Planning Learning for Stakeholders to Consider Residential Environment Improvement in Densely Built-up Area Using 3DVIR - A case study for sustainable community project

Zhenjiang Shen[1], Zhenhan Lei[1], Kentichi Sugihara[2], Yasuha Mizukami[1], Sayaka Yamamoto[1] and Yan Ma[1]

[1] School of EnvironmentalDesign, Kanazawa University, Japan
[2] Gifukeizai University, Oogaki City, Japan
email corresponding author

Abstract

In Japan, planning special measures are necessary for residential environmental improvement in the Densely Built-up Areas. In this paper, we are aiming to introduce the "special measures" through virtual reality in order that residents can acquire a reasonable knowledge to consider how to cooperate with their neighbours for their sustainable community development. Virtual reality technology is applicable to visualize the complicated planning measures in densely built-up area in order to support public participation. For visualizing the planning alternatives, a learning support tool using 3DVIR is suggested in this work for enhancing the stakeholders' understanding of the planning measures for cooperative rebuilding and continuing living in the community of a densely built-up area. A case study has been conducted in the Teramachi Area of Kanazawa city.

1. Introduction

On the basis of recent planning practice in Japan, the concern with pursuing more sustainable community development (Matsudukuri in Japanese) has been rising largely. Meanwhile, decentralization of planning power has been implemented from central government to local planning authority. Design guidelines related to special provisions on Building Standards Act can be decided based on consensus between local government and local residents for their own requirements, and public participation became an important process for compiling a local plan for residential environment improvement project. Visualization of the design guidelines is taken as an effective tool for gaining consensus between stakeholders.

There are numbers of existing research on the design guideline using Virtual reality (VR) system for sustainable community development, which are related to Densely Built-up Areas. Tunegawa et al. (2006) used virtual reality technology, constructed a design support system of public participation in order to build the consensus about design guideline in urban district. Takiguchi et al (2013) developed an online communication tool using multimedia, which can be utilized to exchange ideas between stakeholders. Sato et al (2005) took Oita Station as case study area, and a VR system was developed for residents to use a VR system to experience the virtual district based on different planning alternatives. Kishimoto et al (2010) developed an e-learning tool for residents to study the traditional building style of Kanazawa City in order to gain consensus on design rules regarding townscape design.

In this work, we aim to visualize the planning regulations that can be adopted for improving the residential environment in a densely built-up area in order that the community can be survived through loosening the current standards embedded in Building Standards Act of Japan. For this, an e-learning tool using 3DVIA (http://www.3dvia.com/) is developed to support residents for their studying the complicated planning regulations. 3DVIA is a multiuser VR system and users can share their digital assets through the Internet at anytime and from anywhere. In our tool, the planning schemes are presented based on different types of planning regulations in order that residents can use mobile devices or desktop computers to access planning project area for experiencing the planning schemes and study the regulations. The case study area is one urban block, selected from Teramati Area, Kanazawa City.

2. Research approach

In this work, Special Design Code for Plural Buildings (hereafter, SDCPB) in Article 86(2) of Building Standards Act can be applied for re-building in the densely built-up area. However, the description of SDCPB is difficult for stakeholders to understand only through the law text. Thus, we are planning to develop a visualization tool for visualizing the content of the law test in order that the stakeholders can learn the knowledge of law using the tool.

Firstly, we investigated how SDCPB can be applied in the case of densely built-up area and suggest how to develop the visualization tool. In general, Article 86(2) of Building Standards Act is designated for plural buildings in one united parcel of land in urban area. In the case of small parcels in densely built-up area where most of building parcels is smaller than 100 m^2, rebuilding activities actually become very difficult to keep enough living floor area respectively on each building parcel after rebuilding due to planning regulation defined in Building Standards Act. For re-building in small parcels, SDCPB is possible to be a planning solution. According to the description of SDCPB, contiguous parcels can be looked as one parcel of land. Thus, if residents gain consensus on sharing small contiguous parcels as one parcel, Article 86(2) of Building Standards Act can be available for the plural buildings within the boundary of the untied parcel. It is possible to implement the planning regulations regarding oblique line from front road and neighbour lots among the edge of the united parcel. Consequently, oblique line from front road and neighbour lots will not implemented for the rebuilding of the buildings within the united parcel. Meanwhile, the local government should review on sanitation, fire prevention and structure safety of buildings after rebuilding.

