博士論文

LANDSCAPE PLANNING SUPPORT METHODS BASED ON THE DEVELOPMENT PROCESS OF STREETSCAPE IN DEVELOPING COUNTRY

（開発途上国における沿道景観の成立過程を考慮した景観計画立案支援手法）

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1.1 Research Background

The rapid development of commercial industry has influenced the presence and development of the streetscape in Malang City, Indonesia. Commercial buildings become uncontrolled and spread rapidly throughout the entire City. The spreading of commercial buildings does not particularly increase along with the development of new street corridors but also enter into the corridors of the conservation area. On the other hand, the city planning regulation could not act immediately and decisively to anticipate the growth of commercial buildings. The forming of streetscape in the entire City is exclusively dominated by commercial interests and profit-oriented. Due to the lack of the law enforcement system of the preservation of historic buildings, there were many historic buildings that had transformed into a commercial building. In fact, the existence of a historic building is a part of the history of Urban space as well as the generator of the city image, which provide interrelationship a memory of the Malang City between the past and the future. Ultimately, the quality of the streetscape of the city deteriorated significantly, especially in conservation areas.

1.2 Research Purpose

There are two purposes of this study. First, this study aims to identify the characteristics of the evolving streetscape of commercial buildings in Malang City, based on the analysis of physical characteristics and a visual judgment by a building owner in the development of a commercial building streetscape. Second, the study aims to develop the 3D interactive visualization system to support decision-making in order to improve the quality of the Kayutangan streetscape, as one of the historic streetscapes in Malang City. The utilization of the 3D interactive visualization is important to develop a 3D simulation of an urban streetscape that present various alternatives for landscape changes and facilitate interaction between users with 3d models.

1.3 Research Framework

Research framework divided into three groups as follows, a research background, methodology of research, and the development of the system. Firstly, a research background represents the condition of urbanization in Malang City, who experienced the uncontrolled growth of the commerce area, thus resulting in the declining quality of the streetscape. Secondly, research methodology describes methods of investigation, which consisted of field surveys and people preferences, and concludes with the findings. Case study is using one street of a conservation corridor and two streets of new

commercial corridor. While respondents are the owners of a commercial building that comes from three streets. Lastly, the development of the system describes the background of the development of interactive 3D visualization, the method of system development, and the evaluation of the system.

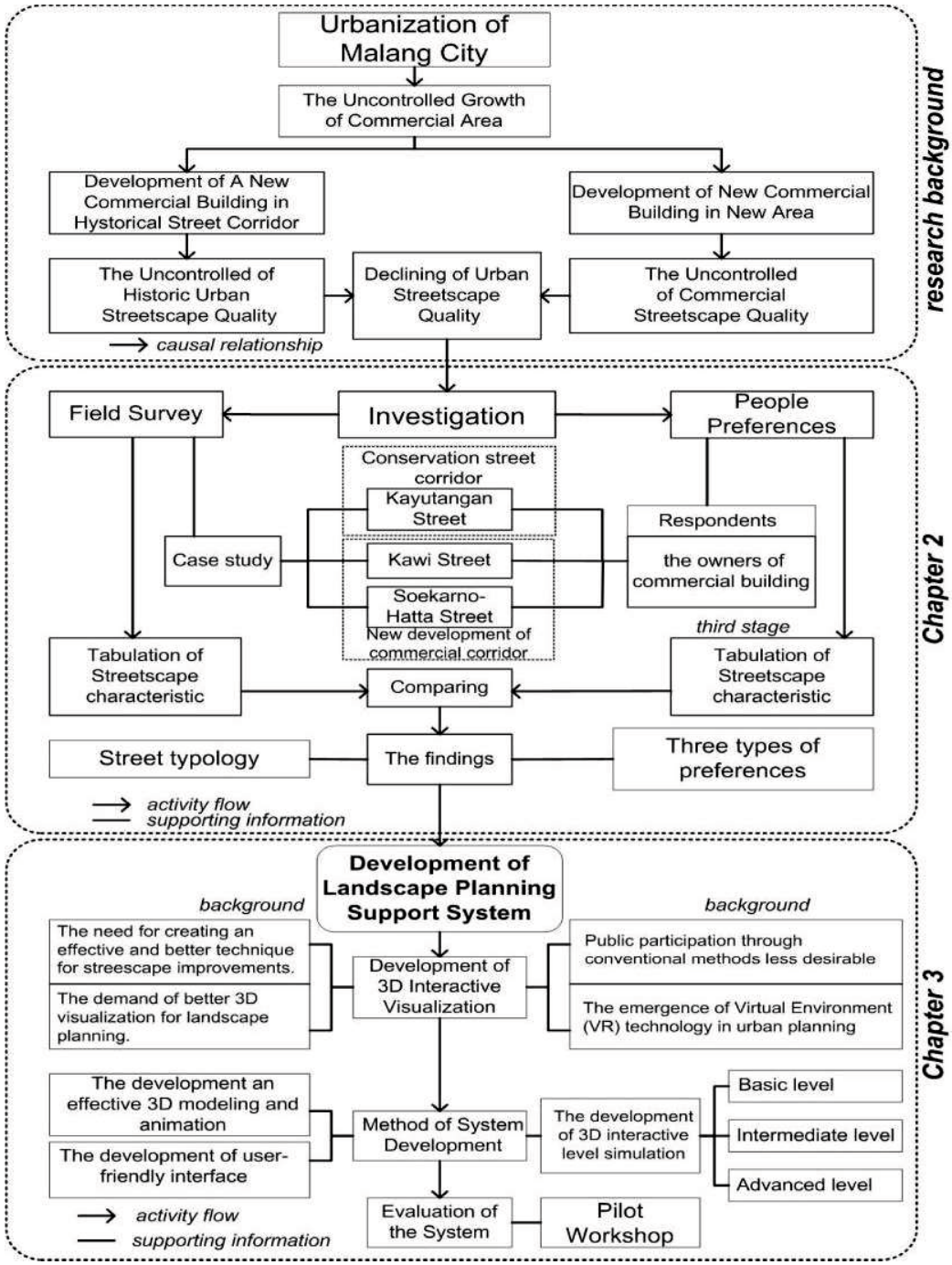

Figure 1-1 Research framework

1.4 General Overview of Malang City[5)]

Malang is located in Java Island and also the second largest city in East Java after Surabaya. Geographically, Malang lies at 112° 06 '- 112° 07' east longitude and 7°06 '- 8°02' south latitude. Malang is the highlands between 429-667 meters above sea level and located approximately 90 km south of Surabaya. Malang is surrounded by mountains which are as follows, Mount Arjuno in the north, Mount Semeru in the east, Mount Kawi and Panderman in the west and Mount Kelud in the south. The total area of Malang is 110.06 km^2 and consists of five districts, namely Kedungkandang (39.89 km^2), Sukun (20.97 km^2), Klojen (8.83 km^2), Blimbing (17.77 km^2) dan Lowokwaru (22.60 km^2).

Figure 1-2 Maps of Indonesia Country and East Java

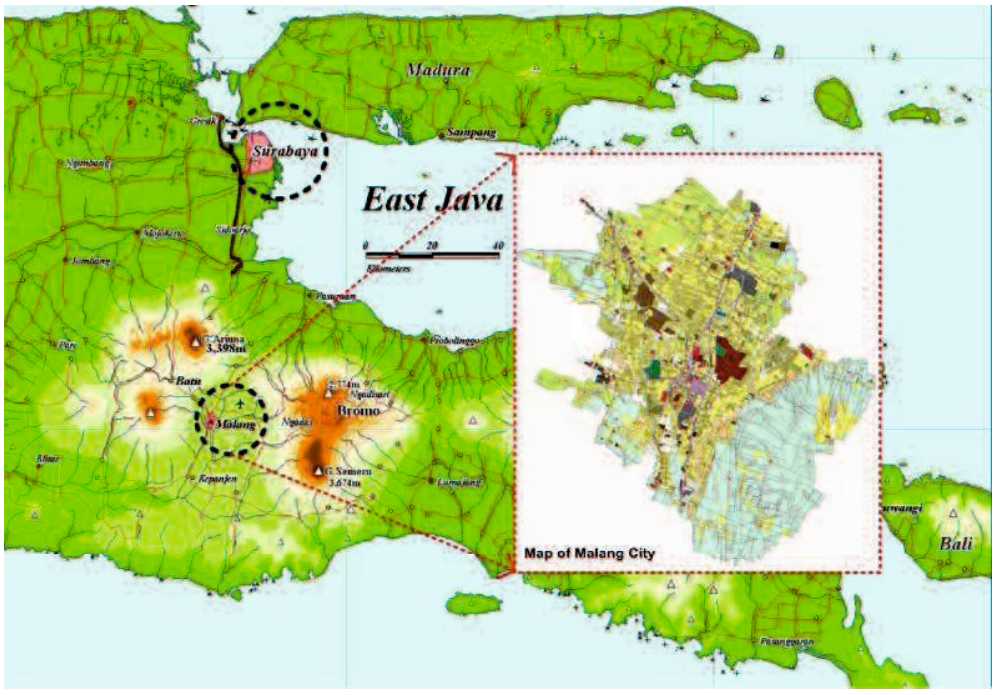

Figure 1-3 Maps of East Java and Malang City

The climatic condition of Malang in 2010 had the average temperature of 23.2°C up to 24.4°C. While the maximum temperature was 29.2°C and the minimum temperature was 19.8°C. The average of humidity was 78%-86%, while the maximum humidity was 99%, and the minimum was 45%. In general, Indonesia region has two seasons, wet and dry season, including Malang City. The relatively high rainfall occurred in every month and the highest of rainfall was occurred in April about 526 mm, in 27 days. The maximum wind speed occurred in October.

According to the result of population census in 2010, the population of Malang was 820,243 people (849,667 people in 2014), consisting of 404,553 males and 415,690 females. The ratio of gender of Malang population was 97.05, which means that every 100 females there are 97-98 males. Based on the census, the average of annual population growth rate within a period of 2000-2010 was 0.86%. Based on the population distribution of five districts, Lowokwaru district has the largest population as much as 186,013 people, while the highest population density located in Klojen district around 11,994 people per km^2.

Most of the population in Malang is the Javanese, and the ethnic minorities are Madura, Arabic, and Chinese. The majority religion is Islam, and the minorities are Protestant, Catholic, Hindu, Buddhist, and Confucian. Malang is also becoming the religious education center for Islamic and Christian indicated by the establishment of many Islamic boarding schools and also the presence of Christian religious education center in the Bible Seminary.

One of the famous traditional arts in Malang is the Puppet Mask of Malangan (Malang Mask). The art style of Malang Mask was the confluence of three cultures, namely Middle Javanese that lived on the slopes of Mount Kawi, Madurese that lived on the slopes of Mount Arjuna, and Tengger that lived on the slopes of Mount Bromo and Semeru.

1.5 Previous Researches

1.5.1 Research about Urban Image

According to Nasar (1998) as cited in Rapoport (1993)[21], it is necessary to take consideration of the prominent features. Every place has many features and consists of three kinds of features, namely fixed features, semi-fixed features, and non-fixed features. The first, fixed features described as permanent features such as building and the street, and these features are slowly changing. The second, non-fixed features described as moving objects, such as people and animals, and these features are constantly changing. The third, semi-fixed features described as changeable elements that can be fixed or changed at any time, such as signs, billboards, plants, and

decorations. In order to make a good city planning, it recommends performing any study that involving a group of people in a particular area, in the process of determining a prominent feature in the built environment. Further, every human has at least two kinds of responses, namely the perceptual-cognitive judgment and the evaluative response. The first, the perceptual-cognitive judgment is a response to the environment-judgments that defined as a human's response to the physical characteristic of the environment. The second, the evaluative response is a judgment of human's feelings to the environment.

1.5.2 Research about the Aesthetic Experience in Urban Space

The assessment of urban space related to human aesthetic experience that inhabit it and associate with the aesthetic processing inside the human body. The aesthetic processing relies on several implicit memory effects and the results of this processing do not have to construct awareness first, in order to affect aesthetic processing[19]. The aesthetic experience is a sense of something that felt directly and immediately, and cannot be created intentionally or by coercion. This experience is not an enjoyment and appreciation that can be suspended at a later time[29]. Moreover, Fenner (2003)[11] also confirmed that the aesthetic experiences as a "raw data" for the research should be analyzed without pre-conception, prejudgment, or limitation. The enormous majority of aesthetic experiences are not concentrated exclusively, in the circumstances of their contents, on formal or simple-sensory matters.

In relation to the fulfillment of the aesthetic sense, the pyramid diagram of Porteous[23] divide the level of human needs into three levels, namely bodily needs, socialization, and self-fulfillment. The fulfillment of aesthetic sense is located at the peak of the pyramid as part of self-fulfillment. Porteous asserts that the fulfillment level of need and interest in the aesthetic sense is heavily influenced by the fulfillment of bodily needs and socialization, which is part of the basic human needs. The fulfillment of aesthetic sense can be achieved when all basic human needs completely fulfilled.

On the other side, Leder (2004)[20] also studied relating to the aesthetic experience and described an information-processing model of the aesthetic experience. Leder stated that there are two evaluation processes of the aesthetic experience, which occurs implicitly in the human body, namely the aesthetic judgment and aesthetic emotion. An aesthetic judgment is an internal process in the human body, which involve human perception. This process occurs on a reciprocal basis between the environments as the object perceived, with humans as the perceiver. The process is called a continuous implicit affective evaluation involving a perceptual analysis, implicit memory, explicit classification, cognitive mastering and evaluation. Implicit process also influenced by

the various aspects related to the memory and classifications. Therefore, an aesthetic preference are simultaneously influenced by the aspect of familiarity. Despite the Leder's model that based on the study of the aesthetic experience of modern art; the amount of processing stages in the model is still able to describe many implicit processes that occur in the human body.

1.5.3 Research about the Visual Evaluation of Urban Streetscape

According to Nasar (1998)[21], the evaluation of urban image is associated with the people and environment. It is extremely diverse and depends on the number of attributes inherent in people, such as biology, personality, sociocultural experience, adaptation levels, goals, expectations, and also internal and external factors. Nasar (1998)[21] also stated that human also possess a feeling and meaning to the environment surrounding and to the imageable element, both negative and positive. The feelings and meanings will construct the evaluative image of the city. Respectively, feelings and meaning are a central part to the perception and reaction of the people to the environment.

Urban images are not identified directly as about a visual because all senses of human perception enter into the formation of the streetscape. Subsequently, the formations are affected by non-experiential factors that increase in scale and it also influenced by age, education, skills, socio-cultural variables, symbolic and associational values of individuals and groups, and diversity in their activity patterns and an extension of the behavioral space[25]. Groups of individuals that have a similar characteristic of culture or socioeconomic will share a common meaning and evaluative images[21]. These behaviors will reinforcement and forming an element of familiarity as part of the aesthetic preferences.

