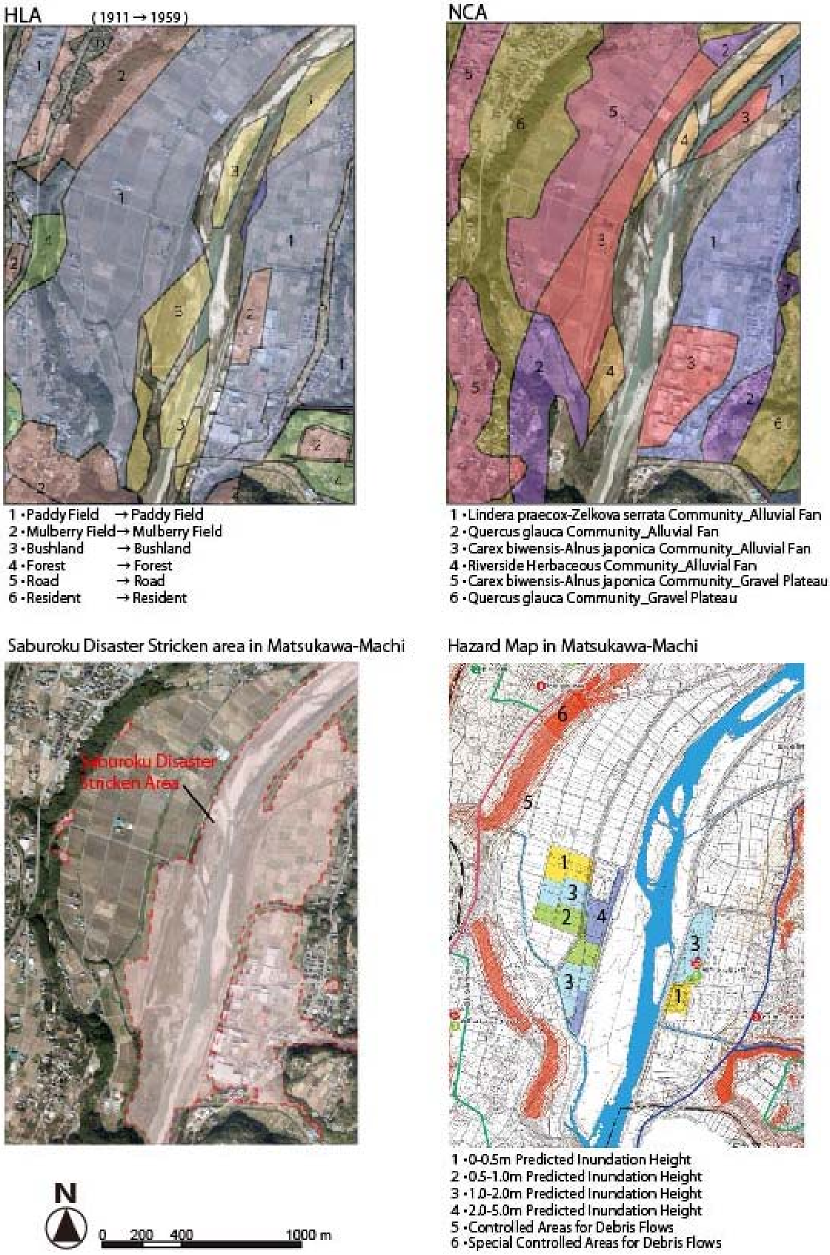

Figure 6. Comparison of two frameworks (HLA and NCA) and existing hazard map in Matsukawa-Machi

Hazard map derived from http://www.matsukawa-town.jp/cms-

4. DISCUSSION

In this study, we suggested two frameworks that can see where are the danger areas for natural disasters visually. The results obtained in this paper support creating safer regional planning and also sustainable city planning for people living in this area. In addition, these simple and holistic frameworks will be useful for local residents to evacuate in case of emergency. Some countries, which experienced many natural disasters have their city-level hazard maps, however, these two frameworks in this study can be one of the supporting documents for hazard maps. And also, using frameworks, such as HLA and NCA, countries where do not possess their city-level hazard maps will be able to create sustainable regional plan by capturing local environmental features.

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The Application of Remote Sensing and Logistic Regression Model to the Analysis of the Growth of Suleja and its Environs, Nigeria

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1
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Key words:

Abstract: Understanding the growth of settlements and factors responsible for the growth is very essential in urban planning and management. The long held belief that growth of Suleja is as a results of its proximity to Abuja was without any empirical evidence to ascertain the major determinants of this growth and their level of influence. This study was aimed at determining the factors responsible for the growth of Suleja by using Landsat TM and Landsat ETM of 1987 and 2001 to analyse the spatio temporal changes in the built up area of Suleja and environs. Logistic Regression model was used to establish the level of impact of the five independent variables of distance to Abuja, distance to road, topography, population and locality influence on the dependent variable, change, between 1987 to 2001. The classified images from the two dates were used to obtain the change in the built up area by subtracting the 1987 image from 2001 image. The resultant image ‘change’ was the dependent variable. Population data, topographic data, time to Abuja and locality were used in modelling the growth of Suleja and environs. The result of the regression showed that the five variables had strong influence on the growth of Suleja and environs with a Relative Operating Characteristic (ROC) of 0.9452. The study also showed that the independent variables had varying influences on the dependent variable, change, ranging from 0.8809 for ROC of distance to road variable which is the highest for the regression of the individual independent variables to 0.5799 the lowest for the independent variable, topography. Using conditional probability equation, the study established that the closer a place is to Abuja the higher the probability of getting developed. The probability of change ranges from 0.057 for areas around Madalla to 0.002 for areas further away towards Minna. The study demonstrated the limitation of using remote sensing in estimating population of a highly developed area. Between 1987 to 2001, all the localities, except Suleja old city, showed a growth in population through remote sensing estimation. Madalla grew from 5,065 in 1987 to 48,669 in 2001 and Rafinsanyi grew from 589 in 1987 to 6,974 in 2001, while Suleja old town grew from 48,522 in 1987 to 110,001 in 2001. Comparing the

population estimate obtained through remote sensing with the census based estimate using the annual growth rate of 2.8 showed that Suleja old town grew from 84,169 in 1987 to 147,481 in 2001. On the other hand, Madalla grew from 6,698 in 1987 to 11,734 in 2001 and Rafinsanyi grew from 1,655 in 1987 to 2,900 in 2001.There is a clear similarity between the rate of growth in built up area and population over the same period using remote sensing estimation. Despite the rate of growth of localities outside the Suleja main town, the policy and impact of Niger State Government is minimal and concentrated in the city centre. The fringes that experienced the highest growth were left without control and planning. Without a proactive policy and involvement of the people in planning and development control, Suleja and environs would continue to grow without plan thereby making sustainable growth and development of this area unrealisable.

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The research and practice on the construction of Smart Community service system

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Key words: Smart Community, Informatization, service system, Yishanwan community

Abstract: As the basic composition unit of smart city, the construction of smart community plays an important role in the developing process of smart city. This research has expounded the concept of Smart Community, and demonstrated its development tendency.With the guidance of the framework of smart community planning, we carried out the practice on the construction of service system of smart community, taking the case of Yishanwan community planning as an example. And we finally equip the system with five main functions including community management, smart medical treatment, smart environmental protection, cultural education, smart security. The Smart Community service system has the characteristics of diversity, convenience, and universality. With the achievement and collaboration of those functions, the service system can provide lots of service, such as convenient information inquiry, social insurance, on-line education, tele medicine, smart culture, and so on. And it is expected to improve the informatization level of community life, as well as change the life style, learning style and working mode gradually establishing a high quality, convenient and comfortable life environment.

1. INTRODUCTION OF SMART COMMUNITY

1.1 Introduction of informatization society

In recent years, China's informatization level is increasing at an incredible speed based on the enormous population. According to the latest "statistical report of status of China Internet network development" published by China Internet Network Information Center (CNNIC), as of December 2014, the amount of Chinese net citizens is 649 million, among them, there are 557 million mobile phone net citizens, and Chinese Internet penetration is 47.9%4. It is quite encouraging that the perspective of China's informatization development is very promising in view of the nearly 10 years of statistical data (*Figure 1*). And it's not a great change that only happened in China. In the whole wide world, the information revolution is becoming more and more intense. Compared to other countries, there is still much room for China to work on.

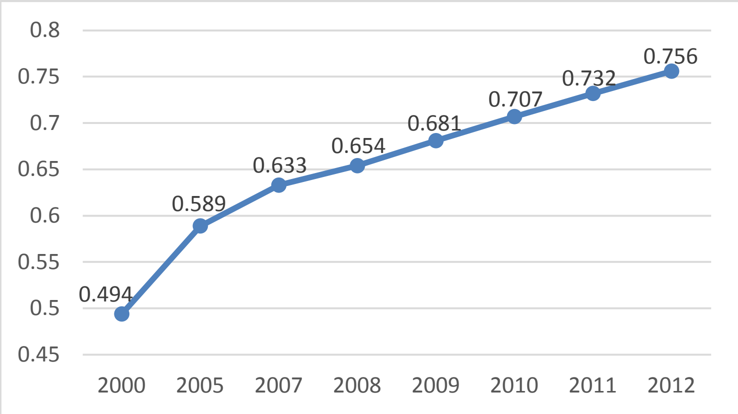

Figure 1. Change of Informatization Development Index of China (IDICN)

Data source: National Bureau of Statistics of the People's Republic of China,

http://www.stats.gov.cn/tjzs/tjsj/tjcb/dysj/201405/t20140506_549559.html

To follow the hot trend of information revolution, China especially pay attention to the development of informatization, meanwhile aim to combine it with China's own characteristic collaboratively. Among the reports of the 18th national congress of the communist party of China, the authorities have made an important policy of promoting the synchronous development of informatization, new industrialization, agricultural modernization, and new urbanization, which makes the construction of informatization a national strategy. China has stepped into the middle-later period of industrialization, only the profound fusion of industrialization and urbanization can constantly promote the process of socialist modernization. In the meantime, new urbanization and agricultural modernization should coordinate with each other, since both of them are the path of development for rural area and agriculture, and they have to rely on each other and promote each other. If we only rely on u rbanization, and neglect the importance of agriculture modernization, it will be difficult to change the condition of rural area fundamentally. Above all, in the process of the development of new

4 "The 35th statistical report of status of China Internet network development" published on February 3, 2015. http://www.cnnic.net.cn/hlwfzyj/hlwxzbg/hlwtjbg/201502/t20150203_51634.htm

industrialization, new urbanization and agriculture modernization, it is informatization that can facilitate and lead them (Figure 2). Only if we follow the general trend of the development of information society, think on the basis of the thought pattern of informatization, and move along the development path of informatization, we can advance and guarantee the development of new industrialization, new urbanization, and agricultural modernization. And with all those efforts, we can realize the leap-forward development of social productivity, achieve the goal of building a well-off society comprehensively, and realize the construction of beautiful China, at last make Chinese dream come true.

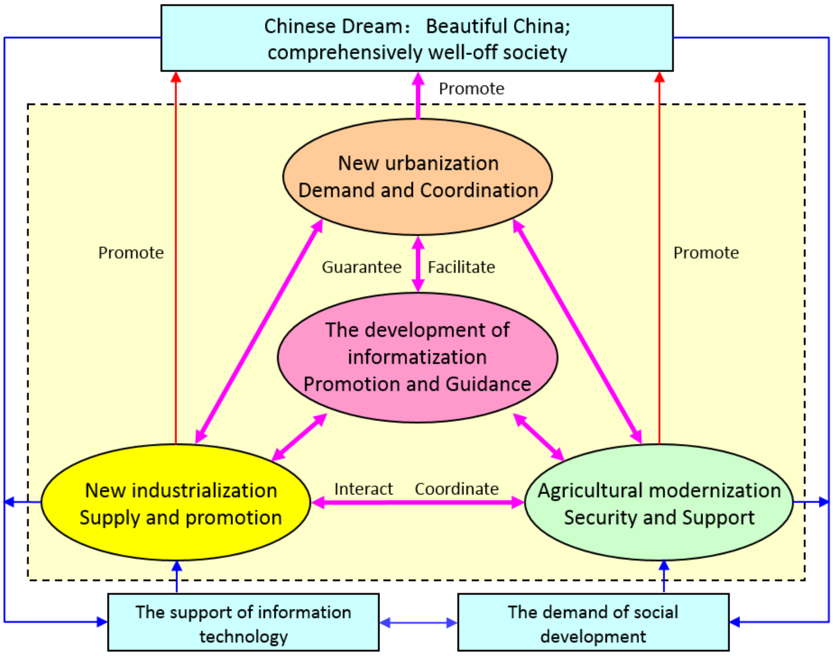

Figure 2. The synchronous development of informatization, new industrialization, agricultural modernization, and new urbanization

1.2 Introduction of Smart City

When the worldwide trend of information revolution interacts intensely with the increasingly growing process of urbanization; when the internet of things goes ahead of human network; when information technology permeates into every aspects of everyday life, our cities are growing more and more intelligent before we notice it. And smart city is the very exciting outcome of the information revolution, which aims at taking control of the intellectually revolution process of city and considering how to get more human oriented achievement. Additionally, in the context of China, the inevitable consequence of the profound fusion of informatization, new industrialization and new urbanization is also the formation of smart city (Mao, Z. Y., Li Z. M., et al. (2013); Li, D. R. (2014)).

Undoubtedly, the planning and construction of smart city has become one of the key directions of Chinese urbanization development. From January 2013, Ministry of Housing and Urban-Rural Development of the People's Republic of China (MOHURD) has selected two groups of 193 c ities (districts, counties, towns) to carry out the national pilot demonstration program of smart city, and the selection work of the third group of the national pilot demonstration cities is undertaking. At the same time, the construction of smart city has escalated into a national strategy, and became a significant method of promoting new urbanization and achieving the sustainable development (Xi, G. L. and Zhen, F. (2014)). In the "China National Planning of New Urbanization (2014-2020)" which was published in March 2014, it has claimed to promote the development of green city, smart city, humanistic city and to improve the inner equality of the city comprehensively. In the chapter of "promoting the construction of smart city", it claims to coordinate physical resources, informational resources and intellectual resources of urban development, and to facilitate the innovative applications of the new generation information technology, like internet of things, big data, cloud computing, so that they can be integrated with the economic and social development effectively. Meantime it also proposes to promote the trans-departmental, trans-sectoral and trans-regional government affairs information sharing and business collaboration, and to enhance the exploitation and application of the socialization of informational resources, and generalize the intelligent information application and the new information service. With all those works mentioned above, it is expected to achieve the informatization of management of urban planning, the intellectualization of infrastructure, the facilitation of public service, the modernization of industrial development, and the refinement of social governance. At last, it emphasizes the importance of strengthening the security ability of city's vital information system and pivotal information resources. In the chapter of "carrying out pilot demonstration program", it claims to go on with the pilot program of promoting creative city, smart city and low carbon city.