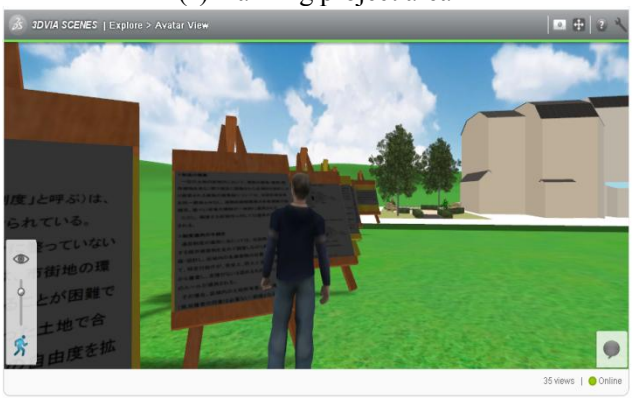
A case study area has been selected for visualizing the law text of SDCPB in our work, where is Teramachi, Kanazawa City in Ishikawa prefecture. According to Article 86(2), a local design guideline should be gained consensus on detailed planning requirements regarding the united parcel among the stakeholders, which refer to Building Standards Act and some relative local ordinances. The visualization tool is developed for stakeholders to learn the local design guideline and review the townscape after the implementation of design guideline.

Secondly, for preparing the digital dataset of the case study area, we measured each of the existed building on case study area and created 3D dataset of each building using Google SketchUp. The biggest numbers of building coverage area, total floor area are calculated based on the local design guideline. For stakeholders' learning, we create the 3D dataset for

representing current townscape without any change in order to find out the unqualified parts of building based on the planning regulations of Building Standards Act. On the basis of the above dataset, we prepared three types of digital assets for possible planning solutions based on the options designated in the local design guideline. The first planning alternative is based on regular planning regulations of Building Standards Act without implementation of Article 86(2), namely SDCPB; the second alternative is based on SDCPB without planning a public space, defined as planning measures No.1. The last alternative is based on SDCPB with a public space, defined as planning measures No.2 in this paper.

Finally, we use 3DVIA to open the digital asset of the case study area for users to share through the Internet. Stakeholders can walk through the virtual world and communicate with other users. For investigating the effective of this tool, we conducted a student experiment in Kanazawa University and analyse the results from respondents to our questionnaire.

(1) Planning project area



(2) 3D digital assets for representing the planning issues

Fig. 1. planning project area

3. Field work and digital asset

3.1. The case study area - Teramachi

As the historical urban district, Teramati Area, Kanazawa City is a historical preservation area. In this work, a planning solution should be suggested to solve the problems for getting compatibility of preserving historical townscape and improving fire-prevention condition in this historical and densely urban area, which should be possible for residents to rebuild their houses and improve residential environment. For and support residents to learn the planning measures, the visualization tool is developed.

The Teramachi area is planned as a quasi-fire-prevention area, where the current roads are narrow with a zigzag pattern. The narrow road network may have an important effect on evacuation route during fire and earthquake. In the Teramachi area, there are large numbers of building parcels which have narrow front roads, and there are also many small building parcels. Moreover, traditional buildings cover most of the district and historical preservation should be considered as one important part of possible planning measures. The case study area of this district is shown as Figure.1(1), where is a low-rise exclusive residential district. The current planning issues are prepared as many digital panels as shown Figure.1(2).

If regular planning regulations defined in Building Standards Act are applied, rebuilding of buildings in the area (Figure.1(1)) will be impossible due to the oblique line of front road and neighbour lots. In this work, our aim is not to find out the planning solution but to visualize the solution for stakeholders. Usually, SDCPB can be implemented to this area. As a solution for this situation, implementing the special design code can make rebuilding possible. In order to visualize the problems of the rebuilding in this area, we conducted a field survey and found that there are no significant differences of size of building parcels and floor areas between the buildings in the area. Because of the narrow road at the front of most house buildings, the total floor area of each building will be restricted by the planning regulation of oblique line. In addition, most of house buildings are considered as unqualified according to articles defined in Building Standards Act except only one house building is qualified. Therefore the rebuilding for improving residential environment is quite difficult.