Visual preferences of the urban streetscape depend on the perception of the public to the values that embodied in the formation of the streetscape. The other hands, the creation of an urban environment both physical and non-physical form are an interwoven perception and appreciation inherent in humans. Physical form of the streetscape is the visual appearance that configures the streetscape, such as building, facade, street, and sidewalk. Meanwhile, non-physical form emerged from the social conditions of the urban environment[21].

1.5.4 Research about Conservation of Historic Building on Streetscape

The law of conservation of historic building for Malang City, Indonesia, can be referred to the Indonesian state laws (No. 5/ 1992) that describes the cultural heritage. The government regulation (PP. No.10/ 1993) also describes about the implementation of the Indonesian state laws. According to the regulation, the definition of heritage

objects is defined as a man-made object, movable or immovable, which is a unitary group or parts thereof or their remnants, aged at least 50 years, or represent the style that represent the typical and distinctive style of at least 50 years. Those heritage objects considered have an essential value to the history, science, and culture of Malang City.

The element of architectural style, material, and shape undoubtedly will influence the visual richness of historic building facades images. These visual elements are considered to contribute the enhancement of the historical images in the streetscape. Among all elements, architectural style was considered as the most influential element for the preserving of the historic character and maintaining the visual richness[4]. According to the historical value, the historic buildings have an existential value for people, at three levels, as follows: the presence of the historic buildings will give or enhance place identity, personal identity and group identity. There are several consideration that related to the activities of planning and design of the historic building. First, integration the past into the present and make the environment into one organic, living whole. Second, the building and the surrounding of a historic building should take into account and both are conceived as one integral whole, not as an assemblage of loose pieces. Third, the details and ornaments are much appreciated and give a feeling of richness and abundance. Fourth, a new or improving design must be in the style of the building and also fitting in their context.

1.5.5 Research about the Transitional Space within Streetscape

The transitional space between the streets with the shop front is the boundary between private zones and public zones[6]. The transitional space also serves as a gathering area for the community. In conjunction with a commercial area, space is also a unifying transition between interior and exterior of the store. According to this understanding, it frequently occurs a conflict of interest in the use and utilization of the transition area. The formation characteristic of transitional space fosters various types and territorial scale between private areas and the public sphere, both physical and psychological scale. Although in reality, the boundary between public and private spaces is indisputable, but in fact it still often arise a claim to the use between spaces. The emerging of claim commonly caused by competing claims between public actors and private actors. Public actors acquire private areas and private actors seeking to acquire public areas.

Building frontage or shop front which has a large degree of transparency to the street will provide expansion and territorial psychological outlook. The expansion of this view will be able to reduce the expansion of the public claims. The typical conflict in commercial areas is the case of private actors that claim against the public areas. Thus,

it often happens that the shop as private actors undertake as much as possible, occupied the area in front of the store, thereby disrupting public convenience and flexibility.

Furthermore, Bobić (2004)6) describe the type of transitional space division that based on three aspects, namely territorial, visual and psychological. Within this understanding of transition space between the street and shop front territorial, it is obtained seven typologies of building interfaces, as follows: integrated, overlapped, confronted, associated, inserted, extended, and suspended..

1.5.6 Research about Computer Visualization for Public Participation

The advancement of computer-based visualization techniques is undoubtedly a significant contribution to the evolution of participatory planning and design, and it also an advanced development of the art of designing with the community[2]. Recently, the documents of urban planning had been produced in digital formats and made accessible for public over the internet. The dissemination of public data of urban planning, as well as urban design, is representing the first stage of decentralization and broader inclusion in a participatory process. Furthermore, the internet is undeniably become the best way of sharing urban planning information and the best media for public participation[35].

In accordance with the advancement of computer visualization, there are high expectations of new visualization software tools that increase the effectiveness of communication during planning and encourage the awareness of the benefits of using landscape simulations during the planning and design process. Computer visualization is utilized as a medium for presentation, and also as an integral component of participatory planning and design processes, in the future[22].

The advancement of computer visualization techniques, such as Virtual Environment or Reality, is capable of creating 3D modeling of planning and urban design which can stimulate and arouse interest of public participation[34]. According to Langendorf (1999) as cited in Shen (2010)[28], he stated that the virtual image's persuasive powers build trust more effectively than traditional measures such as documents of planning. In the future, the development of a virtual reality technology and augmented reality technology will be more widespread and useful for landscape visualization (Bishop, 2000 in Paar, 2006)[22]. The development of virtual reality technology is considered very helpful to provide a better understanding of the visualization of landscape planning at the macro and micro scale. Due to the need for public involvement from a variety of backgrounds, visualization in Virtual Environment (VE) is indispensable in helping the various stakeholders to be able to understand a landscape planning and capable of providing a contribution in decision making. Moreover, due to the majority members of the general public are not urban planning professionals, well-designed visualization

and interactive tools can help expand their participation in urban planning processes[35].

Wergles and Muhar (2009)[34] stated that the animations or virtual environments would become a high advancement over static media. The technology of visualizations become superior in communicating some aspects of the design, and it can be successfully employed in design communication that appropriate and matching with the targeted viewers. The advantage of visualizations for the planners is indisputably capable of stimulating a better discussion at the planning stage and assist people to grasp design concepts more quickly.

According to the rapid development of 3D visualization software, Sheppard (2001) as cited in Paar (2006)[22] stated that 3D software programs, such as Discreet 3d max, E-on Software 'Vue' or 3D Nature 'World Construction Set' (WCS), offered a high degree of visual realism of 3D landscape modeling and rendered both as still images or animations. In a recent development, Lumion 3D software is available and easier to perform a rendered image or animation.

According to Al-Kodmany (2001)[3], The use of 3D computer simulation for planning and evaluation activities of urban design can present interactive visualizations that support the evaluation of the public participation process. Moreover, 3D computer simulation capable of handling complex data involving various types of design variables to produce a comprehensive evaluation. In addition, the cost of using simulation technology in public participation activities perceived still affordable and relatively inexpensive when compared to conventional methods.

Considering about the accuracy of making 3D simulation using a graphical software, Leavitt (1999) as cited in Kim[16], stated that the amount of geometrical details does not necessarily reflect the reality level of the 3D model. Texture mapping and panoramic capturing is a rapid and inexpensive modeling technique, and also have proven successful with the public audience. However, it should be considered that the demand for 3D visualizations for landscape and environmental planning depend on the country-specific planning procedures, the economic situation and the level of knowledge and understanding of the participants include the type and level of computer visualization for the planning of the built environment[22].

1.5.7 Research about the 3D Visualization Strategy of Urban Features

The modeling processing of landscape architectural is very complicated and it requires high effort for constructing of interactive modeling. The development of 3D interactive visualization requires a high performance computer to compromise with the complex modeling structures in real-time. Consequently, it demands a proper strategy to reduce the level of complexity of the 3D model structure without reducing the quality of model representation in real time. The following are some of the modeling strategy

for landscape modeling to overcome the complexity of the 3D model structure as follows: finding a good balance between abstraction and reality; creating optimizing a 3D model, optimizing pixel size, reduction level of detail, and reduction of file size[27].

1.5.8 Research about the Development of Spatial Multimedia in Planning Support System

According to Stefano and Luca (2007)[32], there are three types of spatial knowledge contained in a virtual environment, namely landmark knowledge, route knowledge, and survey knowledge. The first, landmark knowledge is user knowledge with access to the Landmark as a functional form that recognized as a different feature that differs from the surrounding environment and provides unique features, and Landmark is easily found or obtained as a building marker in the virtual environment. The second, route knowledge is a user knowledge with access to the link as a route between recognizable landmarks. The link between the landmark route will constructed a sequence pattern that flows linking spatial patterns between landmarks. Route knowledge is also simultaneously direct the user to a particularly identified routes. The last, survey knowledge is an extension of the traveling. Survey knowledge gives an overview of the interrelationship between the locations, which allow users to determine the desired route.

Volbracht and Domik (2000)[33] stated that the use of efficient navigation is influenced by many factors. In the fundamental principle, users should be able simply to navigate, and there should not be any disruption to explore the virtual environment. Therefore, the construction of a navigation system should be accompanied clear parameters and guidelines for users. Eventually, effective navigation system will produce a convenient system and deliver satisfaction for the user, in order to learn, explore, and discover spatial orientation in the virtual environment. The most influencing factors in the creation of an efficient navigation system consisted of six factors, namely virtual environment, user, task, navigation strategy, navigation aids, and motion control. According to Vinson (1999) as cited Jesús (2010)[14], virtual world is a world created in a virtual environment and developed with the goals and intention. Elements of interactive user, created in a virtual environment intended that users freely explore the virtual environment and able to obtain the desired. Therefore, the development of navigation system for constructing an interactive user is necessary to be built with an appropriate strategy, easy to use, and create familiarity with the navigation system according to the human body.

On the other hand, Brail and Klosterman (2001)[7] describes the important of the use of annotation in the development of spatial multimedia. Annotation defined as a term known as an aid to obtain further information towards understanding the spatial

information. Annotation formed by the creation of a link that is connected to other sources of media information associated with the information needed. There are three types of spatial annotation of multimedia, namely textual annotation, audio annotation, and video annotation. Creating the spatial annotation should be accompanied with the appropriate annotation symbol, in order to create a common perception of symbols between the forms of the information provided with markings given.

1.5.9 Research about the Navigation and User Interaction in Virtual Environment (VE)

Volbracht and Domik (2000)[33] stated that the development of virtual environments media in planning support systems require the user interaction to perform observation and navigation. Through the appropriate navigation, the user is predicted to be effortless to explore spatially as well as spatial valuation. The performance of the user interaction to interact within virtual environments is influenced by numerous factors. Several factors that affect the way users navigate and observations are as follows: age and gender, user's understanding, knowledge of perceivable current sub-section of the environment, current environment model, application task, application domain, other real world environments, experiences in the use of computer and virtual environment, abilities and disabilities in motor and perceptual, and the expectations.

According to the Conniff et.al (2010)[8], the exposure to virtual environments leads to the accurate transfer of spatial layout knowledge. Thus, spatial layout knowledge could be improved through active exploration and promote the computer modeling that capable in presenting the current and future built environments. Moreover, she argued that dynamic presentations of the future environment are likely to stimulate perceptions and reactions closer to the condition in the real world compared with the static images. In a virtual environment, people incline to experience the real world through a self-determined movement and to have a full control of navigation. Thus, it might generate to a deeper and richer understanding of the virtual environment. The ability to take control of navigation of a virtual model

There are two types of interactive in related to the navigation in the virtual environment, namely an active navigation and passive interactive. Laing et.al (2007)[18], the term of active navigation is used to provide the user freedom to interact. Active navigation based on the freedom of observation. The user freely perform an observation urban space within the virtual environment. Kjeldskov (2013)[17] divide the concept of active interaction in a virtual environment into three categories, as follows: orientation, moving, and acting. Orientation defined as orientating oneself in virtual reality that indicates the need for being able to look around in a virtual environment in order to developing a sense of presence. Moving defined as motion in virtual reality that

indicates the need for being able to move around in a virtual environment. Meanwhile, acting is defined as performance in virtual reality that encompasses both the tasks of selecting, moving, rotating and transforming objects in the virtual environment, as well as control on a system level. On the other hand, Howard and Gaborit (2007)[12] described the understanding of passive interactive as the opposite of active interactive. A passive observation is only intended for surveillance activities simulation with 3D modeling without any user involvement in directing the movement simulation and interaction with 3D objects. Users simply observe a simulation model that has been arranged and prepared by the operator or server.

1.5.10 Research about the Utilization of 3D Lingo Script on 3D Interactive Simulation

Behavior script is the most important scripting language in Adobe Director Software. The script is very useful in the development of interactive 3D simulations. Interactive simulation allows user involvement in making a change or adjustment to the model or a 3D object. The types of arrangement of the 3D objects are remarkably diverse. The behavior scripts in Adobe Director Software offers a variety of behavior scripts. Both the movie and the script frames can utilize the behaviour scripts. In technical applications, there are two methods of making the behavior script, namely the direct use of instant behavior and writing the behavior script independently. Instant behavior has been provided in library panel behavior and users simply select and apply the behavior to the sprite. There are two kinds of instant behavior, namely 3D actions and 3D triggers. 3D actions divided into local actions, public actions, and independent actions. While, 3D trigger behavior is functioned to trigger 3D action that has been attached to the sprite. On the other hand, writing a script on their own behavior is recommended for the users who already understand well the language structure of Lingo scripts.

The behavior of Lingo script is the main script that supports constructing an interactive and exciting effect of 3D simulations. In general, all behaviors respond to simple events such as through a mouse click on a sprite or when the play head enters a frame. The behavior's panel inspector or the property inspector functioned to change the behaviour script that had been attached to sprites or frames. All behavior scripts used in each script or frames, identified on the panel.

1.5.11 Research about the Development of User Interface Design (UID)

The most useful features for communication within the user interface system are the language. Through the appropriate language, the user will capable of understanding and using the system, because language is the second oldest gesture communication tool, which used by people to communicate on a daily life. The use of appropriate language also supports the proper understanding of the system usage and reduce

misunderstanding of the signs.

According to the 17 principles for creating and developing a good interface design[31], there are three essential principles for creating and developing a good interface design, namely the familiarity, ease of learning, and ease of use. Familiarity defined as the implementations of all elements in user interface such as the concepts, terminology, and the settings, which are easily understood by the user. Ease of learning described as the creation of the system that is easy to learn for novice users (lay people) and capable of motivating the user to use it. Ease to use defined as the creation of the system that is easy to use for the skilled or experienced users.

The effective use of color can perform the user's system interface more efficiently. The element of color can assist users understand the particular meaning at a glance. Color can also produce a user interface more aesthetically pleasing and refined. The use of color in interface design adds an extra dimension to the user interface and support users understand the complex structures. Color function as communicates meaning, state, differentiation, and emphasis on the user interface. Colors are powerfully reinforcing the graphic symbols on the user interface. On the other hand, Westland (2007)[36] described a harmonious color that creates an inner sense of order, visual balance, which persuade the viewer. Color harmony implies that color scene is neither boring nor chaotic. Even though, harmonious color is subjective, there are seven basic principles for using color or achieving color harmony, as follows: monochromatic color, complementary color, split-complementary color, double-complementary, analogous color, triadic color, and neutral color.

1.5.12 Research about the Familiarization of Cultural Symbols In User Interface Design (UID)

According to Hofstede as cited in Restyandito (2011)[26], he stated that each people has a pattern of thoughts, feelings and actions learned throughout his life. The way of a people grew up will give a considerable impact on the formation of the pattern. One's culture formed because the social environment in which people raised. The difference people have a particular cultural background compared with other cultures.