2. ANALYSIS OF SMART COMMUNITY DEVELOPMENT

Smart city is based on the Internet of things and cloud computing, and its core idea is to form the Internet of things through equipping every object of urban life with sensor. The Internet of things is integrated by super computers and cloud computing, thereby implementing the integration of digital city and city system (Li, D. R., Shao, Z. F., et al. (2011)). The construction of smart city can not only provide more efficient service for residents by improving the infrastructure, but also will motivate the advance of the innovation ability of society and economy, integrating the concept of sustainable development into the development of city (Chourabi and Nam, (2012)). And smart community is further the concrete embodiment on the basis of the structure of smart city, and turns into the basic composition unit of smart city (Jiao, J. Y., (2013)).

2.1 Analysis of the concept of Smart Community

There is no un ified definition about Smart Community, so far. Researchers from different subject areas understand it in light of different discipline. And in general, these ideas can be divided into two categories; one is based on the technology it relies on, and the other one is based on the application it provides. In terms of technology, Smart Community means a new kind of modernized management and service oriented community based on the intellectual processing of mass information, in which sorts of network communication technology such as network of things, network of sensors etc., are taken full advantage of, and sorts of subsystems such as real estate management, security, communication etc., are combined collaboratively, providing a relatively safe, comfortable and convenient living environment for community residents (Li, D. X., (2013)). It is actually the specific embodiment of a whole new concept of technology serving human beings. At a word, Smart Community is derived from community informatization, vigorously manipulating up to date information technology, realizing the intelligence of community management and service, and offering better social service for residents (Liu, J., (2012)). When it comes to the application side, the essential goal of constructing Smart Community is to improve service level and reinforce management capacity, establishing modernized community service and refined community management system, and forming a n ew community status which is resources integrated, benefit evident, and environment friendly. Towards that goal, the way we use information technology to realize the intelligence of information acquiring, transmitting, processing and applying, is basically guided by the actual demand and developing trend of residents and the content and developing trend of community management (Wang, J. C. and Gao, B, (2012)). A researcher has summarized the core concept of application oriented Smart Community into two key words, that is “integration” and “service” (Che, X. (2013)). To achieve “integration” is to integrate all functions like community security, house management, building talk-back etc., and to achieve “service” is to serve the local residents with some necessary service like community medical treatment, community education etc..

In view of comprehensive prospective, both the technology and the application are pivotal for the development of Smart Community. It won't be able to operate the Smart Community effectively without the support of technology; meanwhile, to investigate the application conformed to the actual demand is an essential link which will guarantee the human oriented Smart Community. In effect, Smart Community is a brand new community form which perfect the community service by means of advance information technology, combining above two ways of understanding. It will inherit the construction experience of smart city, which will apply many kinds of up-to-date information technology comprehensively on the community scale, exploit many kinds of information resources, and establish a community public data resource center, so as t o achieve intelligence of community management, community governance, and community social service.

2.2 Research progress of Smart Community

Based on different point of views currently, academic research on Smart Community of different fields of researchers have different preference. And they can be divided into two categories as before as the concept of Smart Community.

One type of these researches focus on t he supporting technology and system designing of Smart Community. For instant, in view of the rapid progress of Android system technology, Feng Yanhong and He Jiaming have designed a set of community service system based on it, integrating the advantage of Android system and wireless communication and promoting the development of Smart Community (Feng, Y. H., He, J. M., et al. (2014)). And Gong Yanxue and Wu Zhixia have put forward an architecture of network of things towards Smart Community in consideration of the actual demand of community and the capacity of the technology of network of things; they can provide guidance for the deployment of intellectual facilities of certain community with the analysis of sensing equipment, network infrastructure, middleware and the fundamental demands of system (Gong, Y. X., Wu, Z. X., et al. (2014)). In addition to above researches, there are some other researchers on the technology applied in Smart Community, like cloud computer technology in management system of Smart Community (Deng, Y. S. and Xiang, T., (2013)), health management system designing based on B/S, and so on.

The other type of researchers focus on sorts of application systems within Smart Community, which are mainly to fulfill various demands of local residents and provide different service, therefore these researches contain diverse contents. For example, for the demand of residents' health care, Yuan Xi and Li Qiang have developed an intelligent health system based on mobile Internet (Yuan, X. and Li, Q., (2015)); Liu Yi has designed a personal health portal system based on the smart medical system (Liu, Y., (2012)). For the demand of community business, Che Xin has designed an electronic commerce system for Smart Community (Che, X., (2013)). For the demand of elder people, Wang Xingang has designed an elder oriented information platform based on the informatization technology (Wang, X. G., (2012)). For the community culture, Lan Fan has explained the impact of new media on traditional community culture, and regards the impact as a transformation from traditional community culture to new-media community culture which should be integrated into Smart Community (Lan, F., (2013)).

All in all, the construction of Smart Community is a complicated system engineering; implementation technology, architecture system and kinds of application system are all key links to achieve Smart Community. Then among all hot issues, we focus on the application system development in this research.

2.3 Application system of Smart Community

Along with the rapid progress and generalization of information technology such as network of things and cloud computing, the supporting role of advanced technology on urban development is getting more and more important. Even though domestic research on Smart Community started late, the practice on it have been carried out vigorously all over the country. Xicheng district of Beijing has established a series of application projects, including One-stop service system, digital home, digital Kongzhu museum and smart parking and so on. Zhabei district Shanghai has designed six main application of Smart Community consist of medical care, culture and education, effective governance, community life, safe community and electronic business. Tianhe district of Guangzhou constructs the Smart Community with representative application of smart house management and smart medical care. Chengdu is building a so called “cloud community network” aiming to cover more than 500 communities and administrative villages and provide information service including current affairs, community activities, and medical care etc. and commodity service including location of shops and price etc.

In view of above practice, a common characteristic is that all the application are human oriented. The demand of community residents or some specific group is the priority of their design principles which has demonstrated the huge trend about how Smart Community improve traditional community – providing convenient service for residents by taking advantage of up-to-date technology, transforming conventional life style, improving life quality, and realizing the fusion of science and normal life. Under the hot tendency, we mainly discuss the construction of service system under the general framework of Smart Community in this research.

3. THE CONSTRUCTION OF YISHANWAN SMART COMMUNITY SERVICE SYSTEM

3.1 The general framework of Yishanwan Smart Community

We take the Yishanwan Smart Community Jiangxia district, Wuhan, Hubei province as example to carry out the research on service system of Smart Community (Figure 3). Yishanwan community consists of 4 administrative villages and 52 natural countries which have 2002 households – a population of 6300. However public welfare establishments of Yishanwan community have fallen behind, and been relatively poorer in consideration of community cultural life and medical care etc. Therefore as it plans the community space layout and industrial layout in the new comprehensive planning, it also calls for the development of community informatization urgently. And it believes that only deepening the application of information technology in all fields of new community, fully excavating, real-time integrating, and effectively allocating the community resources can realize the integration of urban and rural overall development and facilitate social undertaking. Under the background of the synchronous development of informatization, new industrialization, agricultural modernization, new urbanization, the construction of Yishanwan smart community towards new urbanization is to follow both the trend of the era and the approach which conforms to the local developing vision most. According to the experience of the construction of smart city and research achievement of Smart Community, the demand of building Yishanwan smart community is embodied in four aspects: the construction of informatization infrastructure, informatization management, informatization service and the construction of informatization mechanism.

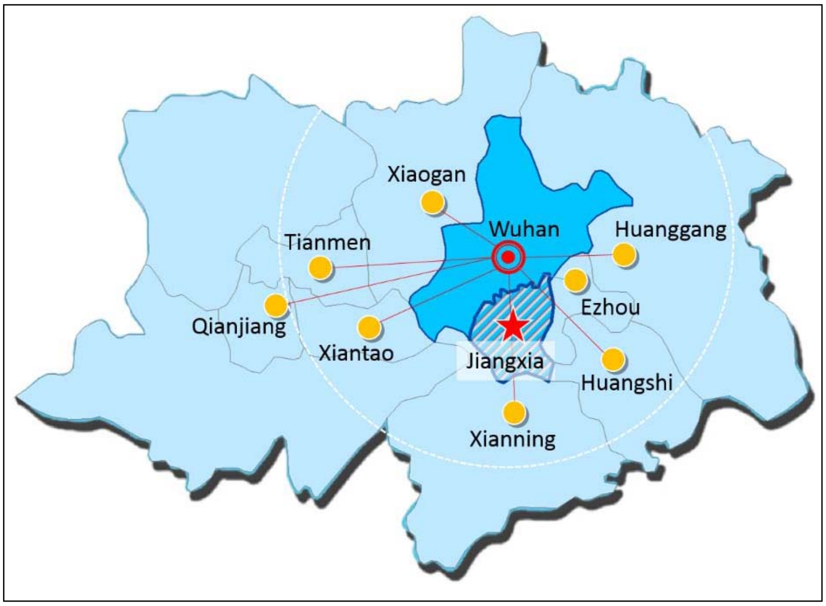

Figure 3. The location and relationship among Jiangxia district and surrounding cities

According to the demand of informatization development of smart community, the general framework (*Figure 4*) of Smart Yishanwan consists of five-layer components, such as base layer, sharing layer, application layer, service layer, and portal layer. And an information center and a security system is working on the integration of the five layers. The framework can be summarized as a project of “Six Ones”，that is organizing one information center, building one base layer (a set of infrastructure), one sharing platform, one application and service system, one information portal, and one security system.

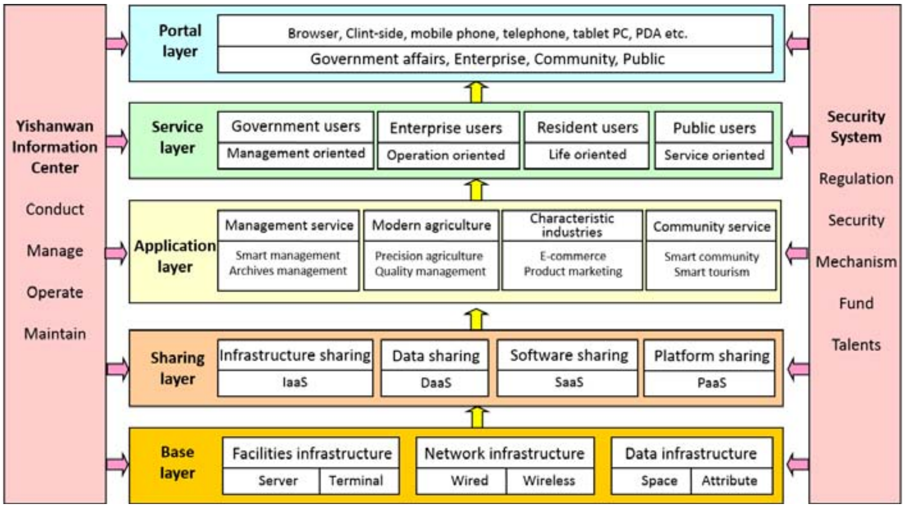

Figure 4. The general framework of Smart Yishanwan community

Under the general framework of Smart Yishanwan, we design four application system on application layer on basis of local demand-management service, modern agriculture, characteristic industries and community service. The management service system is tailored to improve the management and working pattern of government departments and make their working flow more efficient; and it contains a series of subsystems towards community management and service like government portal, gridding community service and paralleled administrative examination and approval system etc. Modern agriculture system will mainly contribute to the profound fusion of informatization and agricultural modernization, aiming to develop the agriculture which is land-intensive, technology-intensive, and ecology-circular. Characteristic industries system is designed to facilitate the fusion of industrialization and informatization, and provide efficient guidance and support for traditional industries and strategic emerging industries; in this system, leisure tourism is taken as a major industry, and will play an important role in improving the comprehensive competitiveness of Yishanwan's characteristic industries. Community service system is designed for the demand of everyday life to optimize traditional life style, learning style and work mode, and improve the quality of residents and life standard, gradually establishing a high quality, convenient and comfortable life environment. Hereinafter it will demonstrate the detailed description about the community service system

3.2 Goals of Yishanwan Smart Community service system

To construct community service system is one of the major applications of Smart Community, and it is a resident oriented project aiming to guarantee residents' livelihood and improve residents' life standard and life quality; at the same time, it is also a fundamental project to strength and innovate social management, and maintain the social stability (Zheng, C. Z., Gu, D. D., et al, (2013)). As the fundamental project of Yishanwan Smart Community, community service system integrates, manages and optimizes sorts of community resources based on the actual condition of Yishanwan, and takes full advantage of all real resources and allocates them effectively, realizing the intelligentization of community management, service, work and life.

As the informatization is permeating every aspect of urban life, there are emerging demands for the community service and management. On the one hand, it should satisfy personalized and diversified service needs of community residents, and accelerate the construction of community service system. On the other hand, it needs to acclimatize itself to the ongoing transformation of society and governmental functions, and be in charge of much social management and public service, giving valid feedback to residents' interest requirement (Jiang, L. Q. and Yao, L. P., (2012)). In a word, "management" and "service" are priority of all consideration. For instance, throughout the establishment of Huaxin smart community, Tianhe district, Guangzhou, community affairs involving general management and public service are organized and sort into two subsystems-the management system and service system, just following above principle (Zhou, J., Liang, X. M., et al, (2013)). And a similar case is the construction of Tsinghua Smart Community, and among its accomplishments, the most outstanding achievements reflect in two aspects. One is the establishment of the one-stop information service platform, realizing the informatization of everyday life of local residents. The other is the implementation of intelligent one-card system, realizing the scientization of management and service (Yu, X. X., (2014)).