3.2. Field survey and digital asset of buildings

In this work, we firstly try to present the planning issues in the case study area using VR dataset based on regular planning regulations in Building Standards Act. For this, we measured the sizes of all current house buildings, road width and boundaries of building parcels. We also measured the necessary setback area and distance from front road. All the information measured in filed survey is necessary for 3D digitizing. More over, after we accomplished creating the digital asset of buildings, we imported the map of the study area to SketchUp from Google Earth, and allocated all buildings based on the map in SketchUp. Next, we edited the building forms based on the regular planning regulations, which including limitations of oblique lines, floor area ration and building coverage ratios. We created the building VR data based on the four meters setback from front roads for building line. Meanwhile, for in order to show the height restriction, the oblique lines from front road, neighbour parcel & north orientation, the buildable spaces of each building parcel are created to express the possibility of rebuilding. The text of all those planning regulations are edited as panels in the digital building dataset as explanations for rebuilding based on Building Standards Act.

Secondly, we created the digital dataset of buildings after rebuilding when SDCPB is applied for the study area. We defined this design scheme as planning measure 1. For this, we calculate the maximum floor area and building coverage under the conditions when SDCPB is carried on each parcel. Based on the special design code of plural building in the united parcel, all building lots can be connected as one united parcel, the planning regulations regarding oblique lines of front road and neighbour lots on each building lot are not necessary to be implemented respectively. Thus, the planning regulations on buildings within the united parcel can be loosened and more floor area and building coverage can be available for rebuilding.

In addition, as SDCPB implemented in the study area, in order to ensure the open space for disaster prevention, we defined planning measure 2 as the following. In the planning measure 2, we move the building parcels in the united parcel in order to make a bigger open space from the vacant use. Even though it is difficult for gaining consensus in planning practice and it will take a long time to organize rebuilding behaviours in the united parcel; the planning measure 2 must be a good planning suggestion in order to improve residential environment because there will be an open place for stakeholders to share in their daily life.

4. Digital asset opened up in 3DVIA

We created a digital asset for representing the current situation of the study area and open up it on the 3DVIA site through the Internet as shown in Figure 2 in order to support the stakeholders to learn the special design code of SDCPB. 3DVIA is one type of the VR technologies and 3DVIA site is free for users to share digital assets. Stakeholders must register an account for their uses before accessing the digital asset of the study area, which is simple in operation and every user can use the 3D spare after logged on. 3DVIA is a platform for multi-user virtual reality environment and can be used for communication using chat system for learning the planning measures between planners and stakeholders. On the other hand, 3DVIA has the function of editing descriptions and comments for each 3D asset and shared virtual scenes. Before stakeholders start to share the scenes for experiencing the entire design scheme based on different planning measures, an e-book can be generated using the spotlight function of 3DVIA for stakeholders to walk through the entire design and gain necessary knowledge of planning regarding each asset (3D parts of the entire digital assets). In this paper, we will focus on the 3D digital assets and the function of the e-book will not be further discussed.

About application of 3DVIA in our work, we prepare four kinds of digital dataset as follows:1) Scene of unqualified parts of current buildings; 2) Rebuilt scene based on regular planning regulation; 3) Rebuilt scene based on planning measure 1(without open space); 4) Rebuilt scene based on planning measure 2 (with open space).

Fig. 2. Current situation in the planning area

Fig. 3. Scene of unqualified parts of current buildings.

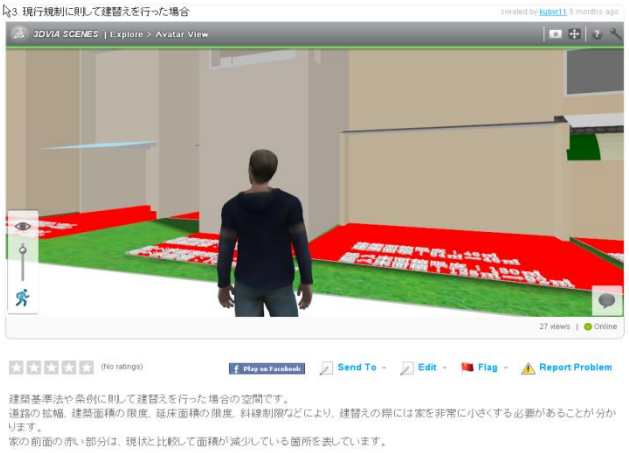
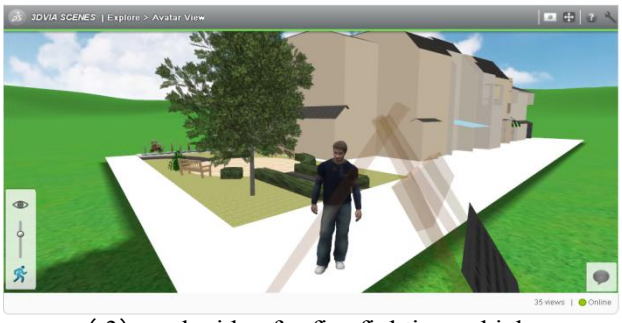