According to Eristi (2009)[10], she stated that the existence of culture influences the way in which people interact in general, as well as interaction with the computer. The development of an interactive system intended to develop the interaction between people and computer. Culture will affect and determine the communication preferences as well as the behavior. Futher, Daniel et al. (2011)[9] described that a language is one part of human beings in culture interaction. Therefore, the selection and use of appropriate language in the design of the computer system will determine the success of the user interaction with the system developed.

1.5.13 Research about the Involving Public Participation in The Process of Urban Planning

Public participation activities should have been conducted early at the beginning of the urban planning and design in order to anticipate problems and mistakes in the process due to incompatibility with the reality on the ground. Public participation is also performed to avoid the appearance of urban design products that are not in harmony with the community living there. The earlier and the more intensively the public involved in urban planning project, the more likely the projects will succeed[35].

In consideration to the image representation for public participation, the public could not understand well an image product from the architect that tends as technical drawings. Community or public requires the delivery of a design idea through a medium that is easy understood[19]. On the other hand, Karki (2009)[15] explained that in the modern techniques like in developed countries, online participation (e-participant) has opened up opportunities for more people to participate and to obtain a better understanding of the whole project. Cultural development of e-participants will be a trend in the future. E-participation contains a wide range of specific individual techniques, such as virtual discussion or consensus. Moreover, the e-participant able to reduce the cost of public participation activities and obtain highly beneficial, especially for dissemination of public policy and open sharing information. Nevertheless, access to the computers is still become the primary requirements for the implementation of e-participant[30].

1.6 Composition of Research Paper

This paper consists of four chapters.

Chapter 1 describes the research introduction. This chapter composed of five sections.

Section 1 describes the background research on the rapid development of commercial industry generating the growth and spread of uncontrolled commercial buildings in Malang, Indonesia. Due to the lack of regulation on City planning, the growth of commercial buildings also entered into a conservation area and affected the declining of the visual quality of the streetscape.

Section 2 describes the purpose of the research consisting of two purposes. The first is to identify the characteristics of the streetscape of commercial buildings in Malang, and the second is to develop an interactive 3D visualization as Landscape Support System for streetscape improvement.

Section 3 describes the framework of research consisting of three parts, namely the research background, research methodology, and the development of the system.

Section 4 describes a general overview of Malang City, Indonesia regarding the characteristic of geography, climate, population, ethnic, and socio-cultural conditions.

Section 5 describes a several previous research related to the following issues, as follows: urban image, aesthetic experience, visual evaluation, conservation of historic building, transitional space, computer visualization, 3D visualization strategy, spatial multimedia, navigation, user interaction in a Virtual Environment, 3D Lingo scripts, user interface design, cultural symbols, and public participation.

Section 6 describes the composition of research paper.

Chapter 2 describes the first stage of study about visual evaluation of urban commercial streetscape through building owners judgment. This chapter is composed of nine sections.

Section 1 describes the Malang city as one of the historic cities that have many building heritages of Dutch colonial. Due to the rapid growth of Malang urbanization and commercial sectors throughout Malang city, there is an emergence of uncontrolled development of new commercial street corridor that disregards the visual quality of the urban streetscape. This section also describes several previous researches related on the commercial streetscape, especially in the historic streetscape.

Section 2 describes the research's objectives and research's methodology. The study aims to identify the physical characteristics of the streetscape of commercial buildings in Malang through the field survey and perform a visual judgment of a commercial building streetscape through the building owner's preferences.

Section 3 describes the historical development of urbanization in Malang started from the Dutch colonial era in 1767.

Section 4 describes the initial development of the historic commercial street that starts from the Kayutangan area in the period 1914 to 1940, including investigating the visual appearance of the commercial streetscape in the Kayutangan Street through historical documentation.

Section 5 describes the development of a commercial streetscape in new areas, including the identification of the development of modern commercial characteristics.

Section 6 describes the features of the commercial streetscape in Malang involving three streets as a case study, namely Kayutangan Street, Kawi Street, and the Soekarno-Hatta Street.

Section 7 describes the preferences of commercial building owners involving 283 respondents from the three case studies. The results of the preferences utilize a correlation analysis to examine the relationship between building function and age respondents against the characteristics of the commercial building streetscape.

Section 8 describes a comparison between the result of the field survey and the building owners' preferences.

Section 9 describes the conclusions and discussion of the results of the study, including formulating the findings of the three typology of the commercial building streetscape and the emergence of three types of judgment.

Chapter 3 describes the second stage of study about the development of landscape planning support system using interactive 3D visualization. This chapter is composed of eight sections.

Section 1 describes the significant of the development of an effective 3D visualization for the improvement of Kayutangan streetscape, in Malang City, Indonesia. This section also describes several previous researches related to the interactive 3D simulation and the utilization of user interface for the development of a decision support system.

Section 2 describes the research's flowchart connecting the chapter 2 to chapter 3. This section also illustrates the relationship between the results of previous studies as the basis for the concept development of 3d visualization.

Section 3 describes the results of early studies about the visual evaluation of the Kayutangan streetscape.

Section 4 describes the comparison of the new system development against the previously developed system.

Section 5 describes a method of system development divided into three discussions, namely the concept of 3d visualization, development of 3d simulation, and development of user interface.

Section 6 describes testing the system through the workshop. The workshop involved five important events consisting of lecture, site investigation, clarification of issues, operating the system, and evaluation. This section also described a number example of 3D simulations according to the priority issues.

Section 7 describes the recommendation for an advanced workshop after the pilot workshop had completed.

Section 8 describes the conclusions and recommendations for the further studies.

Chapter 4 describes the conclusion of each chapter, a research summary, and the recommendations for further studies.

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Chapter 2

VISUAL EVALUATION OF COMMERCIAL BUILDING STREETSCAPE THROUGH BUILDING OWNERS JUDGMENT

Chapter 2
VISUAL EVALUATION OF COMMERCIAL BUILDING STREETSCAPE THROUGH BUILDING OWNERS JUDGMENT

2.1 Introduction

Malang is a historic city with many colonial building heritages. One of the important historic districts is the Kayutangan Street corridor, as well as a commercial area that persists to this day. The rapid growth of urbanization has led to the growth of commercial sectors throughout Malang. Good city planning should draw on the history of urban planning to create continuity in new urban space planning. Failure in city planning is often caused by a misunderstanding of and a disregard for the city's history. The Kayutangan Street corridor should be preserved as a valuable asset in the history and culture of Malang.

Today, the corridor's historic buildings are gradually being replaced by new buildings due to a lack of strong regulations in Malang for the preservation of historical and cultural assets. In addition, there is an emerging new commercial corridor. The rapid, uncontrolled development of the new commercial street corridor has created a city streetscape that is intended to be of economic interest with little regard for structuring a quality visual space. Reflecting on the historical urban space could be a useful basis for planning and designing better cities in the future. According to Nasar (1998)11), as cited in Rapoport (1993), good city planning requires a study that involves a group of people in a particular area in the process of determining a prominent feature in the built environment.

There are many studies related to the preservation of historical streetscapes and the formation process of it in Japan. Watanabe (1982)19) and Nishimura (1991)12)15)19) conducted a major research investigating historic environments all over the country. Nishimura clarified the situation of design review by ordinance to control townscapes in local cities. Moreover, he marshaled arguments for historic preservation in foreign countries. Regarding the cityscape of Indonesia, physical research by Narumi (1997)4) clarified the characteristics of urban transformation in the former colonial city of Medan, Sumatra. In particular, there are a few researches on the transformation of commercial streetscapes evaluated according to owners' preferences. Therefore, it is necessary to accumulate more study results on cityscapes in Indonesia.

On the other hand, Virtual Reality (VR) system combined with the Semantic Differential (SD) method has been widely used to assist research associated with the streetscape analysis in Japan. Matsumoto and Takai (1992)10) performed the investigation of personal preference on streetscape using the SD method through the photographs. Several researchers have shown that the combination of VR and SD

method was considerable effective to perform streetscape's evaluation (Koba & Kishimoto, 2009; Koizumi et al., 2009)8)9). Other researchers conducted typology method and image analysis methods, using pictures, maps and even computer graphic images (Dokyu & Yamamoto, 2003; Seta et al., 2003; Yoshimura & Tsukamoto, 2010)3)16)20).

Hence, this study also performs a people preference method that combined with field survey in order to investigate the visual quality of the urban commercial streetscape. This study analyzes the emergence of three architectural styles and compares the characteristic typologies of the commercial streetscapes in three street corridors, namely Kayutangan, Kawi, and Soekarno-Hatta. Investigating of owners' preferences is conducted by interview and questionnaire on the site. The results of this study will be used as the baseline data in order to develop a VR system for the public participation activities in the following research.

2.2 Objective and Methodology

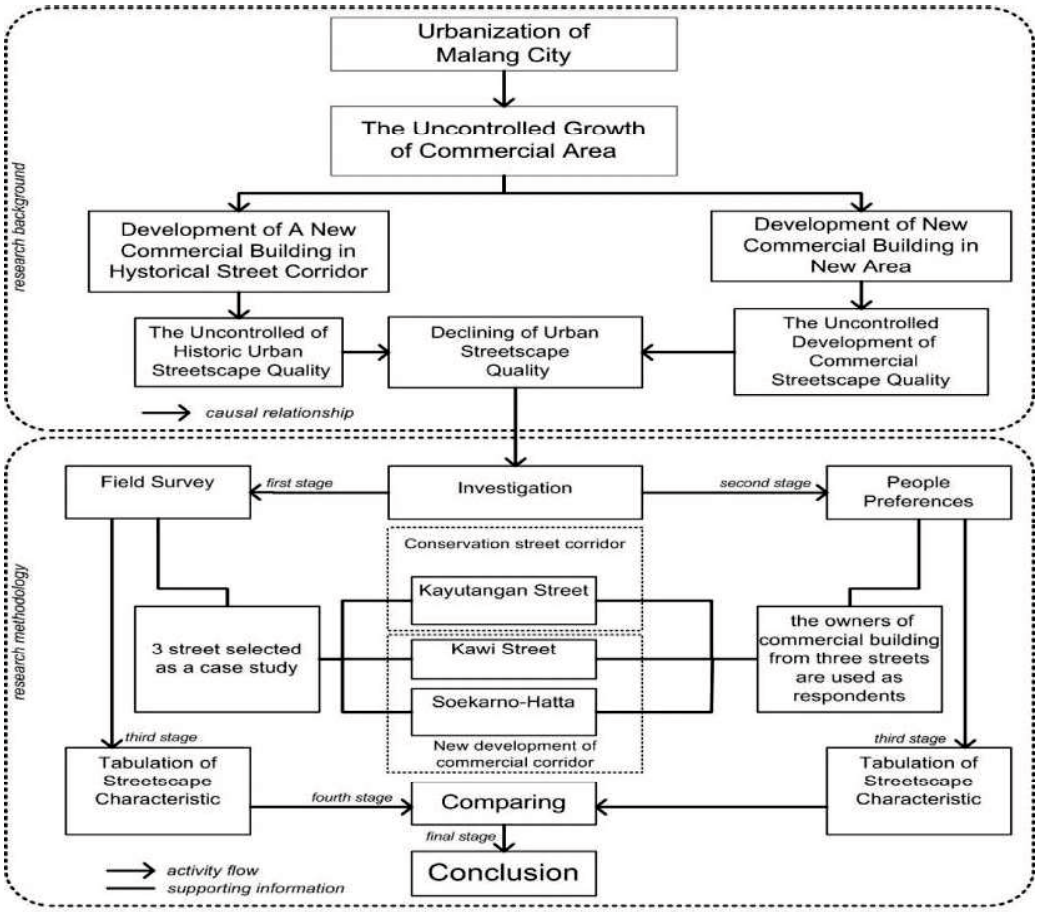


Figure 2-1 Research framework

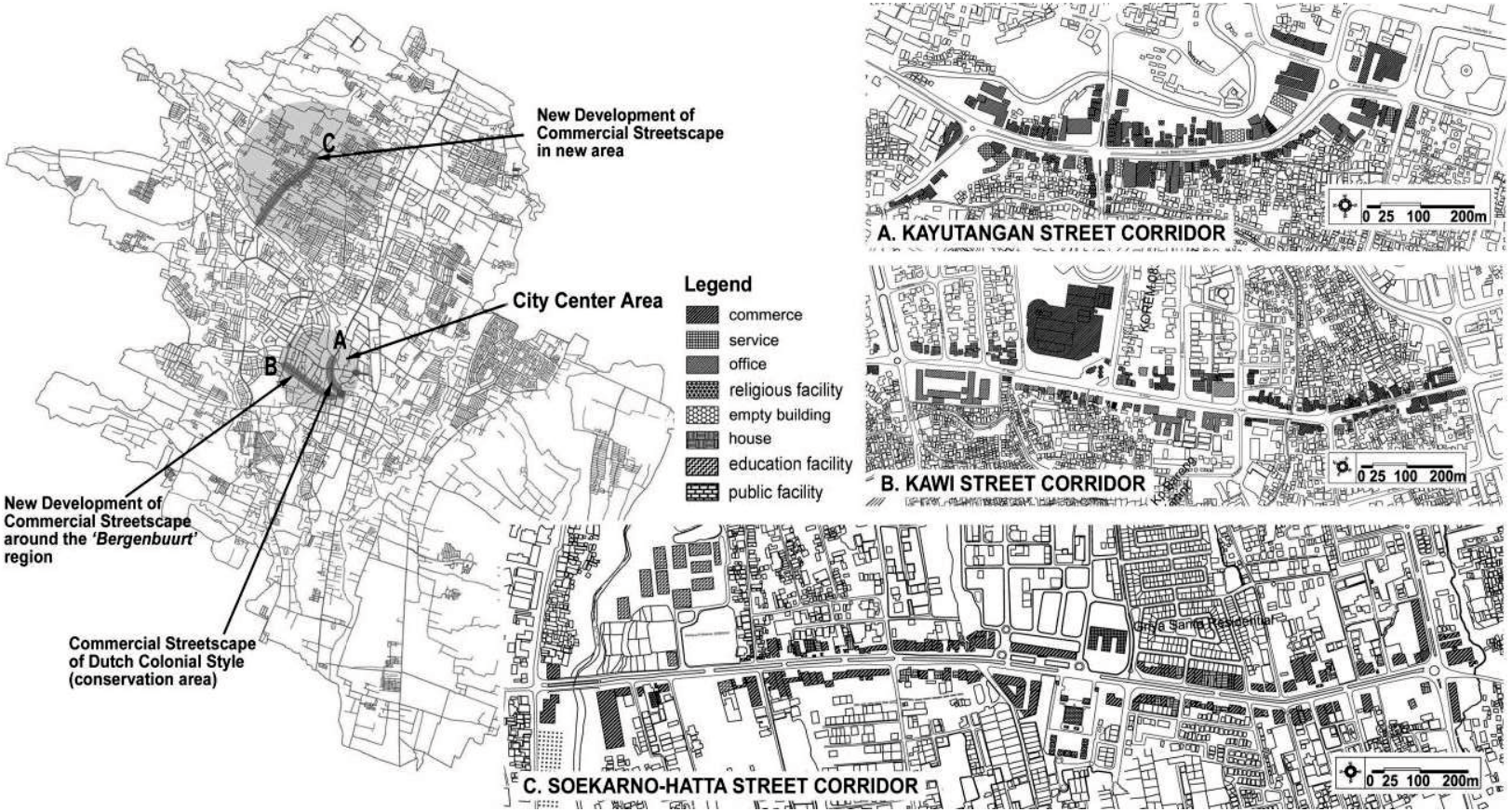


Figure 2-2 A case study map of three street corridors

This study aims to identify the characteristics of the evolving streetscape of commercial buildings in Malang based on the analysis of physical characteristics and a visual judgment by the building owner in the development of a commercial building streetscape. According to Kaplan (1988)[7], preference judgment is a powerful tool for understanding the patterns underlying what we consider aesthetically pleasing.