Taking the integration of all kinds of service resources as starting point and the realization of all kinds of demands of community residents, enterprises and social institutes as ending point, a comprehensive intelligent community service platform should be constructed involving community management, medical care, environment protecting, culture and education,and security. In this process, to make the best of full-developed and advanced network technology is prerequisite, and it is future obligatory to take consideration of the developing requirements and tendency of community informatization. Therefore the specific goals of community service system are embodied in two directions; one is to innovate management method, realizing the refinement and scientization of community management and creating a new mode for it; the other is to innovate service mode, providing human oriented, diversified and socialized public service for all the residents, departments and social institutes and serving new experience of the intelligent life.

3.3 Functions of Yishanwan Smart Community Service system

Based on the two core targets of Yishanwan community service system and the real demands of Yishanwan at present, the service system is equipped with five main functions including community management, smart medical treatment, smart environmental protection, cultural education, smart security (Figure 5). The service system is built upon a series of essential data involving community gridding information, infrastructure information, staff information, medical information and geospatial information and so on. And administrators and community residents are main target users of it. To meet their needs, the system is designed to serve intelligent management means for administrators and serve intelligent service mode for residents, finally realizing the refinement of management and the intelligentization of community service and setting a new life model for Smart Community.

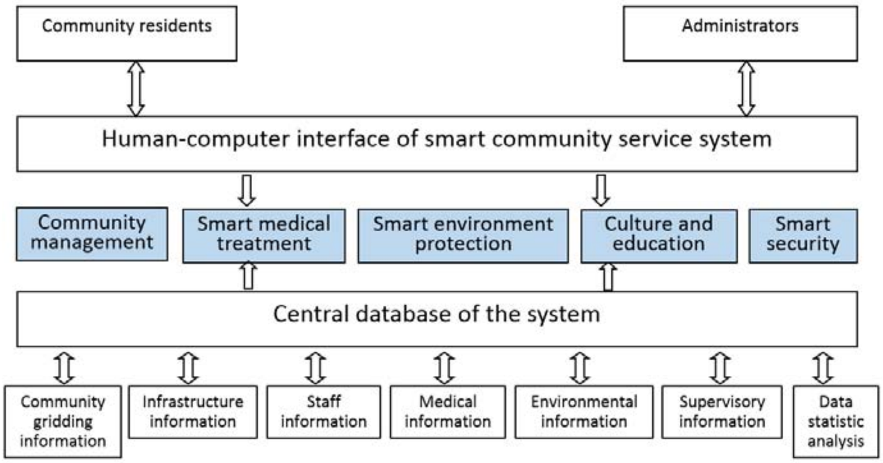

Figure 5. The architecture of Smart Yishanwan community service system

(1) Community management. It is expected to provide real-time management and service for community roads, public facilities, vehicles and persons, reinforcing the scientificity and intelligence of community management and improve the security and comfort level of community life.

(2) Smart medical treatment. To realize inquiry, management of self-health information and self-health care, an electronic health record information system should be constructed. At the same time, it is necessary to maintain close relationship with Wuhan and Jiangxia district's medical system, so that residents are able to make an appointment with certain doctor online, and carry out some other process through Internet, making the medical service more efficient.

(3) Smart environment protection. It is intended to realize various functions such as automatic monitoring, rapid positioning, command and dispatch, development tendency simulation and prediction and so on. The smart environmental protection system will benefit from resources sharing with Wuhan and Jiangxia district, and the sharing process will also enhance its capacity of pollution sources supervising, emergency supervising, solid wastes supervising etc. achieving the scientization, the intelligence and the ecologicalization of environmental protection and supporting the construction of low carbon and green Yishanwan community.

(4) Culture and education. To establish a comprehensive cultural education system by bringing in advanced and full-developed online training courses enable any resident to study initiatively, efficiently and individually at any time anywhere. And these online courses should have a large range of knowledge involving agricultural technology, planting and breeding skill, laws and regulations, health care methods, leisure tourism, traditional culture, public sports and so on. E merging portable terminal equipment such as laptop, smartphone make it easy to access the culture and education system, creating a harmonious neighborhood for Yishanwna local culture and offering a convenient chance to the reeducation of new peasants.

（5）Smart security. The security system will comprehensively manage public safety of the community in a high efficient and intelligent way by dynamically monitoring key areas in real time, like plazas, buildings, roads, scenic spots, enterprises and schools etc. and keeping a cl ose connection with Wuhan and Jiangxia's social service agencies such as police office (110), fire department (119), emergency medical station (120), traffic police department (122) etc.. Through the smart security system, it will be more likely to create a safe, civilized and stable community living environment.

CONCLUSION AND DISCUSSION

The core concept of the construction of Smart Community is to change life by technology, and the application systems of Smart Community are various corresponded to every aspect of life. Under this background, in this paper we demonstrate the construction goals of Smart Community service system and its function designing. The service system has the characteristics of diversity, convenience, and universality. The diversity reflects in that the function module covers various aspects of life which also are the fundamental part of community life; the convenience reflects in that the application of information technology makes the system easy to be used, anyone at any time anywhere has access to the system for corresponding service; the universality reflects in that the design of the system is reproducible so that it can be copied without too much modifications between the similar type of communities.

Based on the human-oriented concept, the construction of Yishanwan Smart Community service system focus on the demand of local residents and administrators all through, aiming to provide more considerate service. This practice intends to implement the construction experience of smart city and takes advantage of informatization in the construction of community, meanwhile contributes to the synchronous development of informatization, new industrialization, agricultural modernization, and new urbanization.The outcome is expected to provide experience and guidance for other smart community.

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Urban green corridor network analysis utilising voluntary survey data: Auckland, New Zealand

Discussing an opportunity for smart city, green urban planning

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Key words: Avian Dispersal, Green Network, Urban Network, Corridor Connectivity, Smart City, Voluntary Data

Abstract: Auckland City is New Zealand's largest and fastest growing city, with smart city aspirations. Like most New Zealand cities, despite increasing urbanisation, Auckland City maintains a high proportion of greenery throughout its urban matrix. The resulting urban green corridor network provides a substantial resource for local at risk and threatened bird species, despite habitat fragmentation. Opportunities for smart city governance in the planning of urban green corridor networks exists through the involvement of residents in data collection. This paper outlines a methodology using Geographic Information Systems for the measurement of urban green network connectivity relative to avian dispersal data collected online from local residents. The GIS methodology involves an analysis of least-cost paths through Auckland's urbanised isthmus using a resistance raster. Avian dispersal data was sourced from Landcare Research NZ's voluntary annual Garden Bird Survey over a six year period from 2008-2013. Measures of the connectivity of open green spaces and corridors are defined as the proportion of greenery along least-cost paths and are analysed relative to the distribution of local bird species. The paper assesses the relationship between avian dispersal and urban green network corridor connectivity and tests of significance found a non-significant ($p > 0.05$) positive correlation. The presence and significance of this correlation will be further assessed on a regional scale in future research by the authors. The relatively unexplored use of voluntary data in urban green network spatial planning, the need to encourage the collection of voluntary data to support pragmatic approaches to ecological conservation in urban environments and the niche which exists for residents to participate in the planning of urban green networks are discussed in the context of developing smart city governance in Auckland, New Zealand.

1. INTRODUCTION

Auckland City is New Zealand's largest and fastest growing city, with smart city aspirations. The city aims to be the world's most liveable city and has ranked in the Top 10 according to the Economic Intelligence Unit's (EIU) liveability index for the past five consecutive years. It also ranked third and twelfth in 2014 according to the Mercer Quality of Living Survey and Monocle's Quality of Life Survey, respectively. The factors considered in these surveys include, but are not limited to, safety/crime, international connectivity, climate, quality of architecture, public transportation, tolerance, environmental issues, access to nature, urban design, business conditions, pro-active policy developments, medical care, hygiene, education, culture, recreation and political-economic stability. In addition, Auckland was ranked as the fifth 'smartest' Asia/Pacific City (behind Seoul, Singapore, Tokyo and Hong Kong) by Cohen, a Smart Cities Council advisor and writer for Fast Company & Inc., as well as by the IBM Future Cities 'Smartest City' Ranking (Auckland Tourism, Events and Economic Development, 2014; Fast Company & Inc., 2015; Smart Cities Council, 2015). Cohen's framework for quantifying smart cities is based on 28 indicators, summarised in *Figure* 1, below:

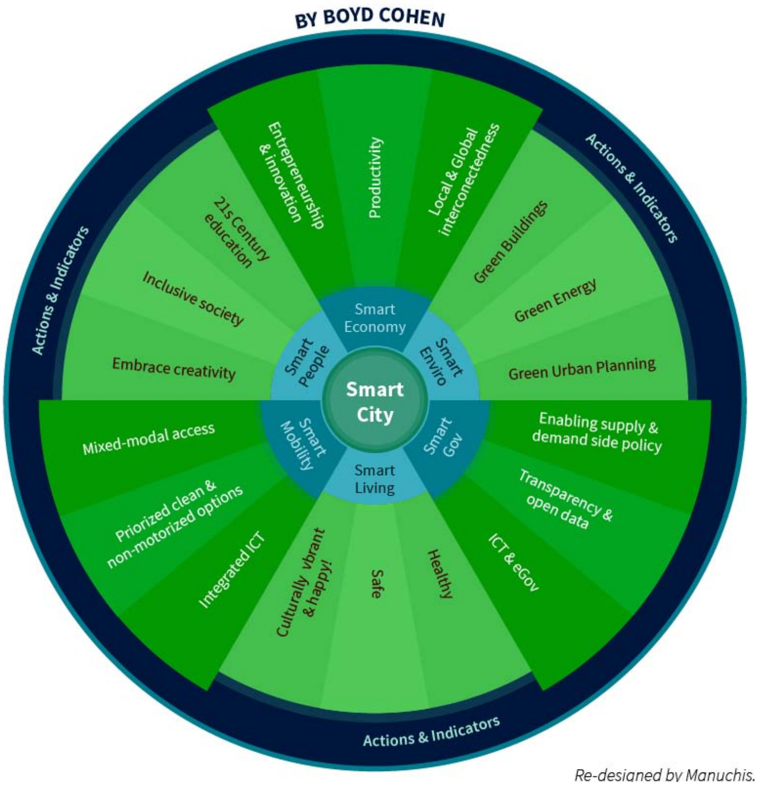


Figure 21. Cohen's indicator wheel for quantifying smart cities (Fast Company & Inc., 2015)

Of particular interest to this paper, for Auckland to orient itself toward being a smart city, according to Cohen's indicators, the city must develop and maintain green urban planning, civic engagement and transparent and open data as part of establishing a smart environment, smart people and smart governance. This paper explores transparent and open data gathered through the use of modern information technology for application in green urban planning.

Like most New Zealand cities, despite increasing urbanisation, Auckland City maintains a high proportion of greenery throughout its urban matrix, see *Figure 2*, below. The resulting urban green network provides a substantial resource for local at risk and threatened bird species, despite habitat fragmentation. New Zealand has 77 at risk bird species and, as Auckland city lies as an isthmus between the Hunua and Waitakere Ranges (two public reserves, conservation areas and biodiversity sources), it has an important role to play in providing corridors for the movement of birds between the two reserves (Robertson et al., 2012). *Figure 3*, also below, illustrates the position of Auckland City between the two biodiversity reserves.

Figure 2. Auckland City maintains a relatively high amount of greenery throughout its urban matrix (Auckland Council, 2015)

Figure 3. Auckland City isthmus and bordering reserves (Google earth V 7.1.4.1529, 2015)

Opportunities for smart city governance in the planning of urban green networks exists through the involvement of residents in data collection. In this paper, Landcare Research NZ's annual Garden Bird Survey collection method is discussed and utilised in a spatial analysis case study which measures urban green network connectivity using Geographic Information Systems (GIS) software to analyse the relationship between avian dispersal and an urban green network. Measures of the connectivity of Open Green Spaces (OGSs) are defined as the proportion of vegetative growth along least cost paths and are analysed relative to the distribution of local bird species using the volunteered data.

The relatively unexplored use of voluntary data in urban green network spatial planning, the need to encourage the collection of voluntary data to support pragmatic approaches to ecological conservation in urban environments and the niche which exists for residents to participate in the planning of urban green networks are all discussed in the context of developing smart city governance in Auckland, New Zealand in the following sections.

2. SMART CITY AND POLICY AIMS IN AUCKLAND, NEW ZEALAND

2.1 Auckland's Smart City Potential

Auckland is poised to be a successful smart city as it has several qualities that allow it, as well as the rest of New Zealand, to be an excellent testing ground for new and creative technologies. Relative to other countries, Auckland City has a small, accessible population of about 1.5 million with demographics similar to other much larger western countries, including

Australia, the United States (US) and United Kingdom (UK). Many companies have invested in launching their products in New Zealand as the country is relatively isolated, allowing for experimental policies and mistakes to be made and, because of its size, new news and trends travel quickly. One well known example is the first international launch of American Eftpos in New Zealand in 1985. Since this time the electronic payment system, now facilitated by Paymark and other electronic payment specialists, has become the standard payment method in New Zealand, displacing the use of cash (Paymark, 2012a). Such smart technology has continued to be developed in recent years; in 2012 Paymark started working with national telecommunications companies and other companies, including Auckland Transport (an Auckland Council organisation), to trial mobile payment methods, where consumers are able to make touch-and-go payments using digital wallets installed on their mobile phones (Paymark, 2012b). Another example, demonstrating the flexibility allowed by New Zealand's smaller market size, is that of Auckland Transport's integrated network pre-paid commuter cards. Auckland Transport contractually employed Snapper Services Ltd. in 2011 to provide integrated pre-paid cards for their transport network, however, Auckland Transport were able to promptly terminate this contract and replace cards and their associated technology across the entire network in 2013 when contractual agreements were not able to be met (Auckland Transport, 2012). Auckland Transport now issues the AT HOP card to its commuters which contributes to Auckland becoming a smart city through multiple avenues; the AT HOP card also promotes the use of WiFi at transport stations and terminals and allows families and employers to manage joint accounts to encourage the use of public transport systems (Auckland Transport, 2015). The statistics on the following page have been put forward by the New Zealand Government to encourage overseas investment in local information technology sectors, outlining the technological capability NZ has at its discretion in the promotion of developing smart cities:

- Information technology (software, electronics and telecommunications) is one of the fastest growing export areas for NZ, totalling an estimated $NZ1.5 billion last year.
- The software sector has grown 66% in the last four years to almost $NZ400 million, while the electronics sector has increased by one third in three years to reach $NZ800 million in 2001.
- NZ is among the most wired countries in the world. Several leading multinational companies are established here, taking advantage of robust networks including five international submarine cable systems.
- The Southern Cross cable provides a 240 gigabit connection with the US and the rest of the world – supporting a sophisticated telecommunications and highly advanced internet structure.
- In 2001- 02, internet commerce doubled to 0.8 percent of NZ's total commerce – putting the country in third place behind Canada (at 1%) and Sweden (at 0.86%), and directly in front of the US.
- NZ has one of the highest rates of personal computer ownership per capita in the world, reinforcing the country's reputation for avidly adopting new technology. The number of PCs in NZ has grown to 1.7 million.
- NZ's expenditure on information and communication technologies as a percentage of GDP is the highest in the world – at 14.4%, ahead of the US at 9%. Its rate of increase in patent applications in 2000 was second only to Finland.
- Regarded among the most sophisticated in the world, NZ's telecommunications infrastructure is providing test-bed conditions and call centre facilities for a host of large overseas-based multinationals.
- NZ was one of the first countries to deregulate its telecommunications sectors in the early 1980s, and excels in niche network and mobile products.
- NZ has since become well recognised as a prime Research and Development test ground - and is home to the world's first trial in General Packet Radio Switch (GPRS) networks by giant Vodafone's NZ arm. GPRS is a faster and more reliable way of sending data by mobile phone.