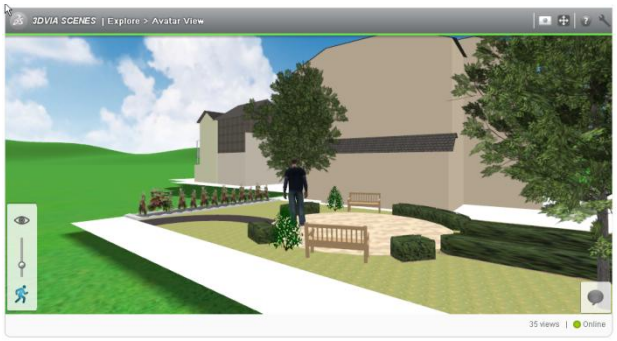
Fig. 4. No enough space problem for rebuilding based on current Building Standards Act

（1）the entire urban block

（2）Solutions for dead-end alley and yard



（3）road widen for fire-fighting vehicle



（4）public space

Fig. 5. Rebuilt scene based on planning measure 1(without new open space)

Fig. 6. Rebuilt scene based on planning measure 2(with one more new open space).

In order to confirm the existing unqualified parts of building as shown in Figure 3, we built a yellow box to express the qualified space for re-building in the study area based on regular planning regulations. The part that protruded from the box can be recognized as unqualified parts of buildings. As for the planning regulation for generating the box, building coverage ratio, floor-area ratio, height limit, the oblique line of front road, neighbour parcels and north orientation are considered according to the Building Standards Act. The regulation based on height limit and the oblique lines are shown in Figure 3. Besides, there are obligations of connecting road, maximum numbers of building coverage ratio and floor-area ratio should be considered that are marked as red colour in Figure 4. For the numbers that are difficult to show in building form, we use explanatory note in the red parts to show how much spare should be cut from the origi-

nal building form. For example, we showed the numbers of floor-area ratio on the roof of the house buildings.

Moreover, we adopt planning measures 1 and 2, in which the blind alley is removed and two-way evacuation route is added. There are two scenes prepared for planning measure 1 and 2 respectively. The rebuilt scene based on planning measure 1, for which we do not move the building lots for generating new open space, but there is a street park originally as shown in Figure 5.

The rebuilt scene based on planning measure 2, in which we moved house building lots and a new open space was considered to centrally locate in the area as shown in Figure 6. Moreover, we also edited some digital asset as signboards to explain the regulations which are necessary to understand in the visual senses..

5. Valid confirmation of survey and system

In our research, we conducted a questionnaire to confirm the effectiveness of the learning tool and find out the disadvantages of this tool. The respondents of our questionnaires are the students who have basic knowledge or have not knowledge about urban planning. We sent questionnaires to each student by E-mail and students answer the questionnaire through a website after they used the learning tool.

The content of the questionnaire are divided roughly into 4 parts: time required for operation; knowledge about urban planning and design; the degree of understanding after using the system; effectiveness of the learning tool.

Respondents spent average 30 minus on using the learning tool. The shortest is 10 minus while the longest is 80 minus. We conjectured that it is because of different degree of knowledge about urban planning and design. Regarding the knowledge about land use zoning, building coverage ratio, floor-area ratio, height limit, oblique lines of respondents before using this tool, we found out that the degree of knowledge have an important effect on learning time. One-third of the respondents spent more time on using the tool than average time. Regarding the question “I know nothing about building coverage ratio, floor-area ratio, total floor area, height limit and oblique lines”, all of the one-third students answered “I know nothing about it” or “I have only heard about it” in stead of “I knew it very well” and “I generally know about it.” On the other hand, two-third of the respondents spent less time on learning tool than average time, none of them answered “I know nothing about it”. Because people who have no

knowledge about urban planning and spent more time than others who have knowledge, it is necessary to improve and simplify the learning tool.