This study used a nonprobability sampling technique through a purposive sampling, namely a judgment sampling. The respondents were building owners in the three street corridors identified in the case study. Interviews and questionnaires were used to obtain opinions from the commercial building owners. We assume that the commercial building owners are people who actively participate in making streetscape changes and who have a responsibility for or an inherent understanding of building appearance.

The case study area is Malang, Indonesia. The research focus is on commercial building streetscapes. Three street corridors were studied. The first is the Kayutangan Street corridor, which is the area of commercial buildings built during the Dutch colonial era. The second is the Kawi street corridor, which is one continuous street that crosses the Kayutangan Street corridor in Alun-alun through Abdurahman Hakim Street. The last is the Soekarno-Hatta street corridor, which is a new commercial development area in the northwestern part of Malang.

2.3 The Historical Growth of Urbanization in Malang

map				
	before 1822	1826	1922	1924 - 1938
number of city center	one (Alun-alun)	one (Alun-alun)	two (added with Alun-alun Bunder)	two (added with Alun-alun Bunder)
city structure	concentred on Alun-alun	concentred on Alun-alun	divided into two center	divided into two center
city shape	radial	grid and linear	grow strongly to the north and the emergence of new growth in eastern	grow strongly to the north and the emergence of new growth from east to west

Figure 2-3 The Historical Growth of Malang Urbanization until 1938

The early growth of Malang was marked by the Dutch colonial period in 1767. Establishment of the Dutch position was marked also by the construction of Alun-alun[a] in 1882 as a center of colonial administration and authority for the production and control objectives. At the time, the Alun-alun of Malang city also became the collection center for production from the fertile lands in the vicinity. City maps from 1882 to 1914 clearly show that Alun-alun is the center of activity in Malang (Handinoto, 1996)[6]. Urban infrastructure is also greatly concentrated around Alun-alun. Similarly, road infrastructure was clearly developed to connect Alun-alun with the outside of the city.

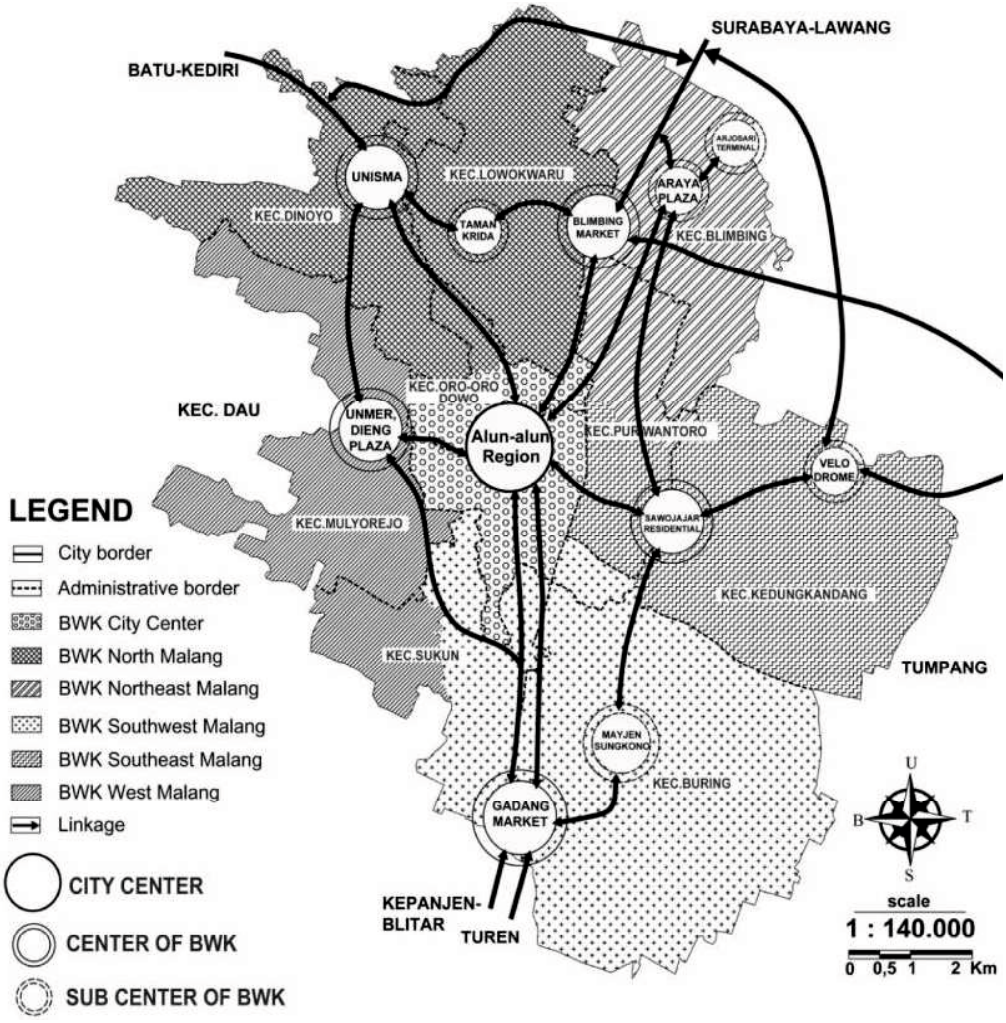


Figure 2-4 City structure and City Regional Division (BWK) plan of Malang in 2008 – 2028

At the beginning of the Dutch occupation of Malang, Alun-alun was built and used to establish an image for the colonial cities in Indonesia, especially the towns on the Java islands. Hence, early in the growth of Malang city, the pattern of the city space is

concentrated around Alun-alun. Owing to the strong position of the Netherlands from 1826 to 1867, this city pattern began to change into a grid pattern—the city pattern of Europe. Between 1870 and 1900, Malang experienced great development, which prompted the Decentralization Act and the formation of the Malang municipality on April 1, 1914. According to Handinoto (1996)[6], the municipality issued an eight-part expansion plan for Malang (Bouwplan I–VIII) between 1917 and 1929 to control the city's shape, which tends to elongate. In 1922, another Alun-alun called Alun-alun Bunder was built as the center of the new government. This was the result of the arrival of a new generation of Dutch who wanted a style that was more Western than that of the existing Alun-alun. Around 1924 or 1925, the municipality implemented the fifth part of the expansion plans by creating a strong east–west main route to counterbalance a linear growth toward the north. The east–west route sweeps away from the train station, continues toward Daendels Boulevard, crosses Kayutangan Street, and stretches east until it ends at Semeru Park in the Ijen Boulevard intersection. The axle path leads to the Kawi and Arjuna mountains in the east.

Based on the regional growth issues of the city, Malang's urban order today has adjusted to the availability and accessibility of facilities in the district. Malang has five orders, as follows:

1. Order II is the center of all activities in Malang City and located in Klojen district.
2. Order IIIA includes; Kelurahan old Pandanwangi, new Purwantoro, old bunulrejo, Jodipan, Oro-oro Dowo, old Lowokwaru, old Mojolangu, Sukun, old Bandungrejosari, Tunjungrejo, Karangbesuki, old Pisangcandi, old Sawojajar, old Kotalama and Mergosono.
3. Order IIIB includes;. Kelurahan Purwodadi, old Purwantoro, new Pandangwangi, Sukoharjo, Kauman, old Bareng, Kasin, Gadingkasri, Samaan, new Lowokwaru, Jatimulyo, Tulusrejo, new Mojolangu, Dinoyo, Merjosari, Tlogomas, Sumbersari, Kebonsari, new Bandungrejosari, Ciptomulyo, new Pisangcandi, Kedungkandang, Lesanpuro, Madyopuro, new Sawojajar, new Kotalama, Tlogowaru, old Gadang.
4. Order IVA includes; Kelurahan Blimbing, new Bunulrejo, Kesatrian, new Bareng, Penanggungan, Rampal Celaket, Tunjungsekar, new Gadang, Bandulan, new Tunjungrejo, Bumiayu and Buring.
5. Order IVB includes; Balerajosari, Arjosari, Polowijen, Kiduldalem, Tasikmadu, Ketawanggede, Tunggulwulung, Bakalankrajan, Mulyorejo, Cemorokandang, Arjowinangun and Wonokoyo.

Order II is the center of all activities in Malang and is located in the Klojen district. The structure of Malang's city services is also planned in accordance with the placement of the functional activity of Malang's city center while emphasizing a city regional division (BWK).

2.4 The Early Growth of the Historical Commercial Street

Kayutangan experienced growth during the period of 1914 to 1940. In 1914, the growth of trade and services in Malang began along Kayutangan and Tjelaket Streets. After 1940, there was very little development in Malang since the Dutch government was occupied with the war. However, the Kayutangan region grew gradually until the 1980s before going into decline due to the development of modern shopping complexes in the region of Alun-alun in 1986 (Handinoto, 1996)6).

After 1986, there were a few changes to the colonial buildings in terms of both function and physical features. The development of other commercial areas in other regions started from the center of Malang, Alun-alun, as the focal point of activity. The growth of commercial buildings followed four stages of change.

According to Handinoto (1996)[6], the development of Dutch colonial architecture in Malang was closely related to the overall colonial architectural development in the Dutch Indies at that time. These developments can be classified as follows: Indische empire style (1850–1900), early modern colonial style (1900–1915), and modern colonial style (1916–1940). The first period was characterized by full symmetrical planning, thick walls, high ceilings, and marble floors. The second period was characterized typical floor plans and symmetrical, detailed architectural elements, such as those found in the Netherlands. The third period was a completely modern style. There were two streams of the modern style, namely an international style and Nieuwe Bouwen. Prominent features of the colonial architecture of this period included strong horizontal and vertical shapes, flat roofs, and white paint[6].

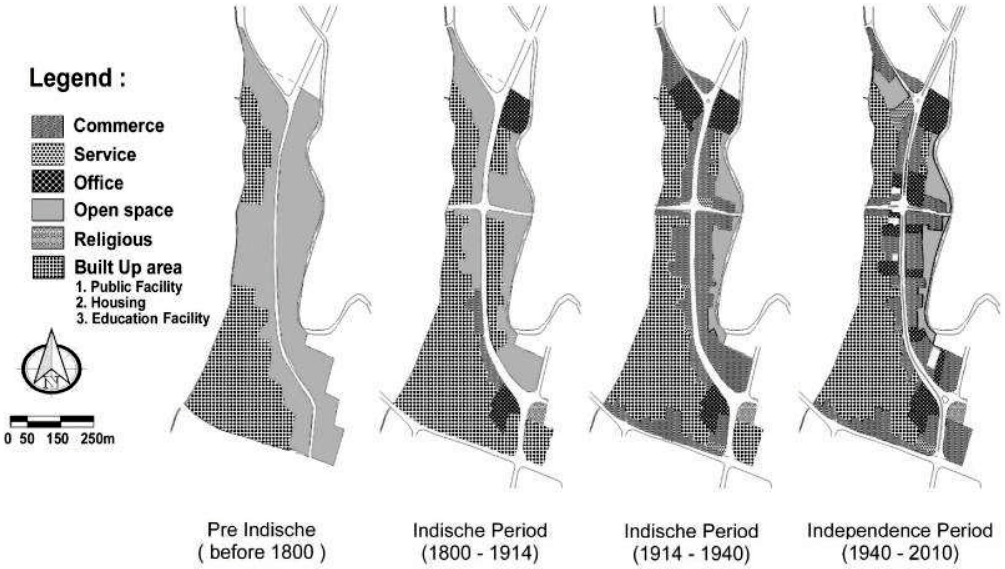


Figure 2-5 The spread of commercial buildings along Kayutangan street from the Pre Indische period until the Independence period (Rizaldi T.L.N. et al.,2010)[18]

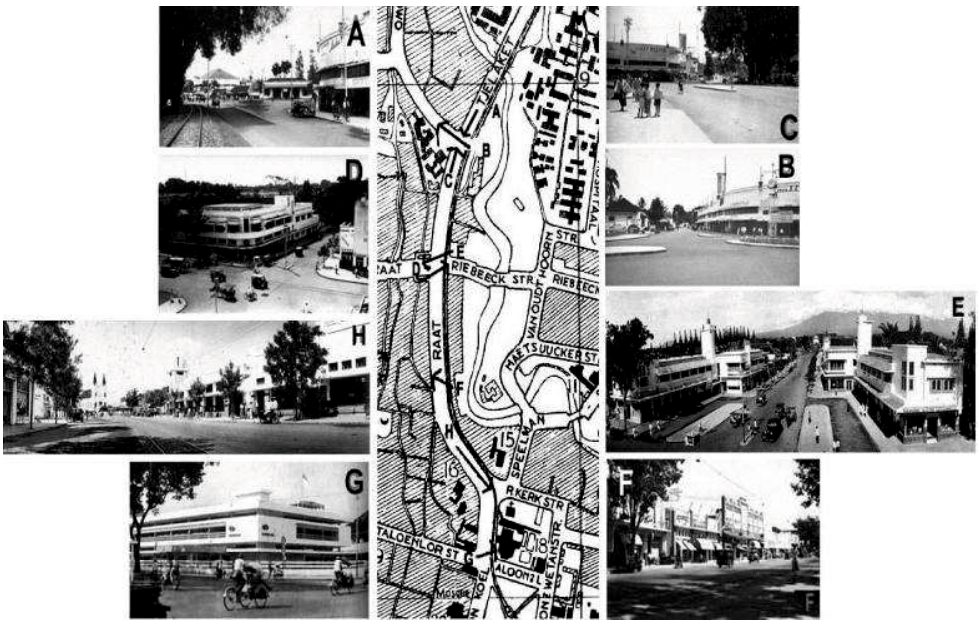


Figure 2-6 The appearance of commercial buildings streetscape in Kayutangan Street around the 1940s [17)]