- New Zealand Government (2015)

More recently, Auckland Transport have also engaged in a Smart Parking initiative, reducing parking related queues, stress and pollution levels with a

Scotland-based company, Smart Parking Ltd., utilising their SmartGuide, SmartRep and SmartEye softwares (Smart Parking Ltd., 2015). They have also partnered with Hewlett-Packard (HP) in a Future Cities initiative that embraces the use of big data to improve traffic flow, safety, law enforcement and improve efficiency of computer aided dispatch systems. The initiative utilises HP's HAVEn big data platform, the HP Intelligent Scene Analysis System, HP Proliant Gen8 BladeSystem, HP 3PAR StoreServ Storage, HP StoreAll Archive and HP FlexFabric to deliver smart city outcomes (Hewlett-Packard Development Company, L.P., 2014).

Auckland has also been host to recent smart city development conferences, including the NZ 2010 Smart Cities Summit hosted by Bright Star Conferences and Road Lighting 2015: Smart City Investment, hosted by Local Government New Zealand, which have both seen a number of professionals attend from numerous local, regional and international councils, universities and private companies with interests in developing smart cities in New Zealand (Conferenz Ltd., 2015; Local Government New Zealand, 2015). The Conferenz 2015 Auckland Transport Summit also saw a focus on developing Auckland as a smart city, and such events create a local climate stimulating both an interest in and innovation toward developing and implementing smart city solutions (Local Government Magazine, 2015).

As derived from the above, smart city solutions in Auckland have primarily focused on transport solutions. This can be explained by the fact that Auckland is a rapidly growing, sprawling city with high commuter numbers and limited public transport capabilities. In fact, Auckland scored comparatively low on the EIU liveability index for infrastructure, and there is currently a high level of media interest on improving city transport, for example through the City Rail Link project. However, it is important to apply smart city solutions to other domains of urban planning policy and decision making for a holistic approach to smart city development. The following section outlines the policy aims specific to urban green planning, the primary topic of this paper.

2.2 Policy Aims

The Auckland Plan is Auckland's 30 year long-term plan adopted in 2012 and is the first long-term plan for Auckland City since its previous seven cities were amalgamated into a single 'super city' in 2010. The council's long-term plan of becoming the world's most liveable city is to be achieved through the realisation of The Auckland Plan's objectives. Despite The Auckland Plan not including any specific references to becoming a smart city in particular, many of its objectives lie in tandem with those of a smart city and refer to 'smart' practices, such as using 'smart thinking' to transform existing sectors. In addition, the attitude of the Council to improving its status as a smart city has been publicised through the media, its ongoing smart city initiatives (for example, those described above) and in other regional policies, including in the Auckland Innovation Plan (APN New Zealand Ltd., 2010a; APN New Zealand Ltd., 2010b; Auckland Tourism, Events and Economic Development, 2014). Its ambitions are also further supported on a national level, for example, in late 2014, NZ Prime Minister John Key and President of The People's Republic of China, Xi Jinping, oversaw a Memorandum of Understanding with Infratil, Sensing Cities and Envision Energy International to build Smart Infrastructure Projects in NZ and Asia, of which Auckland will be a target city (Business Wire, 2014; The Embassy of the People's Republic of China in New Zealand, 2014).

3. GATHERING DATA

3.1 Smart City Methods

Traditional forms of data collection typically include field surveys, observation or questionnaires. These methods, although usually precise, are both time consuming and often geographically limited. In order to capture a wider pool of data smart methods utilising modern information technology are able to be employed. These methods may include the use of mobile, internet or GPS technologies, to name a few, and broaden the scope of data collection by reducing the prevalence of both temporal and geographical boundaries due to the transcendence of technology across large network systems.

3.2 Green Urban Planning

Cities by their very nature are typically centralised urban areas that sit within natural landscapes on a regional level, but which, on a local level, are not symbiotic with natural ecosystems. Through advanced material development, such as permeable pavements and roof and vertical greening, as well as a focus on incorporating green spaces within urban environments, many cities are developing more of a green presence or network within city boundaries. In other less dense cities, including Auckland City, there has remained a high level of greenery within city boundaries since the cities' foundation, despite ongoing urban development and the increasing density of the city. In both instances, the contemporary demand for progressive green urban planning is significant and includes the need to understand natural systems on both the city scale, as well as in the wider regional context.

Quantifying or detailing local biodiversity populations or ecosystem dynamics can be very labour intensive; identifying the individuals of populations, daily, seasonal or annual movements, habitats for different purposes and seasons, predator-prey relationships and so on, repeated across a range of species, requires labour, time and funds that are often not available. Typically, biological surveys may focus on one particular area, environment, species or species dynamic, and this can lead to a limited pool of knowledge, albeit expert, which restricts the quantity and breadth of information available to urban planners. If more data, big data, on a wider scale can be collected and utilised at low cost, in a short space of time and with reduced demand on resources then, combined with the need to be environmentally progressive, more pragmatic decisions can be made with regard to green urban planning.

4. CASE STUDY: NZ GARDEN BIRD SURVEY DATA

4.1 Data

The NZ Garden Bird Survey is an annual survey conducted nationally and supported by the NZ government's Crown Research Institute, Landcare Research NZ. This paper's research incorporates data collected annually between late June and early July over the six year period from 2008 to 2013. The information was collected on a national scale from members of the public who voluntarily uploaded bird sighting information to a public website. The website includes information on how to identify birds, an Online Recording Form, as well as other general and educational information. The annual project is an ongoing research project and can be viewed at http://www.landcareresearch.co.nz/science/plants-animals-fungi/animals/birds/garden-bird-surveys. The Online Recording Form is a website itself (http://www.birdsurvey.org.nz) which can also be filled in and submitted via smartphone. Participants are advised to count birds for only one hour and to record only the highest number of individual birds of each species that are seen together at any one time. These guidelines are designed to ensure each location is sampled for an equal duration and to prevent multiple counts of the same individual at any one location. The Online Recording Form includes fields for survey location and surveyor details, survey date and time, bird counts for a range of species, other specifics including whether the birds are being fed or whether plants in the area are flowering, fruiting or seeding, and an open comment box.

An aerial photo of the Auckland central city area was sourced from Auckland City Council and made available under a Geospatial Data Licence Agreement in accordance with the Creative Commons Attribution 3.0 New Zealand licence. The image was a 3-band RGB 8bit TIFF image taken in

2011 with 0.5m resolution. In addition, Landcover Database v4.0 shapefiles were sourced from the Land Resource Information Systems Portal, a database held by Landcare Research NZ made publicly available under the same creative commons license as above.

4.2 Method

The method first required the identification and measurement of green urban corridors as outlined in Table 1, below. Finally, the bird data were superimposed and spatial relationships statistically analysed.

Table 1. Describing the eight stages to identify and measure green urban corridors.

Stage	Process	Software	Objective
1. Site Extent Identification	Landcover Database v4.0 shapefiles were used to identify boundary lines which were used to Clip the aerial photo of the central Auckland area.	ArcGIS 10.3	To isolate land cover from open water and estuarine vegetation areas.
2. Land cover Classification	30 training samples were created for each classification category and the aerial photo was classified based on RGB statistics.	MultiSpec Application v3.4	To classify land cover at a high resolution.
3. Open Green Space (OGS) Identification	Landcover Database v4.0 Urban Parkland/Open Space polygons were merged with adjacent classified Greenery land cover.	ArcGIS 10.3	To identify 'From' and 'To' location polygons for Stage 5.
4. Resistance Raster Classification	Cost values were assigned to each land cover classification.	ArcGIS 10.3	To create a resistance raster for Stage 5.
5. Least Cost Path Analysis	Least Cost Paths were produced based on the Euclidean and cost-weighted distances between 'From' and 'To' polygons.	ArcGIS 10.3, Linkage Mapper v1.0.9 Toolkit	To identify paths of least cost between OGSs.
6. Green Urban Corridor Identification	250m buffers were applied to all LCPs and OGSs. Connecting LCP and OGS buffers were merged to create complete A to B corridors for each LCP.	ArcGIS 10.3	To create highest likelihood corridors for bird movement between OGSs in the urban environment.
7. Binary Greenery Raster Creation	Classified land cover was reclassified as Greenery (1) or Not Greenery (0).	ArcGIS 10.3	To create a raster showing presence or absence of greenery.
8. Corridor Connectivity Measurement	The proportion of each LCP intersecting with Greenery was calculated.	Geospatial Modelling Environment v0.7.4.0	To measure a connectivity value for each corridor.

In Stage 2, the following land cover categories were classified using a supervised maximum-likelihood classification method: Greenery, Grassland/Herbfields, Bare Surface, Water, Transport Network and Buildings. This stage was repeated during the course of the research incorporating training samples of Transport Network in Shadow and Buildings in Shadow to reduce the misclassification of land cover in shaded areas. Figure 4, below, shows the before and after impact of classifying for these shaded areas. This was an important adjustment to the classification process as a large number of pixels had previously been misclassified as Greenery. Histogram statistics, the Kappa value and McNemar's chi-squared test were calculated to assess the accuracy of the final classified output and are presented in the following results section. The sample training, classification and statistical analyses were all computed using the MultiSpec Application v3.4 software.

Figure 4. Before (top) and after (bottom) classifying Transport Network in Shadow and Buildings in Shadow to reduce misclassification of the roads and buildings as Greenery.

In Stage 4, the cost values for the resistance raster were assigned based on Saaty's Analytic Hierarchy Process (AHP) (Saaty, 2008). The AHP conducts a pairwise comparison of prioritised nodes (in this case, land cover classification), which are scaled based on absolute judgements of the likeness of each land cover classification to natural bird habitat. Goepel's (2014) AHP Online System provides an AHP Priority Calculator based on Saaty's method which was used to calculate the cost values.

In Stage 5, the Linkage Mapper toolkit was utilised within the ArcGIS environment, having been sourced from Circuitscape (2015). This toolkit provides efficient batch processing of least-cost value paths between numerous cores based on cost-weighted distances.

In Stage 6, 250 m buffers were applied based on outcomes of previous research. Mason et al. (2007) conducted a survey of breeding bird communities in North Carolina, USA and highlighted that some birds, including warbler species (the Grey Warbler is native to New Zealand and found in the Auckland region), were recorded only in greenways wider than 300m, while Kilgo et al. (1998) identified a minimum 500m in a survey based on similar species. In addition, Shirley and Smith (2005) recommend a buffer of at least 100m in riparian areas to support forest interior species, this may be likened to urban areas for the purposes of this research as they both represent permanently altered landscapes subjected to recent fragmentation with significant negative edge effects. In this current research, the 250m buffer was applied to both sides of the LCPs as well as the exterior of the OGSs, resulting in 500m-wide buffer zones along the LCPs and 250m-wide buffers around the OGSs, satisfying the recommendations presented by both Kilgo et al. and Shirley and Smith.

The initial intentions of this research were to incorporate bird data only from native New Zealand species, however due to the small scale site extent and scarcity of the bird data within this extent, all species surveyed by the NZ Garden Bird Survey were included.

4.3 Result

For Stage 1, the histogram statistic distributions showed sound distinctions based on the reference accuracy of all classification categories (65-97%), except for Buildings with Shadows (45%); the overall reference accuracy was 81.1%. The calculated Kappa value was 0.769, representing a 'good' result (0.61-0.80) as interpreted by Altman (1991). McNemar's chi-squared p-value $< 2.2e-16 < 0.05$, showing the difference between land cover categories was highly statistically significant.

Stage 3 identified 16 OGSs and in Stage 5 these were linked by 31 LCPs. The OGSs and LCPs are shown in Figure 5, below, on the classified land cover image from Stage 1, alongside the original aerial photo.

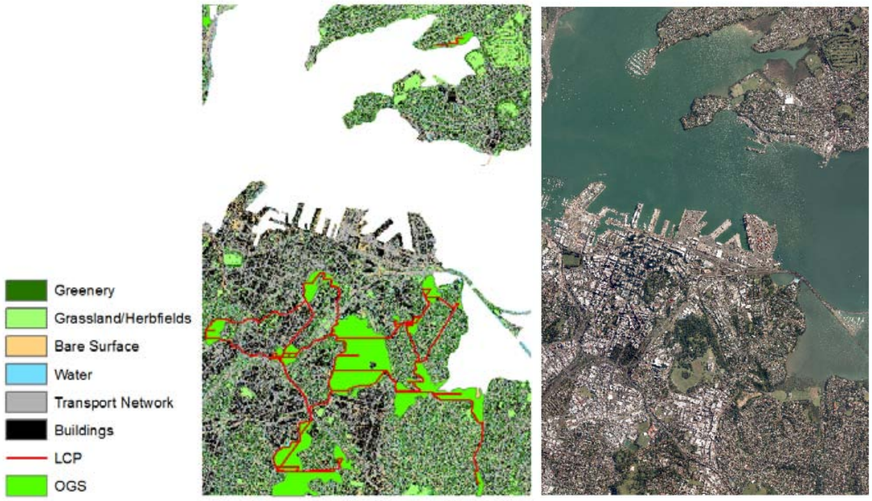


Figure 5. Image showing land cover classification output, least-cost paths and open green spaces (left), alongside the original aerial photo (right).