As is shown in Table 1, as for the question “Have you understood the differences between planning measures?”, the respondents who checked “agree” account for 78%. As for the question “Do you think this tool is useful for you to understand the knowledge about the planning regulations, such as building coverage ratio, floor area ratio and oblique lines??”, only 44% of respondents are agree with that the tool is useful for learning the knowledge of urban planning. For developing the learning tool, the knowledge of land use zoning, building coverage ratio, floor area ratio, height limit and oblique lines are only explained in the panels, less than half of the respondents considered it useful. Thus, only panels are difficult for stakeholders to understand the knowledge of planning regulations and it is necessary to improve the function of learning tool regarding planning regulations. There are some comments from respondents, such as like: “the words on signboards are small”, “the word uploaded on 3DVIA couldn’t be normally seen from the front” and so on. Account for 70% of the respondents commented that “I haven't been able to do it” as the answer for question “Could you understand the relation between the instructions on signboards and the relative3D dataset?”. There are also some comments showed that they don’t know why these signboards are necessary.

As for how to use function of 3DVIA, we explained the usage of operation to respondents in advance. To the question about the manual operation of using 3DVIA, nearly 70% of the respondents chose “difficult to use”. Some participants also commented as "I have no idea about how to use 3DVIA", "it is better to prepare a simple operation manuals " and "it takes time to adapt to use it".

Table 1. Understanding the differences between planning measures.

	Have you understood the differences between planning measures?			
	Strongly agree	agree	disagree	Strongly disagree
percentages of respondents	0	78%	11%	11%

Table 2. About the learning knowledge of urban planning.

	Do you think this tool is useful for you to understand the knowledge about the planning regulations, such as building coverage ratio, floor area ratio and oblique lines?			
	Strongly agree	agree	disagree	Strongly disagree
percentages of respondents	11%	33%	56%	0%

Table 3. About preference streetscape

	Which is the best streetscape for this area?			
	Current situation	Rebuild based on regular Building Standards Act	Planning measure 1	Planning measure 2
percentages of respondents	11%	22%	22%	44%

Finally, regarding the question "which is the best streetscape for this area?", various opinions can be detected in Figure 3. Generally speaking, most of the respondents chose the planning measure 2 that is the best plan prepared by authors. Obviously the solution of residential environment improvement by planning measure 2 is accepted by the respondents through using the learning tool.

Moreover, the learning tool can be used to visualize the planning schemes that got a high evaluation from the respondents. We have many positive comments from respondents, such as "3D model can help us to image the entire streetscape very well", "I think it is a novel method that we can walk through the streets as our preference", "It is convenient that we can see the street from different angles", "Because of representation using 3D, it is visually attractive", etc. Besides, to the question "can you image each of the planning regulations visually by using the learning tool ?", nearly 9 of 10 respondents answered "basically it is possible to do so". Therefore, we can draw a conclusion that it is helpful for respondents to understand the planning scheme through using the learning tool on the Internet.

6. Conclusion

In this paper, we took Teramati Area, Kanazawa City as a case study area in order to promote rebuilding activities through visualizing the special design code in densely built-up area. For this, we present a learning tool which can help residents to learn the planning regulations and planning measures through sharing VR world. In this work, we used SketchUp to edit the current buildings in 3D forms based on field survey. We also used VR cloud technology, namely 3DVIA in this work to upload the digital asset of the study area, residents can walk through the entire study area and exchange their opinion for design coordination using 3DVIA server.

In order to examine the efficiency of the learning tool, we conducted a questionnaire to the students in Kanazawa University. As a result, the evaluation of vision expression is relatively high. In addition, 90% of the

participants presented positive evaluation on the learning tool for understanding the planning schemes. Therefore, we can draw a conclusion that it is helpful for users to learning planning knowledge through using this tool.

Concerning the difficulty in using 3DVIA, however, the answers from 70% of the participants are "difficult to use" and "relatively difficult to use compared with other products". Some participants also have feelings such as "Do not understand how to use 3DVIA", "It is better to read a simple operation manuals firstly" and "the function of 3DVIA has a number of self-limitations and it still takes time to adapt to it".

Finally, 3DVIA has the function of adding annotation, which is not discussed carefully in this paper. Due to the limitations of VR world, it is difficult to make explanation for planning regulations and special design codes using signboard in the VR world using 3DVIA. Although we made a lot of efforts such as signboards in the VR world, it is possible to use e-book function of 3DVIA to solve this problem in the future and the VR scene is not the best choice to explain the planning regulation respectively.

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