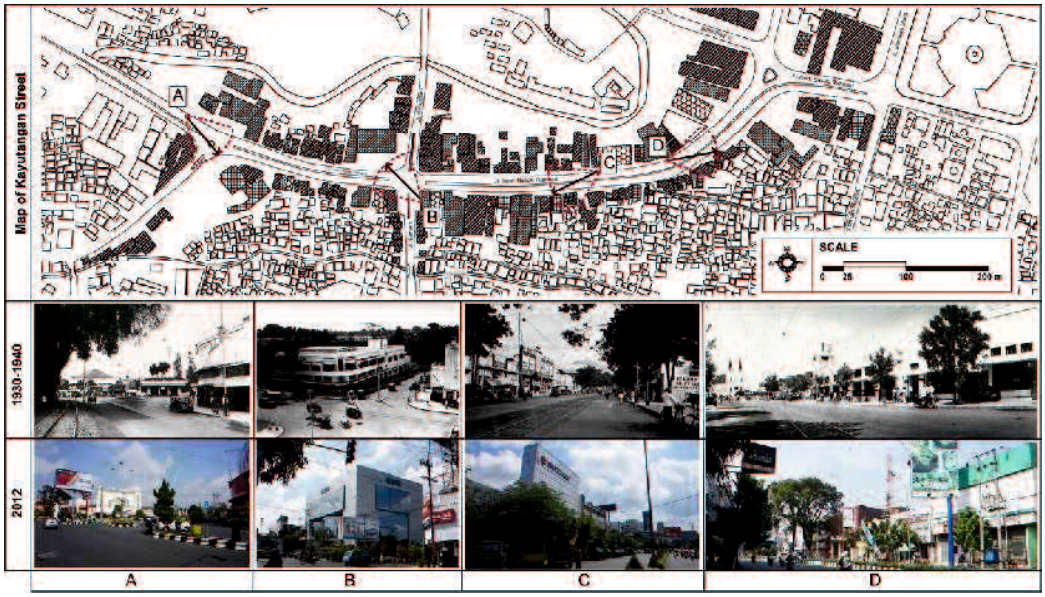


Figure 2-7 The comparison of the some viewpoint in Kayutangan Street between around 1936 and 2012

Recently, Kayutangan streetscape gradually experience changes the visual quality significantly due to the development of modern commercial buildings. The image above shows the comparison of the some viewpoint in Kayutangan Street between around 1936 and 2012. The capturing viewpoint in 2012 was attempted closer to the same viewpoint in old photo. According to this comparison, there are some significant changes to the streetscape character in shape, material, color, height, and trees.

2.5 Development of Commercial Streetscape in New Areas

The streetscape development of new commercial building areas was heavily influenced by modern architecture and contemporary style. The development of new commercial areas occurred on Kawi Street and Soekarno-Hatta Street.

Kawi Street was a new commercial district that grew around a residential area. In the Dutch colonial era, the area was called *Bergenbuurt,* which means the mountains area. At that time, the *Bergenbuurt* region was a residential area for the European communities and developed into an elite residential area that persists today. Kawi Street is the main street that connects the *Bergenbuurt* with the Alun-alun "Merdeka" of Malang. The Kayutangan and Kawi areas are both connected through the Alun-alun "Merdeka." The phenomenon of the development of modern commerce in the Kayutangan area also occurred in the Kawi area. In the Kayutangan area, these developments occurred in commercial land use while in the Kawi area it was residential land use.

Figure 2-8 A several viewpoint in Kawi Street in 2012

Kawi Street was one of a new commercial district that grew around the Dutch residential area. The image above shows the several viewpoint in Kawi Street in 2012. There are several residential buildings which turned into commercial functions while maintaining the character of the Dutch style of residential architecture.

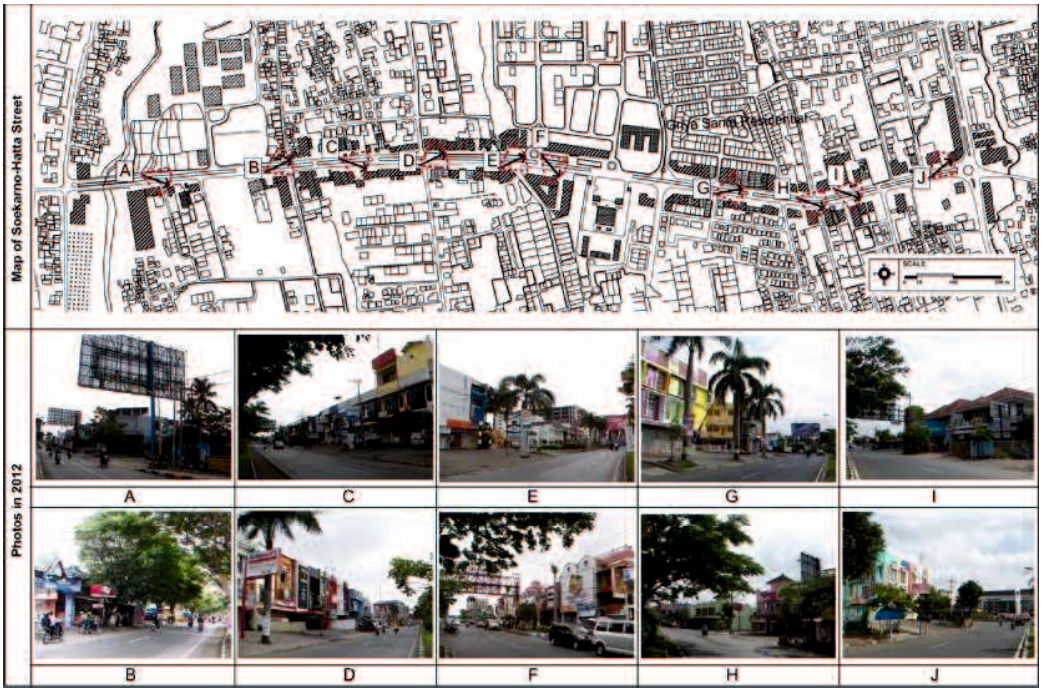


Figure 2-9 A several viewpoint in Soekarno-Hatta Street in 2012

The Soekarno-Hatta Street corridor was also a new commercial area that grew rapidly in the new development area. The image above shows the several viewpoint in Soekarno-Hatta Street in 2012. The prominent characteristics of this area were contemporary forms, various shapes, and colorful appearances. The overall appearance was so impressive and in such stark contrast with the surroundings that each building looks like to compete with the appearance of other buildings. Commercialism is often associated with the present, so the new symbols were quickly adopted, absorbed, and used in the construction of new commercial buildings, especially in Soekarno-Hatta Street.

2.6 Features of the Commercial Streetscape in Malang

2.6.1 Commercial streetscape profile

The majority of characteristic functions of the commercial corridors that developed in the study area are trade (47.22%), service (42.13%), and housing (8.56%). There are a large percentage number of residential functions on Kawi Street that is caused by the existence of former of European's residential in Kawi area in the Dutch colonial era, which subsequently turned into a commercial area. The most numerous types of trade and service facility in the Kayutangan Street is the Bank's business, and followed by a restaurant and a travel agency. Residential building has the largest percentage at the Kawi Street and followed by a food stall and an electronic shop. While the empty

shophouses is found in the highest percentage at Soekarno-Hatta street corridor, and followed by a residential and café restaurant. Soekarno-Hatta region is a new development of commercial corridor in Malang City. However, the construction of a commercial facility, particularly for shophouses, is constantly growing rapidly. Due to Soekarno-Hatta area became a significant area for business development, so the land prices are brought increased expeditiously. There are so many business people who flocked to the Soekarno-Hatta area for expanding its business. Actually, the Soekarno-Hatta corridor was designated as the residential function according to the early city planning regulations. Due to the rapid development of the Soekarno-Hatta area as a strategic area for business, then the planning regulations have to be readjusted.

Table 2-1 The characteristic functions of the commercial corridors in three streets

No.	Function	Kayutangan Street		Kawi Street		Soekarno-Hatta Street		Total	(%)
		West Side	East Side	West Side	East Side	West Side	East Side		
1	Trade	23	27	16	19	66	53	204	47.22
2	Services	25	23	9	25	47	53	182	42.13
3	House	1	0	7	7	10	12	37	8.56
4	Organization	1	0	1	0	0	0	2	0.46
5	Religius building	0	1	1	1	0	1	4	0.93
6	Rent Office	0	0	0	0	1	0	1	0.23
7	Building for sale	0	0	1	1	0	0	2	0.46
								432	100

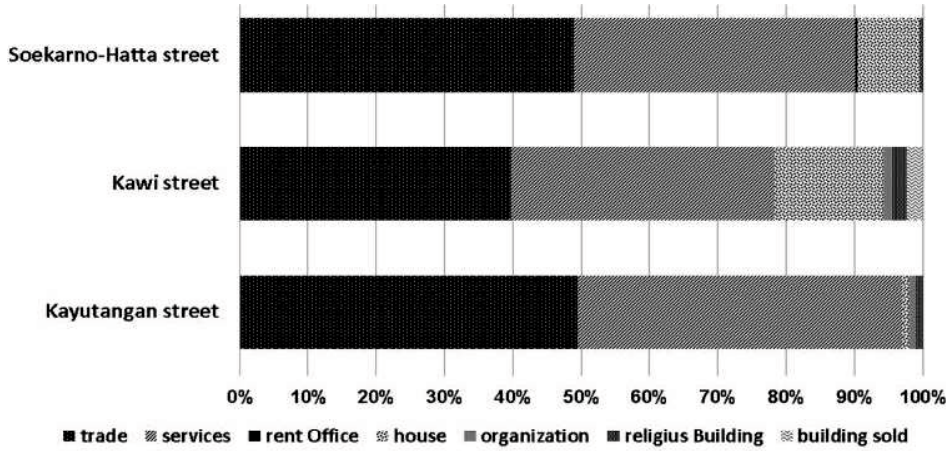


Figure 2-10 The characteristic of commercial building functions in the case study area

The field survey also obtained three characteristics that categorize the commercial building facades by architectural style: Dutch architecture, modern Architecture, and Indonesian architecture.

2.6.2 Physical characteristics of the commercial streetscape

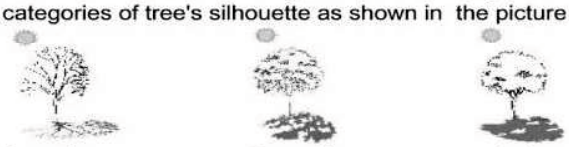
Table 2-2 Characteristic of streetscape elements

Characteristic of streetscape element (S)		Street		
		Kayutangan	Kawi	Soekarno-Hatta
S1: Building setback				
a	have	31.80%	87.90%	94.20%
b	no	68.20%	12.10%	5.80%
S2 : Setback profile				
a	no building setback + no parking lot	18.20%	0%	0%
b	no building setback + parking lot	55.70%	7.60%	0%
c	building setback + no parking lot	14.80%	4.50%	54.20%
d	building setback + parking lot	11.40%	86.40%	26.70%
e	building setback + park	0%	1.50%	19.20%
S3 : Sidewalks				
a	have	96.60%	85.30%	34.20%
b	no	3.40%	14.70%	65.80%
	sidewalk's material :			
c	concrete	0%	5.40%	4.90%
d	stone	81.20%	0%	0%
e	paving	17.60%	94.60%	95.10%
f	ceramic	1.20%	0%	0%
	sidewalk's texture* :			
g	smooth/flat	98.80%	96.40%	97.60%
h	rough/textured	1.20%	3.60%	2.40%
S4 : Tree				
a	have	87.50%	87.90%	73.30%
b	no	12.50%	12.10%	26.70%
	tree height			
c	small (<4m)	38.20%	12.30%	26.70%
d	medium (4-8m)	51.70%	39.90%	33.30%
e	big (>8m)	10.10%	47.80%	40.00%
	leaf density**			
f	no dense	5.60%	12.30%	35.70%
g	medium	67.40%	61.60%	41.40%
h	dense	27.00%	26.10%	22.90%

*) Measurement of sidewalk's texture was carried out by observing a level of surface flatness in two categories of sidewalk's surface as shown in the picture below

1. smooth/flat 2. rough/textured

**) Measurement of leaf density was carried out by observing a shade level of canopy in three categories of tree's silhouette as shown in the picture below.



1. no dense 2. medium 3. dense

Based on the results of the field survey, it can be observed that the Kayutangan Street corridor is largely dominated by profile buildings that do not have building setbacks, but have a canopy and a prominent arcade pattern along the corridor. The typological arcade is very comfortable and provides an active (lively) interaction between pedestrians and the building frontage. These typologies are very different from the

Soekarno-Hatta Street corridor. The interweaving of sidewalks and building frontages is very poor for the creation of active interaction.

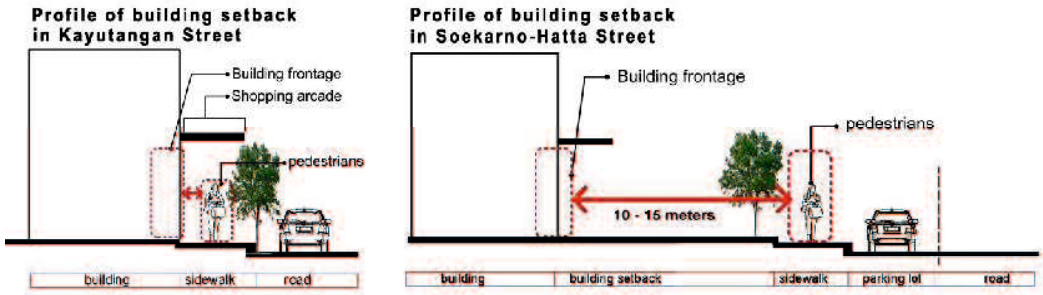


Figure 2-11 The differences of building setback profiles

Table 2-3 Characteristic of streetscape profile

TYPE	STREET SECTION		
	KAYUTANGAN STREET	KAWI STREET	SOEKARNO-HATTA STREET
NO BUILDING SETBACK + NO PARKING LOT	18.18%		
NO BUILDING SETBACK + PARKING LOT	55.68%	07.58%	
BUILDING SETBACK + NO PARKING LOT	14.77%	04.55%	54.17%
BUILDING SETBACK + PARKING LOT	11.36%	86.36%	26.67%
BUILDING SETBACK + PARK		01.52%	19.17%

Most of the Kayutangan and Kawi Street have adequate sidewalks as compared to Soekarno-Hatta Street. While, most of the Kawi and Soekarno-Hatta Street use a fabricated paving for sidewalk's material, and Kayutangan Street uses a combination of natural stone. All street use flat texture in order to make pedestrians easily use the sidewalk.

The arrangement of trees on Kayutangan and Kawi Street has different function and purposes, as compared with that on Soekarno-Hatta Street. Most of the trees on Kayutangan and Kawi Street have big canopies functioning optimally as a shading device. Otherwise, those on Soekarno-Hatta Street consist of small canopy trees functioning as aesthetic device and big canopy trees as a shading device. According to the ratio of the number of the trees and the length of street in every street corridor, it

could be assumed that there are significant differences in the pattern and gap settings of the trees between those three streetscapes.