Finally, Figure 6, be low, shows the green urban corridor network following the application of the buffer areas with the NZ Garden Bird Survey data overlaid.

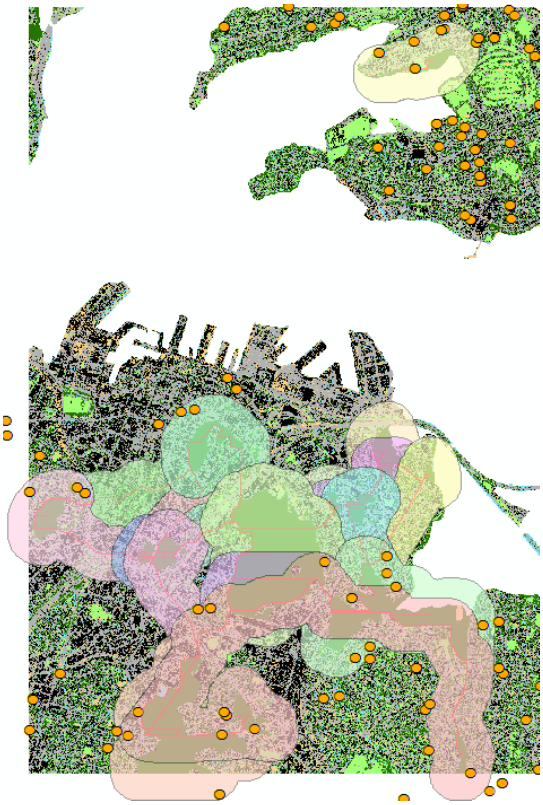
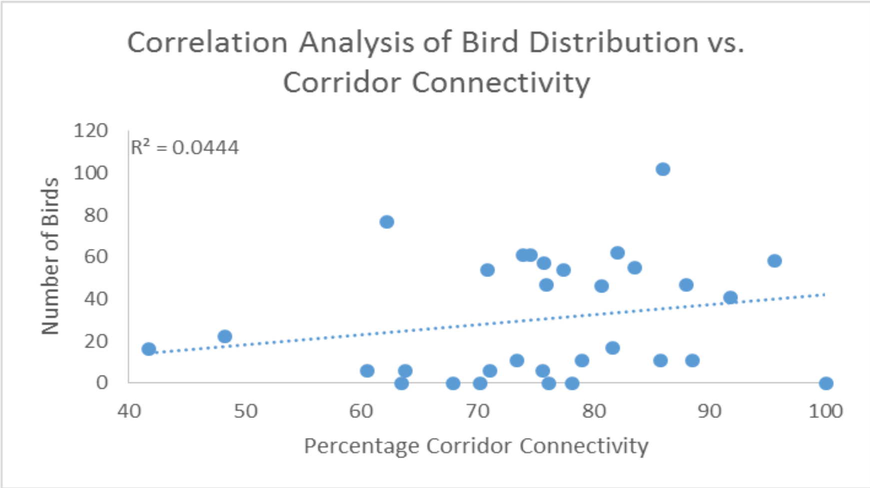


Figure 6. The green urban corridor network identified in the Auckland central city area and NZ Garden Bird data.

The number of birds distributed within each corridor and the measure of connectivity associated with each of the 31 corridors are plotted on Graph 1, below, and display the regression line. The regression line shows a positive correlation between bird distribution and corridor connectivity (Pearson's correlation coefficient $r = 0.2107$), where the number of birds increases with increased connectivity, however this trend is slight and not statistically significant (two-tailed $p = 0.2552 > 0.05$).



Graph 1. Scatterplot showing a non-significant positive correlation between corridor connectivity and bird distribution.

5. DISCUSSION AND CONCLUSIONS

The results of this research found that bird distribution increased as corridor connectivity increased in the Auckland central city area, however this correlation was statistically insignificant. Future research will apply the analysis method of this paper to the entire region from Auckland's Hunua to Waitakere Ranges to assess whether this correlation is found to be more significant at a regional, as opposed to local, level.

In this research, about 20% of the LCPs had no observed birds which may vary significantly in other parts of the Auckland region as the study area in this research was taken from the densest urban area of Auckland, the city centre and central business district. This area also features Auckland Port and the exposure to open water may have had a significant adverse effect on corridors nearer to the industrial/water edge. Analysing the corridors on a regional level with a larger sample size will reduce the impact of these factors on the statistical outcome.

Limitations of the research include the inherent limitations of the supervised maximum-likelihood land cover classification process, the Analytic Hierarchy Process and the NZ Garden Bird Survey data. The classification process, as shown by the effects of shadow on classification, is sufficient, but not perfect and may be improved through increasing the number of training samples and the number of classification categories. It was noted by the authors that in addition to the problem of shadow being classified as Greenery, many sloped building rooftops were classified on the sun-facing side as Buildings, but on the shade-facing side as Bare Surface. The problem of sunlight on rooftops was not shown to be statistically significant however, but this observation will be taken into account in future research to improve the accuracy of the classification output.

The creation of the resistance raster using the AHP was limited as the decision making process was based on reviewed literature by the authors, as opposed to by engaging experts on NZ avifauna. The AHP process is based on subjective measures, however it is a better alternative to assigning cost values without a pairwise comparison method.

The NZ Garden Bird Survey's limitations are many and varied due to the method of collection, however, the effect of inconsistent sampling methods by individuals should reduce as the sample size increases. This research utilised only a small subsection of the data which has been collected on a national scale and, as a result, inconsistent observations may have had a disproportionate impact on the result due to the small sample size.

In addition, numerous bird observation data points were observed in areas outside of the identified corridors and, where these exist in significant numbers, further analysis is recommended. Further, many bird observation data points are positioned according to the addresses of the residences, and may therefore fall on the location of a building itself rather than in its associated garden. It was observed during this research that in some instances this led to bird observation data points lying outside the identified corridors, despite the garden areas themselves falling inside the corridors. It is assumed that with a large enough dataset the effect of this on the results would be negligible, however it is a limitation of the dataset to note.

The NZ Garden Bird Survey provides a big data source for assessing bird distribution on a national scale, but may also be useful on local or regional scales, including in dense urban areas where practical applications for green urban planning may be found. Encouraging participation from residents increases public participation at the base level of green urban planning where the data on which decisions are made can be produced by the residents themselves. Participation is also likely to increase residents' awareness of nature through fostering a sense of guardianship in urban and residential areas, and through the educational attributes of projects such as the NZ Garden Bird Survey, which are likely to have wider flow-on effects for residential support of urban green planning.

It is recommended that further research be conducted on projects that encourage public participation in green urban planning, particularly those involving big data collection methods such as the NZ Garden Birdy Survey, as cities need smart thinking, smart methods and smart data that extends beyond transport and industry, to involve nature and ecology in the process of smart city planning. These projects present opportunities for residents to be included in society, for improved local government access to transparent and open big data, and positive implications for the environment through progressive green urban planning outcomes, producing smart people, smart governance and a smart environment.

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The Study of a Development Model for Simplified Green Buildings in Taiwan

– The Case of the AGS1 Experimental House

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Key words: Simplified Green Buildings, the AGS1 Experimental House, Development Model

Abstract: In view of recent major concern that Taiwan now ranks second in the world in terms of cement consumption per capita, accounting for 95% of the building structures in Taiwan, and with reinforced concrete building structure leading to illegal gravel mining impacting the natural environment, this study aims to address the problems through "Simplified Green Buildings" concept which will dramatically reduce the high percentage of reinforced concrete buildings in Taiwan by establishing a development model for green buildings with a high functional performance in safety, healthiness, comfort and energy conservation. "The Simplified Green Buildings", as an approach extends the thinking of green buildings and examining the excessive green building design that currently predominate. Following the belief of "less is more", it puts emphasis on examining the regional natural environment and climate characteristics, and establishes an innovative green building protocol for design focusing on necessity, sustainability and passivity in terms of the surrounding environment, structure, materials, comfort and decoration and finish of the building.

This study firstly clarifies the local climate characteristics of Taiwan, the green buildings and manners of using green materials in Taiwan by using literature review analytically, then deliberately explains the development model of green buildings for the green environment, green structure, green materials, green living, and green decoration and finishing under "simplified" concept; secondly infers the practical and appropriate residence environment model encompassing "combination of correct temperature and humidity values indoor, reduced building weight of envelope structures and heat gain of window, prevention of excessive interior decorations, choice of the envelope material with high resistance to moisture permeability, air exchange mechanism with proper intermediary space, and best fitted air conditioning model. Furthermore, this study presents effectiveness evidences of some of the functions of the buildings of the AGS1 experimental house by using methods of case study encompassing the aspects of "weight reduction to 2/3 of the reinforced concrete, reduction of carbon footprint and total carbon emission at every stage with and without 40 year usage by 30.7% and 43% respectively; heat gain from thermal transmittance and thermal conduction estimated by using Overall Thermal Transfer Value (OTTV), which is equivalent to only 15.32% of the heat gain found in the combination of reinforced concrete building structure with window opening without thermal insulation treatment."

At last but not the least, this study creates the concept of "Development Model of Simplified Green Buildings in Taiwan" by aggregating the case study data and presents the description of development of the AGS1 Experimental House on the basis of the effectiveness evidences of some of the functions of the buildings of the AGS1 experimental house, and also presents suggestions on the direction for short thesis researches in the coming future hoping to facilitate the positive development of green building sector in Taiwan.

1. FOREWORD

Global warming and the energy crisis constitute twin threats to Taiwan, so we are faced with the task of increasing residence comfort and to energy efficiency. In tackling these threats, the development of green buildings needs to focus on weight reduction, carbon reduction, and energy conservation. Taiwan faces the problems of excessive cement use and illegal gravel mining. It ranks second in the world for cement consumption per capita thanks to reinforced concrete (RC) building structure accounted to over 95% of all building structures. Furthermore, environmental illness sources such as the high thermal transmittance and the heat and coldness cumulating effect of reinforced concrete structures (Figure 1-1) and excessive decoration and finishing indoors, lead to sultry summers and cold wet winters, resulting in dew formation and fungus contamination of walls, which seriously affects the health of residents in Taiwan. Furthermore, in view of the issues and concerns about high carbon emissions, high energy waste, and the threat to comfort indoors during the life cycle of a reinforced concrete building structure, it is essential to make changes in the structure of reinforced concrete buildings (Figure 1-2).

Figure 1-1. The wall in a conventional reinforced concrete building structure or brick masonry wall.

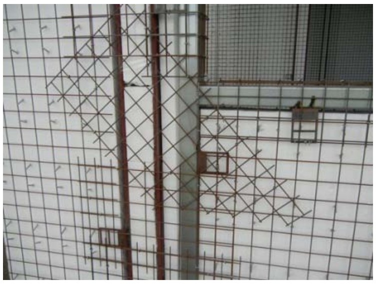


Figure 1-2. The wall in the AGS1 c omposite building structure.

Among the various green building techniques in application in the mainstream green buildings in Taiwan, quite a few were introduced into Taiwan along with the experiences accumulated in countries in high latitude regions. Numerous certified green material products have been introduced into Taiwan from overseas, and excessively promoted green building designs mislead us through the predominant product promotion and marketing calls over our concerns for real benefits and effectiveness. This study firstly interprets the development model of green buildings under "Simplified" concept which encompasses a g reen environment, green structure, green materials, green life, and green decoration and finish. Secondly, by taking the AGS1 experimental house as t he object in question, assesses and calculates the carbon print and overall carbon emission of the composite building structure as well as a reinforced concrete building structure, and also the thermal transmittance (Ui) of structural elements, examines the ratio of influence between the heat gain of the envelope and the window, and conducts tests and verifies on the part of building function effectiveness and benefits of the AGS1 experimental house, and finally presents the research results and conclusions and also some suggestions.

2. INTRODUCTION

2.1 Motivation and Purpose

The motivation of this research is to establish a development model of green buildings centering on s afety, healthiness, comfort and energy efficiency by to the “simplified green buildings” concept and particularly by taking the regional and natural environment and climate characteristics of Taiwan into consideration. The purpose of this research is to present “The Development Model of Simplified Green Buildings in Taiwan” which encompasses topics such as the argument over the efficiency of energy conservation windows, the “Simplified Green Building Model for a Detached House on the Plains of Western in Taiwan”, the “Construction Method of the AG Innovative Green Structure”, and Development Model of the AGS1 Experimental House. Furthermore, it presents both the research results on “ Tests and Verification of Some Architectural Benefits of the AGS1 Experimental House,” and suggestions for the direction of future development in hope of facilitating the positive development of green building industry sector in Taiwan.

2.2 Study method and process flow

This research makes use of research methods including a literature review and case study by compiling “The Development Model of Simplified Green Buildings in Taiwan”, comparing the respective contrasting data of carbon emissions and thermal transmittance (Ui) of the Building Envelope and Window Combinations of the AGS1 Experimental House Building Structure and Conventional Reinforced Concrete Building Structure, and finally further exploring and concluding the optimal and most appropriate combinations. (Figure 2-1).