Table 2-4 Characteristic of tree canopies

Tree canopy	Street		
	Kayutangan	Kawi	Soekarno-Hatta
Type 1: Columnar 	7 (7.87%)	5 (3.62%)	2 (0.95%)
Type 2 : Round 	56 (62.92%)	35 (25.36%)	67 (31.90%)
Type 3: Vase 	20 (22.47%)	91 (65.94%)	67 (31.90%)
Type 4: Fountain 	6 (6.74%)	7 (5.07%)	74 (35.24%)
Number of trees	**89**	**138**	**210**

Note :
Data tables contains the number of trees and their percentage of trees in each street.

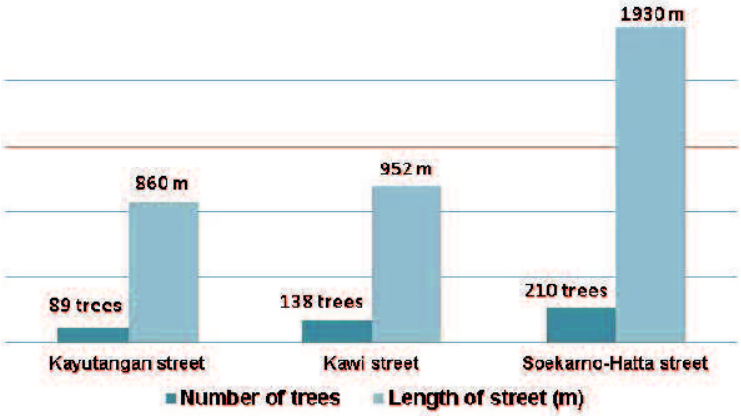


Figure 2-12 The comparison between the total numbers of trees and length of each street corridor

The facade typology developed during the early growth of the commercial buildings in the Kayutangan Street corridor tended toward monochrome color facades—mostly white. Over time, the buildings gradually began to change to a trendy new look with patterns and a variety of color combinations. The phenomenon of this development greatly occurred on Soekarno-Hatta Street.

Table 2-5 Characteristic of building facade

Characteristic of building façade (B)	Street		
	Kayutangan	Kawi	Soekarno-Hatta
B1 : Façade style			
a Indonesian	2.30%	26.60%	20.90%
b Modern	60.50%	59.50%	79.10%
c Dutch	37.20%	13.90%	0.00%
B2 : Façade shape			
a simple	61.20%	39.00%	28.60%
b curved	1.20%	1.30%	0.00%
c various shape	37.60%	59.70%	71.40%
B3 : Façade detail (ornament)			
a have ornament	44.00%	9.20%	16.70%
b no ornament	56.00%	90.80%	83.30%
B4 : Façade texture			
a smooth	56.30%	89.60%	91.40%
b rough	28.70%	5.20%	3.20%
c shiny	14.90%	5.20%	5.40%
B5 : Façade finishing (material)			
a painted	51.90%	75.90%	75.70%
b cladding	28.20%	2.30%	10.40%
c glass	13.00%	6.90%	7.00%
d stone	1.50%	4.60%	2.60%
e ceramic	5.30%	0.00%	1.70%
f wood	0.00%	0.00%	1.70%
g bamboo	0.00%	0.00%	0.90%
B6 : Façade color			
a monochrome	40.00%	9.30%	13.80%
b two color	35.30%	41.30%	29.80%
c three color	9.40%	37.30%	23.40%
d various color	15.30%	12.00%	33.00%
color theme			
e analogous	58.30%	63.80%	44.40%
f complementary	40.50%	36.20%	55.60%
g tertiary	1.20%	0.00%	0.00%
B7 : Commercial signs			
sign shape			
a text	10.10%	19.00%	6.00%
b image	0.00%	0.00%	0.00%
c text & image	88.60%	81.00%	94.00%
d text & lighting	1.30%	0.00%	0.00%
sign placement			
e integrated	68.40%	69.60%	54.90%
f separated	5.10%	1.80%	6.10%
g combination	26.60%	28.60%	39.00%

There are two types of characteristic of building façade among all street, as follows:

1. The similarity of the majority characteristic of building facade among all street on the six characteristic, namely modern façade styles, no ornament, smooth texture, painted finishing, a combination between text and image on sign shape, and integrated sign placement.
2. The dissimilarity from the majority characteristic of building facade among all street on the three elements, namely façade shape, façade color, and façade color themes

Table 2-6 A number of a visual characteristic from the field survey

Building Streetscape Characteristic		number of various types						
		Dutch style	%	Modern style	%	Indonesia style	%	Total
Building Profile & sidewalk	Building setback Profile shape Sidewalks width	4	23.53	7	41.18	6	35.29	17
Tree	Tree shade Tree height Leaf density	6	37.50	5	31.25	5	31.25	16
Façade form	Façade shape Façade detail Façade texture	4	40.00	3	30.00	3	30.00	10
Façade Finishing	Material finishing Façade colour Façade colour's theme	5	16.67	14	46.67	11	36.67	30
Sign	Sign shape Sign placement	6	23.53	8	41.18	6	35.29	17

Based on physical characteristics, streetscape profiles are grouped into three categories of building style and five categories of building streetscape elements. The three categories of building style are Dutch, modern, and Indonesian[b]. The five categories of streetscape elements are building profiles and sidewalks, trees, façade form[1)5)], façade finishing[2)13)], and commercial signage[13)]. The categorization of building styles is intended to determine the amount of growth in the three styles of buildings on the three streets studied. The grouping based on the characteristics of the streetscape elements is intended to facilitate the identification of typological diversity and the streetscape elements in each group.

The groupings produce various types of characteristics of the commercial building streetscapes. Based on the results, it can be observed that the highest variation in commercial building streetscape characteristics was found in the façade finishing elements in the modern style. In addition, the lowest amount of variation was found in the façade form elements in the modern and Indonesian styles. Moreover, there are emergences of the various façade that represent a style of commercial building Architecture on each street corridor, as follows:

1. Dutch architecture

   Dutch architecture style was actually came from a modern style in the Netherlands and that style was adapted to the climate in Indonesia.

2. Modern Architecture

   Modern Architecture style performs a variety of new materials evolving a coloring a building appearance, such as ceramic, reflective glass, aluminum and galvanized.

3. Indonesian Architecture

   Indonesian Architecture style has also contributed to the overall appearance of

all streetscape. The prominent characters are the use of various shape of pyramid roof, wide overhang and use a natural colors like brown color and its variations.

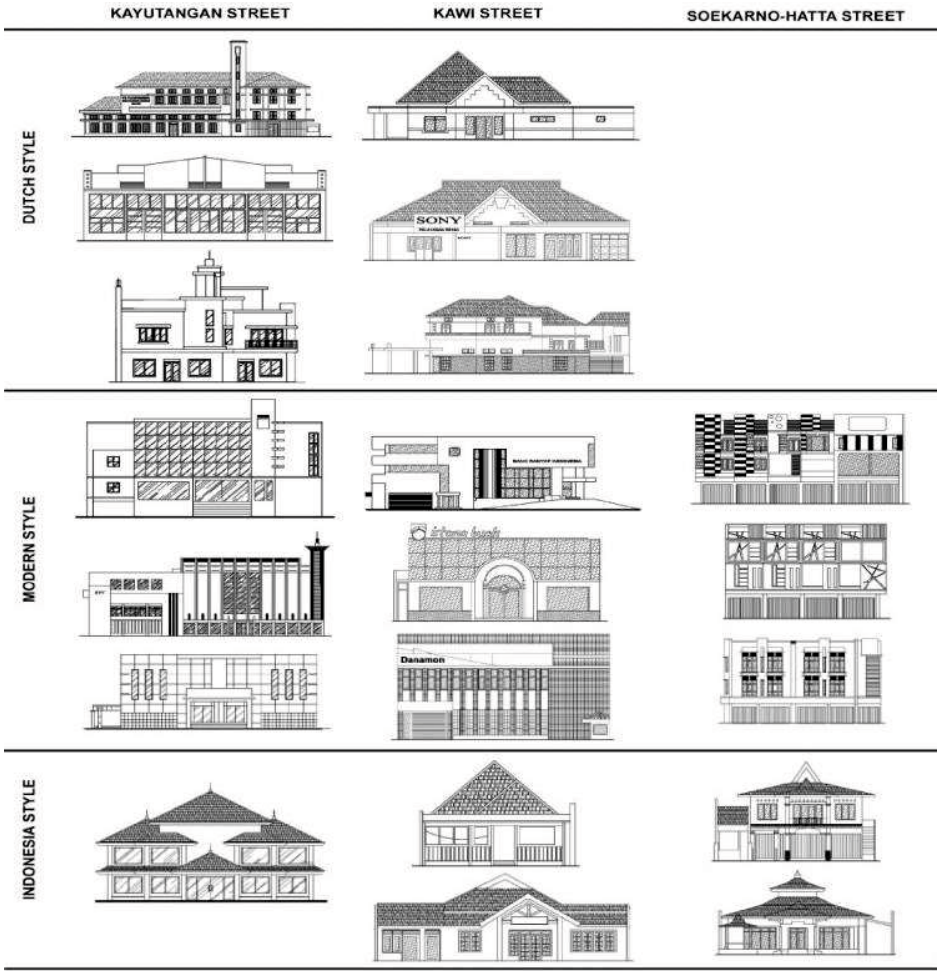


Figure 2-13 The emergence of three architectural style of commercial building façade

2.7 Preferences of Commercial Building Owners

2.7.1 Building owner characteristics

A total of 283 buildings was studied. The total number of successfully obtained questionnaire results was 173. The age characteristics of the respondents were very diverse. Kayutangan Street was dominated by the elderly (> 50 years), Soekarno-Hatta Street corridor was dominated by the young (20-50 years), and Kawi Street was dominated by the combination between the young (20-40 years) and the elderly (> 60 years). In tune with the age of respondents, Kayutangan Street was dominated by old buildings over the age of 40 to 50 years, Kawi Street was dominated by buildings over

the age of 20 to 40 years, while Soekarno-Hatta Street dominated by new buildings below the age of 20 years. (see figures 2-14 and 2-15).

Table 2-7 Total population of commercial buildings

Street Corridor	number of commercial buildings based on architectural style			Total
	Dutch	Modern	Indonesia	
Kayutangan street	37	66	1	**104**
Kawi street	10	23	17	**50**
Soekarno-Hatta street	0	102	27	**129**
Total	**47**	**191**	**45**	**283**

Table 2-8 A commercial types of building owners

types of commercial	a number of commercial function on each street (%)		
	Kayutangan	Kawi	Soekarno-Hatta
Bank	3.45	5.13	1.32
Cafe	1.72	17.11	0
Food stand	1.72	7.69	0
Home school	1.72	0	0
Hotel	1.72	0	0
Office	12.07	12.82	15.79
Restaurant	5.17	2.56	15.79
Salon	1.72	0	1.32
Shop	1.72	0	2.63
Showroom	1.72	0	0
Store	63.79	48.72	46.05
Fotocopy	0	2.56	0
Healthcare	0	2.56	1.32
Boutique	0	0	1.32

The identification and classification of the main types of commercial functions that are commonly found in the respondents are shown in table 2-9. The table is a summary of the complete table. Commercial activities are generally carried out on the ground floor only, but there are some commercial functions that use more than one floor. No merging of commercial functions in the three classifications was found. Generally, a merge function occurs between commercial functions with the residential function. Most of the buildings used in the sample functioned as stores, offices, or restaurants: 84,48% in Kayutangan Street, 69.23% in Kawi Street, and 82.89% in Soekarno-Hatta Street.

Table 2-9 Most common commercial functions of owners' buildings

commercial function	street		
	Kayutangan	Kawi	Soekarno-Hatta
store (%)	65.52	48.72	48.68
office (%)	12.07	12.82	15.79
café & restaurant (%	6.90	7.69	18.42
Total (%)	**84.48**	**69.23**	**82.89**

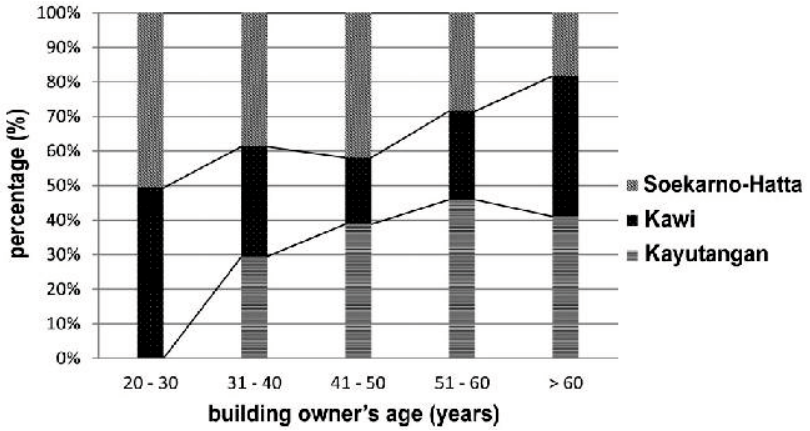


Figure 2-14 Characteristic of age of building owners

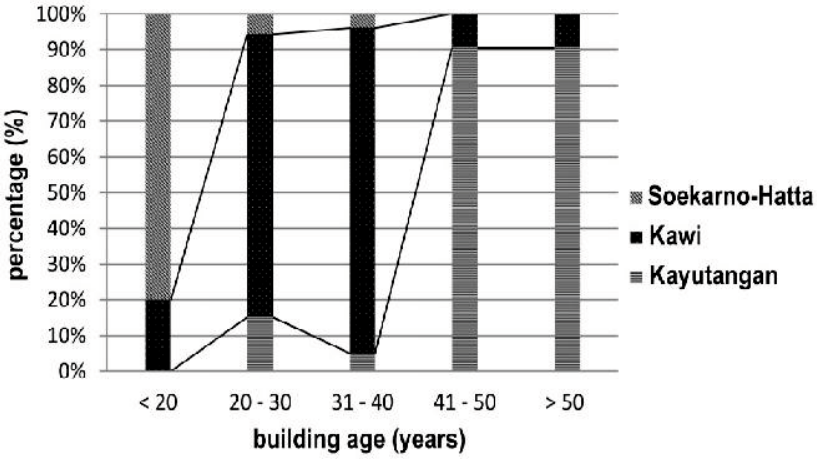


Figure 2-15 Characteristic of building age

2.7.2 Building owner preferences

According to the results of the questionnaire, most building owners seem to prefer a simple façade, an Indonesian façade style, no ornaments, a smooth texture, painted finishing, two colors, text and images for commercial signs, and combinations of sign placement.