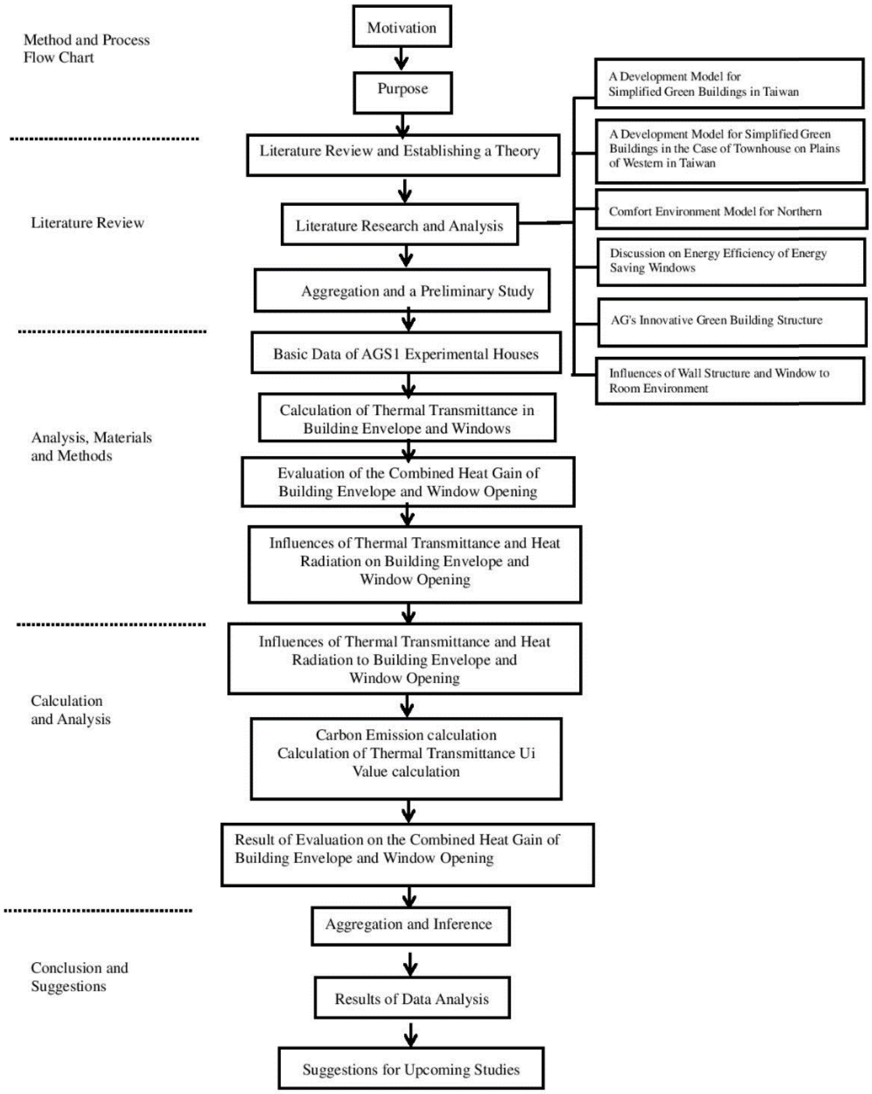


Figure 2-1. Study Method Process Flow

3. Literature Review

3.1 "Development Model of Simplified Green Buildings in Taiwan”

This section is a s ummary of “The Simplified Green Buildings” (Chih-Peng Liu, 2015) and briefs the articles and overview of each article as the following:

3.1.1 Climate characteristics of Taiwan

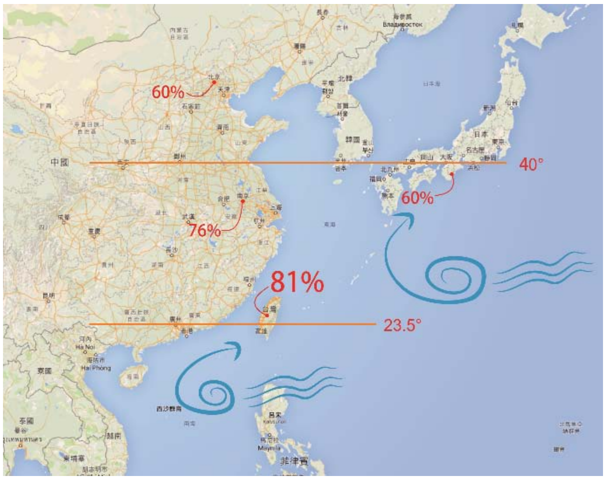


Figure 3-1. Illustration of Taiwan’s climate characteristics for high humidity

In reply to climate change impacts to the natural environment, Taiwan desperately demands the development of building structure best suited to her regional climate characteristics; and this article discusses the problems such as earthquake, windstorm, flood, landslide, acid rain, UV, moisture, mites and termites, sun-shading building convention; and also presents the results of pilot exploration on forming the green building supportive environment under the climate conditions north in Taiwan (Figure 3-1).

3.1.2 Discussion on Green Buildings and Green Materials in Taiwan

綠建築標章
GREEN BUILDING

Not only reduction but also efficient use of energy, which is also suitable for indoor environments and eliminating the sick building syndrome.

Now, around the world, green building assessment methods and classification systems both adopt energy performance and indoor environmental quality as evaluation criteria, as shown in the table.

Assessment method	Evaluation Methods of Green Buildings around the world
USA LEED	Base for sustainable use, efficiency of water use, energy & atmosphere, materials & resources, indoor environmental quality and innovative design
Canada GB Tool	Resource consumption, economic load, indoor environmental quality,maintenance and service quality, economy, business management, transportation
UK BREEAM	Management, health and comfort, energy, water resource, materials, land usage, ecosystem and pollution
CHINA	Residential environment planning and design, energy and environment, indoor environmental quality, Residential water environment, materials and resources
JAPAN CABEE	Indoor environment, warm environment, temperature setting, exterior thermal load control, natural energy, high-efficiency equipment, monitoring and management system
TAIWAN EEWH	Biodiversity, green, water-based, daily energy saving, CO_2 reduction, waste reduction, water resources, indoor environmental quality and improvement of sewage and garbage

Source: The study of the interactive effects of green building energy performance and living quality (Architecture and Building Research Institute, Ministry of the Interior)

Table 3-1. Evaluation Methods and Ceriteria of Green Buildings around the world

The practical benefits of green buildings and green materials in Taiwan must be clarified with further practical studies and thinking; and this article explores issues such if industrialized housing, energy conservation carbon reduction, and LEED myths, and the significance of devising on-site water retention and water safe; the benefits of Diatomaceous Earth and photo tiles, indoor daylight vs. lighting energy saving, arguments on energy saving windows, green energy technology and subside myths, reuse of old buildings and building material recycling and reuse (Table 3.1).

3.1.3 Simplified Green Environment

Behind convenience provided by the environment is dependence inevitably, excessive use of environment control system is contributed by profitability and consumer behaviour, hence the concept of simplified green environment basically lies on avoiding excessive impact to environment and also conserving the environment coping potential. This article further discusses issues such as valuing residence living environment, living environment water treatment, and the environments of Dr. Tanaka' eco-environment pond v s. AG extreme green environment and extreme cultivation environment.

3.1.4 Simplified Green Structure and Simplified Green Materials

A building structure contributes to carbon emission during the building life cycle and also affects the upcoming energy efficiency of the building, therefore, weight reduction and materials suited to the site are basic considerations. This section explores issues in market mechanism and sustainable environment, building planning, locale incompatibility found under the global frugal style, wooden structure problems, brick wall structure concerns and also discusses the possible development of green structures and green materials for the conventional buildings in Taiwan encompassing use of water permeable or impervious tiles and porous materials, roofing tiles, walls and tiles, leakage, thermal insulation, and stilt style buildings.

3.1.5 Simplified Green Living and Simplified Green Decoration and Finish

While enjoying readily available conform living environment we inevitable weaken the immunity to cope with environmental change. Among energy conservation strategies the best one is to grow a good daily living habits and to reduce dependence on equipment and facilities, and to made efficient use of resources. Simplified green living and green finishing and decoration concept aim at 20% energy saving from making good use of the physical environment of building, 10% energy saving from daily power use concept and patterns, and in the remaining 70% of energy consumption, 20% to be offset by using renewal or natural clean energy sources, and the rest 50% to be saved by using low energy consumption device or equipment. 40% material consumption can be saved in the building structure finishing and the remaining 60% can be saved with low pollution healthy materials or recycled materials. This section presents the ideals of ordinary space and living habits, learning design from the mother planet nature, household sewer treatment conceptual pictures, humidity issues, intermediary space uses, applications of building infrastructure and geothermal air conditioning, residence healthiness inspection and improvements, sick house, living audio system, establishment of smart home; and the analysis on the trends of i-Japan cities and housing planning.

3.2 Simplified Green Building Model for a Detached House on the Plains of Western Taiwan

The normal pattern of climate in plains west in Taiwan sees wet and cold north-easterly monsoon winds and mild south-westerly winds. Most regions see wet and hot or wet and cold climate except toasty summer in the south regions. This section tackling the issues such as sun shading in the south-western direction and ventilation and convection, indoor humid proofing, wall water proofing, dew proofing, use of intermediary space and geothermal energy application, outdoor extreme green environment, scope of comfort humidity and temperature indoor, toxic free finishing and decoration, and window thermal insulation treatment, etc. and finally creates the concept illustration of "Simplified Green Building Model for Detached House in Plains West in Taiwan" (Figure 3-2).

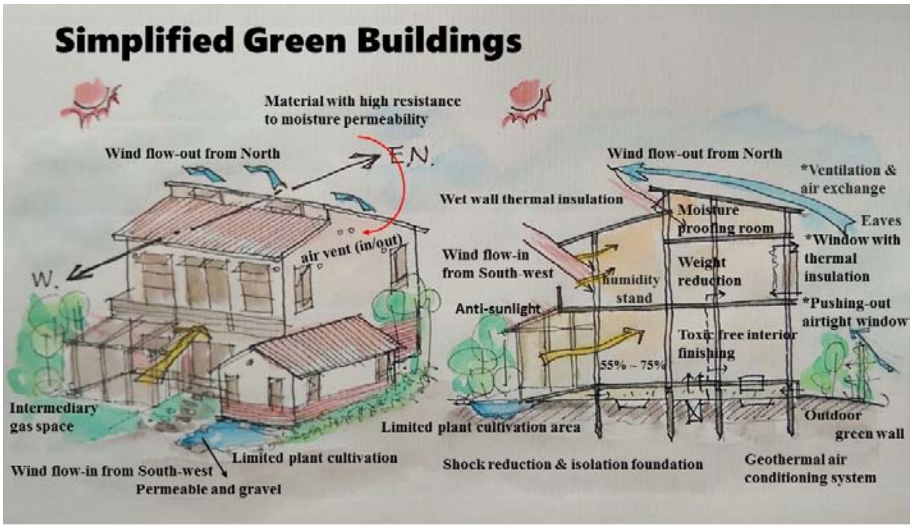


Figure 3-2. Concept Illustration of Simplified Green Building Model for A Detached House on the Plains of Western in Taiwan

3.3 Concept Illustration of Comfortable Living Environment in the Northern Region of Taiwan

In a typical year, regions north in Taiwan sees climate featured sultry or wet and cold ambient air for 25% of the period, not advisable to introduce the air in and therefore air conditioning systems are used with windows and doors shut; high humidity affects thermal conduction in windows and wall, heat convection, thermal conduction, and the indoor heat grain rate; therefore to address the concerns on room structure absorbing moisture and inviting fungus, the reciprocating complimentary features of demand of sun exposure of room window in the summer and the winter, and heat exchange demand in closed room, the inferences on " The optimal temperature and humidity combination for room, composite structure building envelope and common windows wanting treatment with finishing for enhancing thermal insulation and reducing heat gain can be done by preventing excessive indoor decoration and finishing, selecting the envelope material with higher humidity resistance, and devising the mechanism of proper intermediary space for air-exchange; in this fashion, with the consequent little energy flow between the indoor and outdoor spaces the air conditioning system is responsible for the loading of energy adjustment in the human body, lighting and appliance indoor, this will be the optimal model of the green building environment for residence buildings under climate conditions in regions north in Taiwan.” (Figure 3-3).

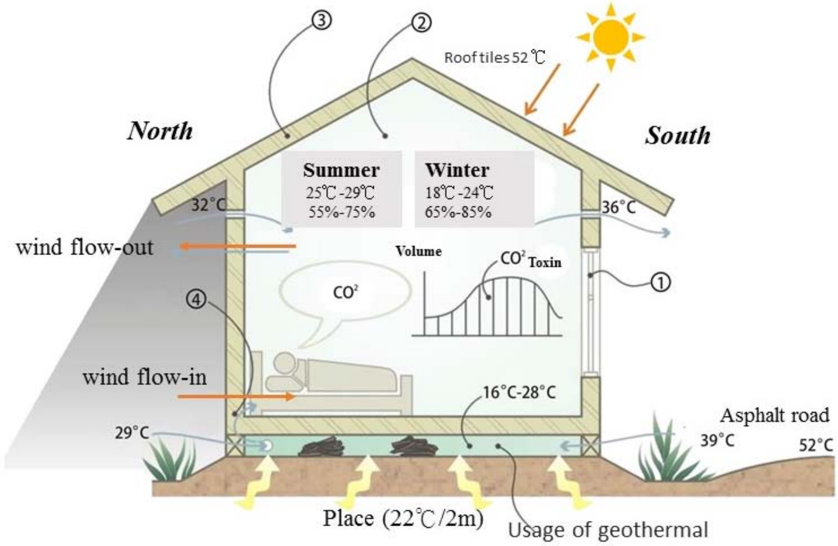


Figure 3-3. Concept Illustration of Model of Comfortable Living Environment in the Northern Regions North of Taiwan

① Window opening

② Temperature and humidity

③ Adiabatic roof

④ Ventilation and air exchange

3.4 The dialectic about the efficiency of energy conservation windows

This study tries to demonstrate issues of green materials by taking the argument on the function energy conservation window as an example; due to the recent exaggeration on the function of energy conservation window in Taiwan, Taiwan see booming construction of buildings with glass façade envelope. A pair of contrast models on Function or Performance of Thermal Insulation Glass takes presence in a recent Green Building Materials Exhibition organized by Architecture & Building Research Institutes, MOI, (Figure 3-4), the models each coming with a lighting bulb as energy source emitting light through an energy conservation glass or non-energy conservation glass respectively to demonstrate the thermal resistance effect shown in the temperature difference felt by touching each glass. This experiment is used to prove that energy conservation glass is functional in lucratively reducing heat gain caused by the sun radiation and in turn saving energy consumed by air conditioning system. Two building models with glass facade envelope exposed under the emission of the lighting bulb, the temperature probe in the middle of the model with non-energy conservation glass displays a temperature of 32.4℃ compared to the model with energy conservation glass a temperature of 28.1℃. This experiment implies that the with energy conservation glass leads to room temperature difference by 4.3℃.