Table 2-10 A number of visual characteristics of building owners[c]

Building Streetscape Characteristic		number of various types						
		Dutch style	%	Modern style	%	Indonesia style	%	Total
Building Profile & sidewalk	Building setback Profile shape Sidewalks width	4	23.53	7	41.18	6	35.29	17
Tree	Tree shade Tree height Leaf density	3	30.00	4	40.00	3	30.00	10
Façade form	Façade shape Façade detail Façade texture	5	31.25	6	37.50	5	31.25	16
Façade Finishing	Material finishing Façade colour Façade colour's theme	5	29.41	5	29.41	7	41.18	17
Sign	Sign shape Sign placement	5	23.53	6	41.18	5	35.29	16

This result was also grouped into three preference categories based on the architectural style of the commercial building, namely Dutch, modern, and Indonesian. This grouping was intended to get the owners' preferences for visual evaluation based on each façade style.

The result of the compilation of building owner's preferences imply two types of building owners' preferences among all street, as follows:

1. The similarity of the majority preferences of building owners among all street on eight characteristics, namely a medium tree height, a simple façade, no ornaments, a smooth texture, painted finishing, analogous color, text and images for commercial signs, and combinations of sign placement.
2. The dissimilarity from the majority preferences of building owners among all street on three characteristics, as follows:
   a) Respondents in Kayutangan and Soekarno-Hatta Street prefer to medium leaf density, while respondent in Kawi Street prefer to dense leaf density.
   b) Respondents in Kayutangan and Kawi Street prefer to Indonesian façade style, while respondent in Soekarno-Hatta Street prefer to Modern façade style.
   c) Respondent in Kayutangan Street prefer to monochrome color, while respondents in Kawi and Soekarno-Hatta Street prefer to two colors.

Moreover, the result also imply a significant a high percentage of preferences on five characteristics, namely a medium tree height, a smooth texture, painted finishing, façade color themes, and a combination text and images on sign shape

Table 2-11 Compilation of building owners' preferences

Characteristic of streetscape element (S)		Street		
		Kayutangan	Kawi	Soekarno-Hatta
S4 : Tree				
	tree height			
c	small (<4m)	13.80%	0.00%	15.79%
d	medium (4-8m)	79.31%	76.92%	76.32%
e	big (>8m)	6.90%	15.38%	6.58%
	leaf density*			
f	no dense	10.34%	7.69%	13.16%
g	medium	50.00%	35.90%	44.74%
h	dense	39.66%	48.72%	38.16%
Characteristic of building façade (B)		**Street**		
		Kayutangan	**Kawi**	**Soekarno-Hatta**
B1 : Façade style				
a	Indonesian	40.32%	71.43%	35.53%
b	Modern	25.81%	25.71%	50.00%
c	Dutch	22.58%	0.00%	3.95%
d	Mix	4.84%	2.86%	9.21%
B2 : Façade shape				
a	simple	75.86%	82.05%	50.00%
b	curved	1.72%	2.56%	2.63%
c	various shape	17.24%	10.26%	42.10%
B3 : Façade detail (ornament)				
a	have ornament	26.67%	33.33%	44.59%
b	no ornament	70.00%	61.54%	55.41%
B4 : Façade texture				
a	smooth	86.21%	90.91%	77.78%
b	rough	6.89%	6.06%	7.94%
c	shiny	0.00%	3.03%	14.28%
B5 : Façade finishing (material)				
a	painted	63.79%	76.92%	78.95%
b	cladding	3.45%	0.00%	5.26%
c	glass	25.86%	7.69%	7.89%
d	stone	0.00%	0.00%	0.00%
e	ceramic	0.00%	0.00%	0.00%
f	wood	1.72%	2.56%	3.95%
g	bamboo	0.00%	0.00%	0.00%
B6 : Façade color				
a	monochrome	31.03%	32.43%	14.86%
b	two color	27.59%	35.14%	35.14%
c	three color	20.69%	13.51%	29.73%
d	various color	17.24%	18.92%	18.92%
	color theme			
e	analogous	86.21%	82.05%	67.11%
f	complementary	12.09%	12.82%	34.27%
g	tertiary	0.00%	0.00%	0.00%
B7 : Commercial signs				
	sign shape			
a	text	18.97%	7.69%	5.26%
b	image	0.00%	2.56%	1.32%
c	text & image	77.59%	82.95%	85.52%
d	text & lighting	0.00%	0.00%	2.63%
	sign placement			
e	integrated	33.33%	24.32%	35.62%
f	separated	14.29%	5.41%	8.22%
g	combination	44.44%	62.16%	54.80%

*) Criteria of leaf density refers to the shade level of tree canopy.

Correlation analysis was also conducted on stage questionnaire data processing, which is used to find out the relation of the respondent's answer to aging building owners and building function factors[14].

Table 2-12 Correlation analysis between building use and characteristic of commercial building streetscape

Characteristic of streetscape element (S)	value of correlation significance		
	Kayutangan street	Kawi street	Soekarno-Hatta street
S4 : Tree			
tree height	0.391 **	0.405 **	0.944 **
leaf density	0.185 **	0.135 **	0.137 **
Characteristic of building façade (B)	**value of correlation significance**		
	Kayutangan street	Kawi street	Soekarno-Hatta street
B1 : Façade style	0.209 *	**0.016** *	0.536 *
B2 : Façade shape	**0.002** *	**0.001** *	0.174 *
B3 : Façade detail (ornament)	**0.019** *	**0.000** *	0.921 *
B4 : Façade texture	0.900 *	**0.000** *	0.653 *
B5 : Façade finishing (material)	**0.039** *	0.120 *	0.642 *
B6 : Façade color	0.987 *	**0.010** *	**0.000** *
color theme	1.000 *	**0.000** *	0.971 *
B7 : Commercial signs			
sign shape	1.000 *	0.106 *	**0.021** *
sign placement	0.554 *	**0.002** *	**0.000** *

*** based on Pearson Chi-square (α= 0,05)**
**** based on Spearman's Rho Correlation (α= 0,05)**

Table 2-13 Correlation between age of respondents and characteristic of commercial building streetscape

Characteristic of streetscape element (S)	value of correlation significance		
	Kayutangan street	Kawi street	Soekarno-Hatta street
S4 : Tree			
tree height	0.311 **	0.568 **	0.709 **
leaf density	0.106 **	0.127 **	0.350 **
Characteristic of building façade (B)	**value of correlation significance**		
	Kayutangan street	Kawi street	Soekarno-Hatta street
B1 : Façade style	0.885 *	0.535 *	0.729 *
B2 : Façade shape	0.306 *	0.853 *	0.507 *
B3 : Façade detail (ornament)	0.873 *	0.906 *	0.834 *
B4 : Façade texture	0.714 *	0.287 *	0.250 *
B5 : Façade finishing (material)	0.776 *	0.534 *	0.701 *
B6 : Façade color	0.679 *	0.604 *	0.226 *
color theme	0.768 *	0.653 *	0.108 *
B7 : Commercial signs			
sign shape	0.123 *	0.419 *	0.112 *
sign placement	0.210 *	0.886 *	0.135 *

*** based on Pearson Chi-square (α= 0,05)**
**** based on Spearman's Rho Correlation (α= 0,05)**

Based on the results of the statistical correlation analysis using the Pearson Chi-square and Spearman's Rho Correlation analysis (see table 10 and table 11), the following conclusions were obtained:

1. According to the Kayutangan Street respondents, there is a strong correlation between building use with facade shape, façade detail, and façade finishing (material).
2. According to the Kawi Street respondents, there is a strong correlation between building use and facade style, façade shape, façade detail, façade texture, façade color, façade color theme, and the placement of commercial signs.
3. According to the Soekarno-Hatta Street respondents, there is a strong correlation between building use and facade color, sign shape, and the placement of commercial signs.
4. The preferences of all respondents from the three streets show no relationship between the ages of respondents and the streetscape characteristics.

The presence a strong correlation between aspects of the building use with some characteristics of commercial buildings streetscape indicates that respondent's preference relating to the functions of its commercial buildings. It can be assumed that there are similarities preferences or opinions against some preference of commercial buildings streetscape criteria among the building's owner which has a similar commercial function. Moreover, the similarity of these preferences can be assumed that the owners of commercial buildings have similar opinions and desires to the formation of the commercial buildings streetscape on similar commercial type.

2.8 Comparison of the Field Survey (FS) and the Building Owners' Preferences (BOP)

A comparison of the field survey and the building owners' preferences is performed by comparing the value of the highest percentage. According to this result, there are four elements that have the same value of visual evaluation in all corridors, namely the characteristic of façade detail, façade texture, façade finishing, and shape of the commercial sign. The same preferences between field survey and the owner's preferences that found in one or two street corridors were as follows, the characteristic of tree height in Kayutangan Street, leaf density in Kayutangan and Soekarno-Hatta Street, facade style at Soekarno-Hatta Street, facade shape in Kayutangan Street, 8facade color and color theme in Kayutangan and Kawi Street. Meanwhile, the preferences that has no similarity on the three street completely, was found in the characteristics of sign placement.

Table 2-14 Comparison of visual evaluations from the result of the field survey and building owners' preferences

Characteristic of streetscape element (S) and building façade (B)		Street					
		Kayutangan		Kawi		Soekarno-Hatta	
		FS	BOP	FS	BOP	FS	BOP
S4 : Tree							
	tree height						
a	small (<4m)						
b	medium (4-8m)	●	○		○		○
c	big (>8m)			●		●	
	leaf density						
d	no dense						
e	medium	●	○	●		●	○
f	dense				○		
B1 : Façade style							
a	Indonesian		○		○		
b	Modern	●		●		●	○
c	Dutch						
d	Mix						
B2 : Façade shape							
a	simple	●	○		○		○
b	curved						
c	various shape			●		●	
B3 : Façade detail (ornament)							
a	have ornament						
b	no ornament	●	○	●	○	●	○
B4 : Façade texture							
a	smooth	●	○	●	○	●	○
b	rough						
c	shiny						
B5 : Façade finishing (material)							
a	painted	●	○	●	○	●	○
b	cladding						
c	glass						
d	stone						
e	ceramic						
f	wood						
g	bamboo						
B6 : Façade color							
a	monochrome	●	○				
b	two color			●	○		○
c	three color						
d	various color					●	
	color theme						
e	analogous	●	○	●	○		○
f	complementary					●	
g	tertiary						
B7 : Commercial signs							
	sign shape						
a	text						
b	image						
c	text & image	●	○	●	○	●	○
d	text & lighting						
	sign placement						
e	integrated	●		●		●	
f	separated						
g	combination		○		○		○

FS : Field survey
BOP : Building Owner Preference

2.9 Conclusion

The results of this study indicate that there are three kinds of typology for the commercial building streetscapes in Malang: Dutch, Indonesian, and modern. The characteristics of each typology are as follows:

1. Typology of Dutch style
   a) Dominated by the Nieuwe Bouwen style, characterized by horizontal and vertical shapes, flat roofs, and white paint
   b) Sidewalks positioned adjacent to the building frontage creating a shopping arcade corridor
   c) The presence of trees with a dense leaf type lined along the sidewalks, forming a corridor along the building frontage
2. Typology of modern style
   a) Dominated by contemporary architecture characterized by an irregular building form and the use of various shapes and colors
   b) Sidewalks mostly separated from the building frontage by parking lots
   c) Placement and selection of trees along the sidewalks intended more for aesthetics than for shade
3. Typology of Indonesian style
   a) Can be formed in a modern or traditional style. Mostly, building form is simple, and natural materials are used. However, the prominent feature is the use of a gable roof.
   b) Mostly, sidewalks are separated from the building frontage by a parking lot or open space
   c) Placement and selection of trees along the sidewalk are intended for both shade and aesthetic function

It might be concluded that building use influences preferences. Owners of commercial buildings with similar functions appear to have preferences similar to the characteristics of the commercial building streetscapes. This might correspond with Nasar (1998), as cited in Michelson (1976)[11]: "Groups of individuals of similar cultural or socioeconomic characteristics share common meanings and evaluative images."

Three types of judgment also implied from the comparison of the field survey and the building owners' preferences:

1. Coincident

   The preferences of building owners coincides with the existing of streetscape, especially in the facade detail, facade texture, facade finishing, and the shape of commercial signs.

2. Incongruity

   The preferences of building owners have no coincident with the existing of streetscape, especially in tree height, leaf density, the façade style, façade shape, façade color and color themes, and placement of commercial signs.

3. Similar opinion

   Most of the building owners imply a similar opinion to the existing of streetscape, especially in the tree height, façade style, façade shape, façade detail, façade texture, façade finishing, the color theme of façade, shape of commercial signs, placement of commercial signs.

Table 2-15 Streetscape typology of the comparison between field survey and owners' opinions

Elements of Building Streetscape		STREETSCAPE TYPOLOGY					
		Dutch Architecture		Modern Architecture		Indonesian Architecture	
		Field Survey	Owner's opinion	Field Survey	Owner's opinion	Field Survey	Owner's opinion
Building Profile & sidewalk	Building setback	no		> 2m		> 2m	
	Profile shape	canopy		prominent-canopy		canopy	
	Sidewalks width	>2m		no		1 - 2 m	
Tree	Tree shade	provide shade	provide shade	no tree	provide shade	provide shade	provide shade
	Tree height	small-medium	medium-big	no	medium-big	medium-big	medium
	Leaf density	medium	medium	no	dense	medium	dense
Façade form	Façade shape	simple	simple	various shape	simple	various shape	simple
	Façade detail	no ornament	no ornament	no ornament	no ornament	no ornament	no ornament
	Façade texture	smooth	smooth	smooth-shiny	smooth	smooth	smooth-shiny
Façade Finishing	Material finishing	painted	painted	painted	painted	painted	painted
	Façade colour	monochrome-two-three colours	monochrome colors	monochrome-two-three colours	monochrome-two colors	two-three colours	three -various colours
	Façade colour's theme	analogus	analogus	analogus-complementary	analogus	complementary	analogus
Sign	Sign shape	text & image	text & image	text + image	text&image	text + image	text&image
	Sign placement	integrated+ combination	combination	integrated+ combination	combination	integrated+ combination	combination

All building owner preferences for the Kayutangan Street area nearly accord with the existing conditions. The interesting preferences from the Kayutangan and Kawi respondents show that the majority of respondents prefer the Indonesian façade style. This may lead to the assumption that a building's owner is considered to have a strong role in the changing conditions of the Kayutangan streetscape formation.

Significant differences also appear in the respondents from Soekarno-Hatta Street. The three characteristic elements of the façades show that the existing façades in the Soekarno-Hatta corridor, mostly use varied shapes, a variety of colors, and a blend of complementary colors. In contrast, the majority of building owners prefers a simple form and the use of two colors with a blend of analogous colors.

Finally, the results of the identification characteristics of the streetscapes of commercial buildings through the field survey were compared with the results of building owners. The diversity of characteristic shows the pattern of streetscape typologies (see table 2-15). There are two significant differences to the streetscape characteristic between the result of field survey and the owner's opinion, namely the characteristic of tree in Modern Architecture and the characteristic of façade finishing in Modern and Indonesian Architecture.