Figure 3-4. Contrasting Models of the Effects of Energy Conservation Glass

To the further analysis on the argument, while energy conservation glass isolates the radiation energy of some wave lengths the energy actually remains in the film of the glass and will emit to the indoor space through the high moisture, therefore the only energy reduction happens partially outdoors, and the enthalpy outdoors is still transmitted inward to the indoor through glass and wall, as a result the energy conservation effectiveness is very limited. What misleads the public are as the follows: the high tech image shown by the glass facade, the fact in countries located at high latitude the buildings need to maintain higher temperature indoor with the sun radiation energy during the daytime, plus the features such as comparatively lower cold radiation transmittance rate under low humidity, so popularity of building with glass facade envelope in the high latitude regions is for a reason, however it is not the case in Taiwan due to her high humidity and low latitude. The misleading appeal of these glass products in fact adversely encourages the architects and property owners to introduce glass facade envelope deliberately to the trends. Unfortunately it is a wrong approach in terms of energy conservation.

3.5 Green structure of the AG Innovative Buildings

AG-LSRC AG light steel reinforced concrete construction method is developed especially for the composite building structure pinpointing the natural environment in Taiwan, noticed as the installing method that meets cost effectiveness and eco concerns, and falls into the following new edge process flows (Figure 3-5, 3-6):

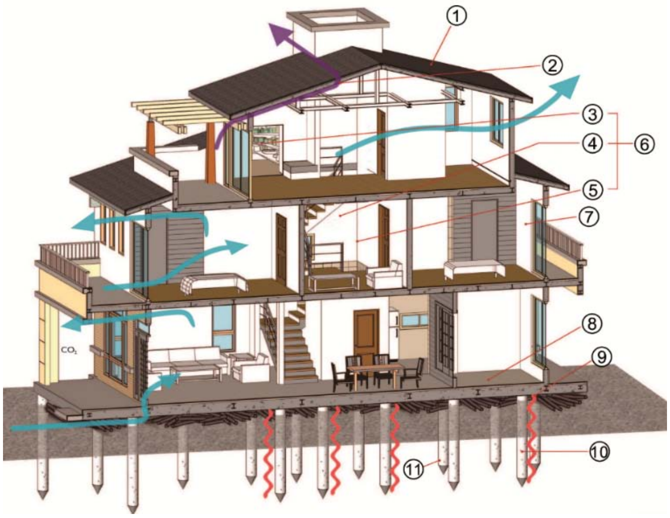


Figure 3-5. Illustration of AG Innovative Composite Structure Building

① High-performance insulation

② Convection and radiation

③ Increased storage space

④ Without large beam and staircase reduction

⑤ Column angle reduction

⑥ Increased indoor space of 12%

⑦ Without dew formation and fireproof

⑧ Moisture proofing design on floor

⑨ Isolation foundation by 70%, shock reduction to 2/3

⑩ Damping to 2/3

⑪ The system of geothermal air conditioning provides 16~28℃convention and air exchange.

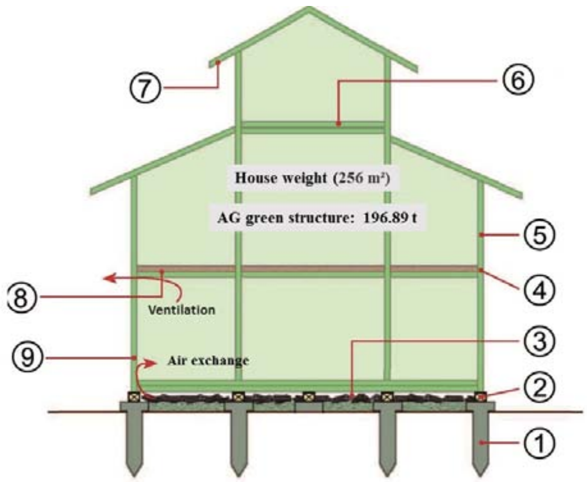


Figure 3-6. Illustration of the Structural System of the AG Innovative Composite Structure

① Root-like damper base

② High-performance shock reduction and isolation foundation

③ Geothermal air conditioning system

④ Cage steel frame and building framework

⑤ Wet light steel reinforced concrete construction system

⑥ Dry preparation roof

⑦ Convection and radiation

⑧ Beam connection with columns

⑨ Column setting with smaller steel frames

3.5.1 Shock Reduction & Isolation Foundation

To reduce the absorption and transfer of earthquake energy by using innovative foundation design and installing shock isolators, and also to release the energy with vibration isolating device, so as to dissipate impact energy, protect structure safety and minimize consumption of structure materials (Figure 3-7).

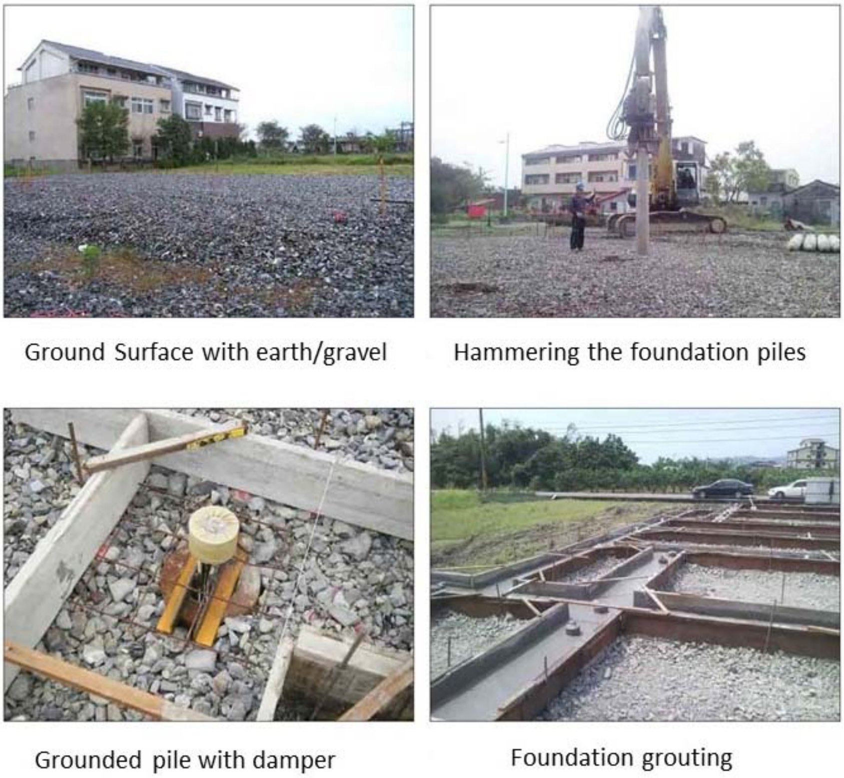


Figure 3-7. Illustration of the Foundation in the AG Innovative Composite Structure

3.5.2 Cage Steel Frame

Building Framework are built with combination of hot roll steel and cold roll steel elements, horizontal braces and wall panel assemblies, to form a cage structure, hence the structure is lighter and tougher compared with beam and column structure system, and brings considerable competing strength in construction work safety, speediness, precision and cost effectiveness. (Figure 3-8)

Figure 3-8 Illustration of Building the Steel Framework of the AG Innovative Composite Structure

3.5.3 Light Weight Wall Panel

The wall panel built with 3D system wall assembly and light weight concrete, brings the advantageous edges of weight reduction, high thermal insulation, leakage and dew proofing (Figure 3-9).

Figure 3-9 Building Structure Methods of the AG Innovative Composite Structure

3.6 Calculation of Related Carbon Emissions

Carbon Footprint is defined as the CO2 emitted directly or indirectly by the product during its production and its activities during its entire service life cycle. Currently there are no estimated guidelines or standards available for the check-up or assessment of CO2 emissions during a building’s service life cycle either domestically or overseas, and some building materials come without CO2 emission data. This study tries to define the life cycle of current general buildings' main structure and operation for assessing their carbon footprints, with eight stages identified; "Material Production", "Material Delivery", "Site Operation", "Daily Usage", "Daily Repair and Maintenance", "Re-modification and Renewal", "Demolition" and "Debris Disposal". Each stage is defined and concluded respectively within the scope of the research and assumed conditions.

In the case of the analysis of the on carbon footprint during the life cycle of a reinforced concrete building, i.e. the school building for College of Engineering, on the campus of National Ilan University, the case is reviewed in two separate situations, including daily use and excluding daily use. In the case of the building structure alone, it contributes to only 15% of the carbon footprint ratio, while the structure along with daily use contributes 85%. The report leads to two argument lines: Firstly the carbon footprint lies mainly on usage stage; secondly, a r einforced concrete structure is likely to lead to escalating energy consumption during its use in the future.

3.7 Influence of the Wall Structure and Windows on the Indoor Environment

According to recent ITRI research results, removal of the stored heat coming through the building's envelope accounted for 96% of the electricity use by household air conditioning, of which windows accounted for 57%, walls 17%, and the roof 22% (Chiu, Chi-Cheh, 2009). This indicates that the building envelope and windows seriously influence on residence's temperature and humidity. Hence it is vital to review the types and combinations of building envelope structure and window insulation in order to understand their influence on residence's temperature and humidity, and also carbon reduction.

Concerning the studies on the effect of wall structure to the Overall Thermal Transfer Value (OTTV), the Technical Code for Energy Conservation Design of Buildings of Taiwan, ENVLOAD (Envelope Load) is used to conduct the analysis on a building's heat gain (Lin, Hsien-Te, Yang, Kuan-Hsiung, 1997). In Hong Kong, the authority adapts the analysis results of a building's heat gain out of OTTV as the basis for estimating the air conditioning cooling load and for improvement, in view of the steady increase of electricity use by air conditioning year by year. (Joseph et al., 2005)

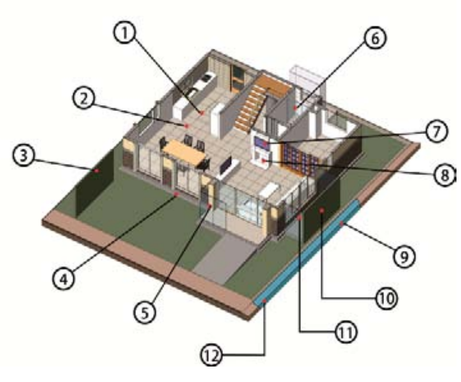
ENVLOAD allows for taking into consideration the intrinsic factor of heat generating objects and thus using different calculation patterns to specific locations, and also the overall heat of heat elements; Compared to the differences between OTTV and ENLOAD, OTTV takes into consideration the overall heat of the building envelope, Chou, Chang-Hsien et al (2013) adapts an approach of changing the building envelope structure, window glass material and opening sizes as proper combinations, so as to conduct a comparison of the OTTV heat gains for the purpose of improving the indoor heat gain, saving construction cost, and eventually achieving the goals of energy saving and carbon reduction.

4. ANALYSIS OF MATERIALS AND METHODS

4.1 Basic Information on the AGS1 Experimental House

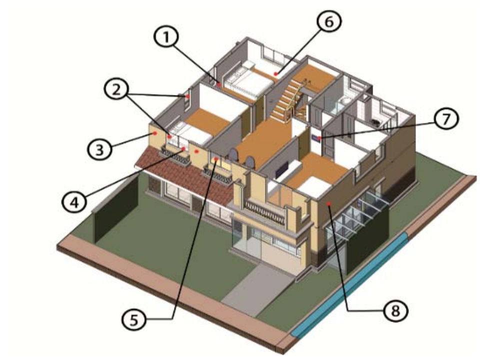
The AGS1 stands for one of the typical 3-story detached townhouses in the "Tu-Shih Green Home Community" developed by the AG Housing group, located in Aspire Park, Lung tan District, Taoyuan City, in northern Taiwan, where the community land area is about 3000 m², the site area of the experimental houses 232 m², and the area of all the buildings 256 m² (Figure 4-1)

Figure 4-1. Layout for Tu-Shih Green Home Community and the AGS1 Experimental House



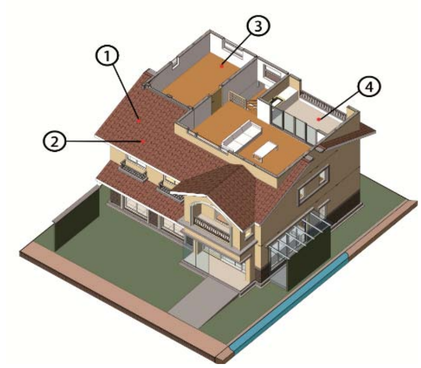
① Raised storage design
② Water proofing floor
③ Green wall design
④ Ventilation holes
⑤ Wind proofing glass
⑥ Bathroom weather/ moisture proofing design
⑦ Air quality monitor
⑧ Damper and geothermal air conditioning/ Moisture proofing design
⑨ Sewage/storm water management
⑩ 3D Green wall
⑪ Intermediary gas space design
⑫ Micro climate pond

Ground floor Design: Mainly the foundation structure and geothermal air conditioning system, plus the optimal use of space under the floor surface; outdoors are green walls, intermediary gas space, and emergency or auxiliary attachments



① Geothermal air conditioning system
② Each room with small and large ventilation windows
③ Convection ventilation design
④ Airtight windows
⑤ Window with thermal insulation
⑥ Toxic free interior finishing
⑦ Air quality monitor
⑧ Wall exterior, frost proof

2nd Floor Design: Toxic free interior finishing, air quality monitor, window with thermal insulation, energy conservation window, convert ventilation, plus wall thermal insulation



① Ultra thermal proof roofing
② Disaster proof tiles
③ Year-round moisture proof storage
④ Balcony facing south for washing and drying clothes without being affected by the cold wet NE monsoon

3rd Floor Design: Roof with thermal insulation, moisture proof room, balcony, water tank shelter, and dry preparation roof

This study conducts calculation and analysis on data of the AGS1 experimental house and makes inferences in the aspects of the carbon emission and envelope thermal transfer value taking those of conventional reinforced concrete structure as contrast group. Firstly this study establishes the basic data on the AGS1 experimental house related analysis items and methods such as ca lculating carbon emissions of reinforced concrete structure and composite structure, calculating the thermal transmittance value Ui of building envelope and windows, and then creates the simulations on the possible combination of heat proofing for the envelope and window opening.

4.2 Calculation of the Thermal Transmittance of the Building Envelope and Window

This calculation targets the thermal transmittance of the building envelope and windows basically in accordance with the related methods for envelope thermal insulation calculation provided in the Green Building Design Technical Standards by the Construction and Planning Agency, Ministry of the Interior (CPA, MOI, 2O12). The calculation on the thermal conduction in the building envelope and window is conducted on the basis of the structure's materials and combination used; the calculation for the reinforced concrete building structure is made to the conventional methods for general buildings, while the calculation for the AGS1 experimental house structure is conducted from the related data and other data provided by the developers and those listed by green building technical standards.

4.3 Assessment of Heat Gain for Combination of Building Envelope and Window Opening

In respect of assessing the heat gain of the combination of building envelope and window openings, the assessment falls into two methods, one taking the influence of the window change to heat gain into consideration, and the other taking the said influence along with the thermal radiation.

4.4 Influence of Thermal Transmittance and Thermal Radiation on Various Combinations of Building Envelope and Window Opening

In view of the fact a window is prone to influence to heat gain of outdoor environment accounted by the sun thermal radiation, this study tries to establish the heat gain by comparing the increase values to the Ui of window. The calculation of building envelope's thermal transmittance Ui, observes the data provided in the Green Building Design Standards (Taiwan Architects Association, 2012), while the heat gain at window opening is mainly resulted from the heat provided by the sun thermal radiation in addition to the heat from window's thermal transmittance; to the research by Chou, Chang-Hsien et al (2013), utilizes an estimated calculation of the Overall Thermal Transfer

Value (OTTV). The heat at the window opening resulting from the sun's radiation based on the climate data of the northern region of Taiwan during the period from 1980 to 2010 is estimated, and the building in question in this study was assessed during the air conditioning season between May and October, the OTTV results obtained from the calculation show the ratio between the total value of thermal transmittance and main heat transfer amount, and with these results in mind, we can figure out the comparative ratios respectively from the wall, envelope (Qw), window openings (Qg), and windows subject to the sun's radiation (Qs) between the reinforced concrete building structure and the composite building structure.

By comparing the Qw, Qg, Qs values calculated based on the OTTV, the average ratio of Qw:Qg:Qs of the reinforced concrete building structure was 19:1:3, while in contrast that of the composite building structure was 16:1:3. On the basis of the research results it is found that the envelope material is the key influence on the thermal transfer amount, where Qs is three (3) times that of Q. In other words, the average heat gain at a window equals three (3) times the heat gain from thermal transmittance. In this study, the Ui value, i.e. the Window's Thermal Transmittance, was raised four (4) times for taking a comprehensive view of the influence of thermal transmittance and thermal radiation on the heat gain of a building.

Group 1, with actual Ui, the heat gain change found at 1 hour interval

Group 2, with Ui raised to 4 time value, the heat gain change found at 1 hour interval

Based on the data analysis, this study expects a satisfactory comparison of importance between reinforced concrete building structure and the composite building structure of the AGS1 experimental house, furthermore, also the conditions of heat gain changes in relation to the window opening with different treatments under the parameter of raised heat gain influenced by thermal radiation.

5. CALCULATION AND ANALYSIS

5.1 Calculation of the Weight and Carbon Emission in a Reinforced Concrete Structure and the AGS1 Experimental House Structure

The AGS1 Experimental House Structure in question has a weight of only one third of the composite structure (196.89 t /622.51 t) (Figure 5-1) of that of conventional reinforced concrete structure due to firstly exclusion of the raft foundation which massively uses bars, cement and gravel, secondly using structural steel system as main framework, and thirdly using 3D lightweight wall as well as lightweight aggregate concrete.

The AGS1 Composite structure comes with structural steel, 3D lightweight wall and lightweight aggregate concrete as its main components; when excluding the 40 years daily use, the total carbon emission of reinforce concrete structure reads 93.58t while that of composite structure reads 53.51t, the latter sees carbon emission reduction of 43% compared to that of reinforced concrete structure. When including the 40 years daily use, the total carbon emission of reinforce concrete structure reads 374.31t while that of composite structure reads 259.37t, the latter sees a carbon emission reduction of 30.7% compared to that of a reinforced concrete structure

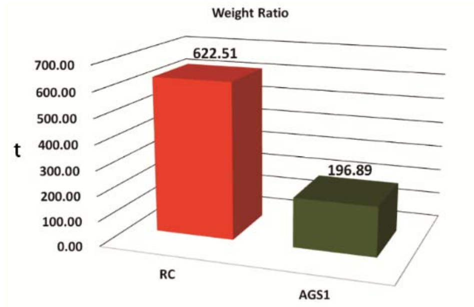


Figure 5-1. Weight comparison – the AGS1 Composite vs. RC structures

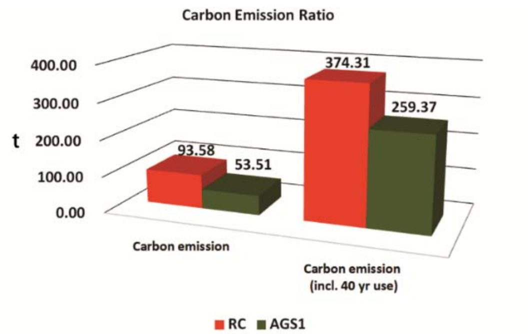


Figure 5-2. Comparison in Carbon emission –the AGS1 Composite vs. RC structures

5.2 Calculation of the Building Envelope Thermal Transfer Rate in a Reinforced Concrete Structure and the AGS1 Experimental House Structure

Figure 5-3 shows the thermal transfer rate Ui of each element in the components of the building envelope and windows in the reinforced concrete structure and that in the AGS1 experimental house's composite structure; the Ui readings of both the roof and wall of the AGS1 experimental house's composite structure proved lower than the Ui readings found in those of reinforced concrete structure; in terms of Ui, the reading of the wall in reinforced concrete structure is 8.75 times higher than the readings of the wall in the AGS1 experiment house's composite structure. Figure 5-3 shows the data of structure in question and Ui reading of each component, where the ratio of between the composite structure and the reinforced concrete found in the walls is approximately 11.4% (0.4/3.5) while the ration in the roof is approximately 37.5% (0.36/0.96).

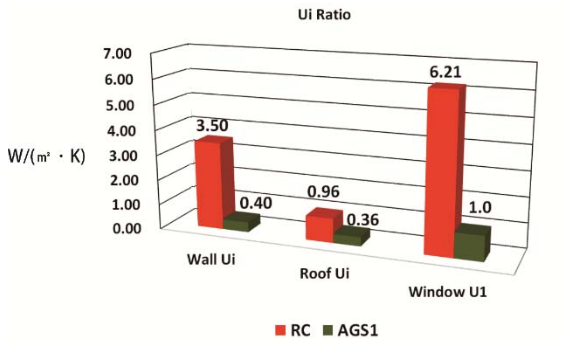


Figure 5-3 Ui Ratio of Each Element between the AGS1 Structure and the RC Structure

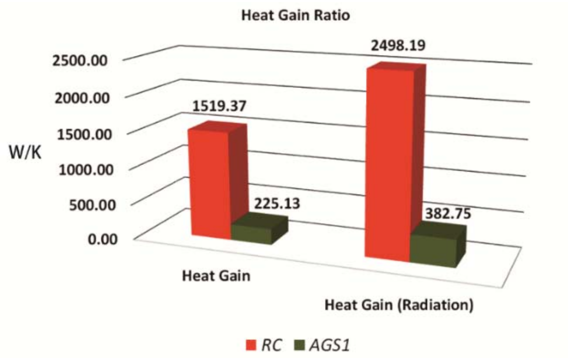


Figure 5-4. Heat Gain in the AGS1 Structure and RC Structure

5.3 Assessment Results of Heat Gain in the Combination of Building Envelope and Window Openings

The AGS1 Experimental house comes with floor of 230.8200 m², pitched roof area of 140.74m², wall area of 302.52m², partition area of 118.45m², and opening area of 52.5400 m²

1. Influence of Thermal Conduction to Heat Gain of Each Combination of Building Envelope and Window Opening

These are the heat gain facts to specific window opening ratio in the wall of the AGS1 experimental house, in the case of reinforced concrete structure with a thermal insulation roof and of the experimental house composite structure with the same. Compared to the ratio found in average window opening in reinforced concrete wall, the heat gain of the AGS1 experimental house after the envelope thermal insulation and window opening thermal insulation is only 14.8% (Figure 5-4)

2. Influence of Thermal Conduction and Thermal Radiation to the Heat Gain of Each Combination of Building Envelope and Window Opening

In view of that during the air conditioning season from May to October the average daily thermal radiation at the window location is taken into consideration only when the reading reaches three times of heat gain reading contributed by thermal conduction, this study straight expands the window thermal transfer rate Ui to four times for taking an overall consideration over the fluency of thermal conduction and thermal radiation to the heat gain of the building structure. The result found in the reinforced concrete building structure with a thermal insulated roof reads 2498.19 W/K, while the resulting heat gain in the PS panel in the AGS1 experimental house composite structure is 382.75 W/K，only 15.32 % that of the conventional roof and conventional window of the reinforced concrete building structure (Figure 5-4)

6. CONCLUSION AND SUGGESTIONS

6.1 Conclusion

1. Through the literature review, this study first examined the regional climate characteristics of Taiwan, before discussing Taiwan's green buildings and the applications of green materials, elaborates the development model using green environment, green structure, green materials, green life, green decoration and furnishing under the "Simplified" concept; further this study infers the proper models of green buildings environment for Taiwan regional characteristics, including the "correct combination of indoor temperature and humidity, reducing heat gain from the building envelope structure and windows, reducing unnecessary interior decoration, and selecting building envelope materials with high moisture resistance, a proper mechanism of air exchange in the intermediary space and also a proper air conditioning model."
2. This report presents the "Design Model for the AGS1 Simplified Green Buildings for Detached House in the plains of western in Taiwan" Argument on E nergy Saving Windows, "Construction of

AG Innovative Green Structure" and "the AGS1 Experimental House" exclusively developed by AG Housing Group.

3. This study assesses and estimates the following by using the Emission Coefficient Method: the carbon footprint and overall carbon emission at each stage of the ASG1 building in question, and the composite building structure compared to a reinforced concreate building, the results which indicate a reduction of 30.7% and 43% respectively under the condition of with or without daily use/occupancy for 40 years.
4. The AGS1 Experimental House shows ratios between the Thermal Transmittance (Ui) of various structural elements and that (Ui) of a reinforced concrete buildings as follows: the wall reads about 11.4% and the roof about 37.5%. In the heat gain estimated by using Ui, the AGS1 experimental house show a heat gain predominantly higher than that of reinforced concrete buildings with common windows. In estimating influence of Thermal Transmittance and Thermal Radiation to heat gains of various combinations of building envelope and window opening by using OTTV on the basis of the heat gain results from the study on the AGS1 Experimental House, it is found when taking only thermal conduction into consideration, the AGS1 experimental house, coming with composite structure plus PS panels, shows a Ui reads only about 14.8% of that of reinforced concrete buildings with common windows; and when taking both thermal conduction and thermal radiation into consideration, the influence is higher, the former (the AGS1) shows a Ui of only about 15.32% of the latter.

6.2 Suggestions for Future Research

For the development of environment supporting green buildings under Taiwan's various regional climate characteristics, it takes a more practical approach on tasks ranging from defining and establishing the scope of room comfort (the temperature - humidity combinations for comfort under high humidity) to gaining indoor energy consumption data of the room with windows closed under the various building conditions and various living styles of an average household over a whole year (influence of humidity on air conditioning energy consumption). Then it takes effort to compile the related regulations and technical standards helpful to the building development planning, building designs, and construction practices under the local autonomy law, or to present better instructions for the design of typical residential buildings in Taiwan, so as to present residence building design guidelines that promote a green lifestyle, comfort and health.

The follows highlight the several issues wanting further research:

1. The influence of felt air temperature difference and humidity control on the energy conservation of air conditioning system,
2. Concept of geothermal applications or the air exchange in intermediary space,
3. Concept of reverse cycle air conditioning,
4. Characteristics of room heat gain under high humidity

It is the practical information and knowledge acquired from the development model of Simplified Green Buildings that demands more participation and implementation by the staff from different agencies, and the research focus can be extended from the current residential building construction engineering to that of other functional buildings and their environments. Furthermore, it is advisable to promote future research on the performance tests and verifications on the AGS1 Experimental House and the related short thesis papers, as they will facilitate the positive development of the green buildings sector in Taiwan.

The follows highlight the several issues wanting further research:

1. Influence of applications of bedroom air intake or exhaust holes and vents to the indoor air quality
2. Study on t he changes in the indoor temperature, humidity and lighting use after the thermal insulation process in the bedroom window opening.
3. Development and tests on geothermal air conditioning assembly.
4. Research on the design of dehumidified residential storage space and its energy consumption.
5. Research on the design of the residential moisture-proof cabinets and benefit assessment.
6. Research on the design of the residential intermediary space and its related energy consumption.
7. Research on the design of residential bathroom with cold radiation influence reduction design and the related performance.
8. Research on the Energy Consumption Visible Design of the AGS1 Experimental House and the benefit assessment.
9. Research on the Guided Tour Design of the AGS1 Simplified Green Building Development Model and the benefit assessment.
10. Exploring the influence of humidity on r esidential indoor comfort and energy conservation efficiency by using software for analyzing the Energy Plus Building Overall Energy Consumption (or Ecotect Computer Aided Building Thermal Environment Analysis) - in the case of the AGS1 Experimental House with combinations of Multiple Structures and Window Openings.

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Visualization tool of urban structure using statistical data

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Key words: Urban structure, visualization, Google Earth, grid square statistics

Abstract: In Japan which reached population decline society, a compact city policy is promoted. On the other hand, citizen participation in urban planning has also been promoted. Compact city policy, is one of the policy to control the urban structure of urban areas with the aim of building a sustainable urban structure.

Citizen's understanding about the current state of the urban structure and its problem is indispensable to promote citizen participation in this policy. However, there was not much effective means to tell the present conditions and a problem of the urban structure to a citizen until now.

The authors tried to create a "visualization of urban structure tool” for a better understanding of citizens about the urban structure. The tool is one that utilizes Google Earth with existing grid square statistics. Because this tool can overlay statistics data on the aerial photograph by using Google Earth, a citizen is easy to grasp urban structure.

In addition, we had some citizen use this tool experimentally and analyzed their reaction. As a result, we found a change of the citizen’s consciousness for the urban structure.

We hope that this tool propels the citizen participation in compact city policy strongly

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