At later stage, a compilation of the diverse typologies of commercial building streetscapes will be used as a database for the development of a system of decision making in urban planning through the development of VR system as one method of urban simulation. The purpose of using urban simulation is to present the reality simulation to the observer and predict responses to real situations. Furthermore, a VR system could make an interactive model for a good design decision and get more responses and attention from the wider community.

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Notes

a) Alun-alun (in earlier times was written as Aloen-aloen or Aloon-aloon) is a wide open field that is surrounded by a grassy road and it can be used for a variety of community activities. Alun-alun 'Merdeka' was first built by the Dutch government in 1882. The spatial concept of Alun-alun is actually derived from the conception of spatial structure of the traditional city on Java Island. The important buildings were constructed around the Alun-alun include the palace of the king (the local authorities), the Great Mosque, and other official buildings. In Dutch Colonial era, Alun-alun was used as an administrative center and symbol of colonial power. This resulted that Alun-alun perform as the center of Malang city until today.

b) Term "Dutch Architecture" is defined as the architecture that was built when the Dutch colonization in Indonesia. Term "Modern Architecture" is defined as the architecture that was built after Indonesia's independence and not oriented towards architectures such as the Dutch colonization, and tends to follow the development of architecture at the time. Term "Indonesia Architecture" is defined as the architecture that characterize the locality and culture of Indonesia

c) A number of various types of building profiles and sidewalks have the same number with a number from field survey. This element is not the subject of questionnaire to the building's owner and this element function as the preference's background to other building visual elements.

Chapter 3

DEVELOPMENT OF LANDSCAPE PLANNING SUPPORT SYSTEM USING INTERACTIVE 3D VISUALIZATION

Chapter 3
DEVELOPMENT OF LANDSCAPE PLANNING SUPPORT SYSTEM USING INTERACTIVE 3D VISUALIZATION

3.1 Introduction

Architects and urban planners have a responsibility to create urban spaces that ensure that an urban experience is comfortable and satisfying for the community. The evaluation of urban images is an important way to ensure a valuable aesthetic experience. Because the evaluation process is closely related to humans and the environment (Nasar, 1998)[8] and in order to obtain an adequate evaluation results, the process of urban planning should involve effective public participation.

On the other hand, the government should be anticipate urban growth through proper urban planning. Further, the community requires the delivery of design ideas through a process of public participation in a medium that is easily understood by them (Laing, 2011)[7]. Public participation activities should be conducted in the initial stages of the planning process and urban design. The earlier and more intensively the public are involved in an urban planning project, the more likely the project will be to succeed (Wu et al., 2010)[14]. Hence, governments require proper advice and an effective response from the community regarding any city spatial planning efforts.

According to Paar (2006)[9], the demand for 3D visualizations for landscape and environmental planning depends on country-specific planning procedures, the economic situation, and the level of public participation. This process is also related to the strategic approach to be made to the public which must be adapted to the development of technology and culture. Computer visualization can be optimally used in the planning process to build an environment through community involvement if the method is popular in the community and these technologies are easily accessed and operated. Moreover, 3D visualization in VR technology has been greatly developed rapidly. When virtual reality systems were developed in the late 1980s, a further window of opportunity opened for architectural and urban visualization, and they hold promise for public participation planning as well (Al-Kodmany, 2000)[1]. Until now, the development of VRML provide a major influence on the development of the methods of planning and design of the built environment that leads to the formation of a more interactive visualization.

Indonesia is a developing country that requires expert help and better techniques to design city plans more effectively. The urban landscape has grown rapidly and uncontrollably in Malang, especially the Kayutangan streetscape, an important historic corridor in Malang. The Kayutangan streetscape had undergone some significant changes that include the demolition of some historic buildings, an emergence of

unbalanced modern buildings, a narrowing of the sidewalk, original building façades that have been covered or changed color, and a disorderly abundance of commercial boards along the street.

The conventional method of urban planning that involves direct meetings with the public is perceived as incapable of handling the rapid growth of Malang. Images and other 2D media presentations are also less favored because of the varying levels of public understanding of technical drawings. On the other hand, advanced computer technology and Internet communication have spread quickly throughout Malang society. This is an opportunity to develop online public participation utilizing web technology. Further, virtual environments in planning support systems require user interaction for observation and navigation. Through interaction, the user is expected to freely explore the space as well as asses it. Therefore, it is necessary to develop an interactive 3D simulation system for urban planning that can be distributed via the web.

With respect to the development of interactive 3D simulation, there are many studies in Japan that use Virtual Reality (VR). Honjo and Lim (2001)[2] studied the visualization of landscape in a garden and introduced an interactive simulation for various design scenarios. Koba and Kishimoto (2009)[5] examined desirable building forms and façades in Marunochi. Further, several researchers have developed VR systems and user (web) interfaces for building consensus. Kawakami and Shen (2006)[4] assisted consensus in public participation by developing a decision support system for district planning in Kanazawa city. Koga et al. (2008)[6] developed a landscape planning support system for public participation that also used models as an analog tool. Takiguchi et al. (2009)[12] developed multi-media tools to support town-planning workshops. Shen and Kawakami (2010)[11] developed a visualization tool on a multi-user platform to represent design alternatives and supplement traditional presentation material for reaching a consensus on townscape designs.

Many studies have developed, tested, and proved various visualization models, including web-based interfaces. Almost all these user interfaces directly focus on the interactive 3D simulation and comprise a wide range of interactions panels from simple to complex. However, no one has emphasized the need for adequate design of the user interface for the interactive 3D visualization, nor considered the diversity of user understanding in developing countries. Especially for developing countries, not everyone is able to operate the system properly. On the other hand, a user interface design should encourage people to engage in decision making. Therefore, it is necessary combine an interactive 3D simulation with an appropriate user interface.

Furthermore, the use of interactive 3D visualization to facilitate public participation is most likely a genuinely new approach for Indonesian countries. Therefore, this system is most probably the first one in Malang. In addition, the most of the

participants will have never seen or used a similar system. Hence, in order make it easy for participants to utilize the system, we propose a strategy for interactive 3D simulation that embeds three types of 3D simulation: passive observation, active navigation, and active interaction.

In summary, the development of landscape planning support system through the use of interactive 3D visualization in the developing country (Malang City, Indonesia) has some significance, as follows:

1. Indonesia is a former colonial country that has many heritage of historic colonial buildings and also historic streetscape, especially in big cities such as Malang City.
2. Recently, the uncontrolled and rapid development of commercial buildings has influenced the visual appearance and development of the streetscape in Malang, especially in the historic streetscape on Kayutangan Street.
3. The city planning regulation could not act immediately and firmly to anticipate the uncontrolled growth of commercial buildings and it also seem incapable to encounter the intervention of commercial interests.
4. Referring to the developed countries, an interactive 3d simulation system has been used in city planning support system and had proved effective to encourage public participation in the decision-making.
5. Therefore, the development of similar systems need to be piloted in developing countries in order to assist city and local governments to anticipate the development of the city streetscape through effective public participation and the development of an adequate system.

3.2 Research Framework

This study was a follow-up of previous study. The results of previous research on visual evaluation generated a streetscape typology and three types of judgments. Four stages were performed to develop the landscape planning support system, as follows:

1. The concept of 3D visualization
   Six concepts were performed to develop an effective 3d modeling.
2. Development of 3D visualization
   Two types of simulation were developed to support the interactive level hierarchy.
3. Development of user interface
   The development three types of user interface: basic interactive level, intermediate interactive level, and advanced interactive level.
4. The workshop
   A pilot workshop was conducted to perform testing, evaluation and feedback in order to improve the system.

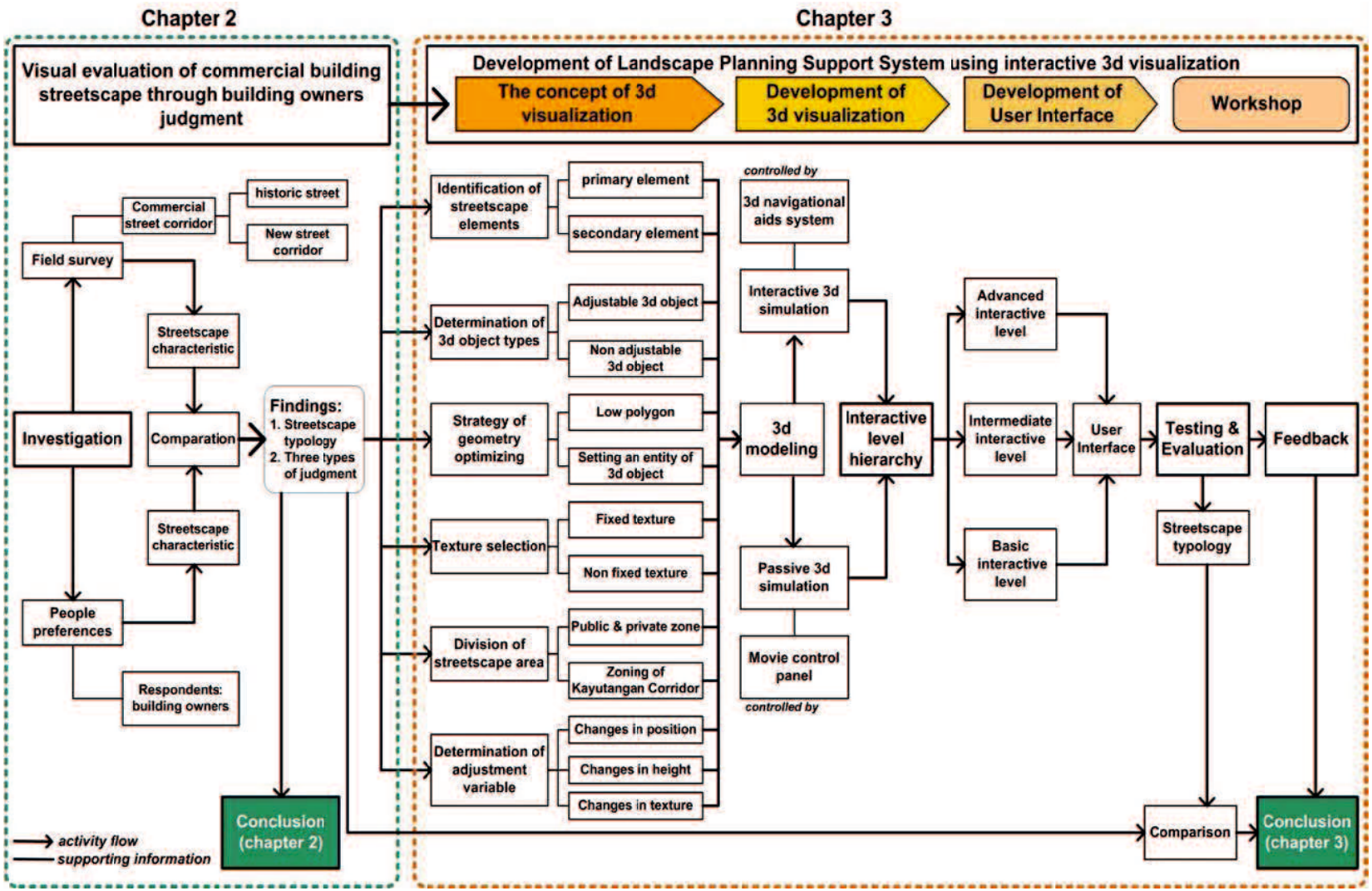

Figure 3-1 Flowchart of the research

3.3 Early Studies: Visual Evaluation of the Kayutangan Streetscape

This study focused on a commercial building streetscape in a historical district, the Kayutangan Street corridor, which has been a commercial area in Malang since 1914, during the Dutch colonial period. The urban image of the Kayutangan streetscape is a symbiosis of the Nieuwe Bouwen[a)] style, with wide sidewalks and trees arranged along the street. Overall, it embodies the concept of a Dutch tropical city that has been adopted as the basis for the conservation of the Kayutangan area.

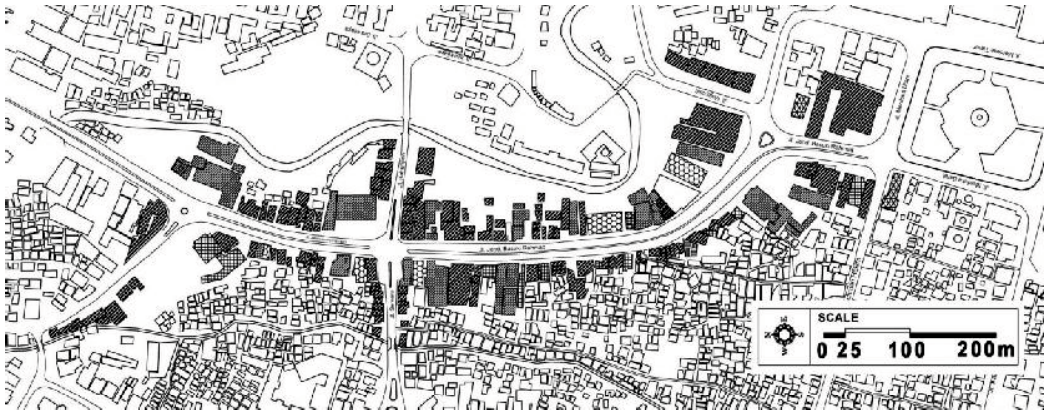

Figure 3-2 Map of Kayutangan Street

The Kayutangan streetscape is conserved by control of the buildings and environment through regulations for building coverage (KDB), floor ratio (KLB), floor height (TLB), green coverage (KDH), and building setback (GSB). Based on regulatory reviews between 2001 to 2011, the rules were changed regarding the development of new commercial buildings in the Kayutangan area as follows: building coverage decreased by 10%, maximum floor ratio limit increased to 3.0, building height increased between 4–20 floors, green coverage was 40%, and building setback now ranges between 4–13 m. The sidewalk width also was narrowed from 4 to 2 m to widen the street. There is not much awareness of the need to preserve the unity of the sidewalk width with the historic buildings along Kayutangan streetscape. In summary, the present regulations are not capable of conserving the Kayutangan streetscape as a whole.

Recently, the Kayutangan streetscape has gradually degraded in visual quality because of the inability of weak city regulations to preserve historical and cultural assets. The Kayutangan streetscape had undergone some significant changes that include the demolition of some historical buildings, emergence of unbalanced modern buildings, narrowing of the sidewalk, covering of original building façades, color changes of building façades, and the disorderly abundance of commercial boards along the street. The rapid and uncontrolled development of the new commercial street corridor has led to the construction of a city streetscape simply for economic interests

and disregarded a structuring of qualified urban space. Hence, the reflection of the historical urban space is necessary to be the basis of city planning and designing.

A visual evaluation of Kayutangan streetscape investigated the physical characteristics of the streetscape elements consisting of building setback, setback profile, sidewalk, trees, and building façades. The investigation determined three typologies of commercial building streetscapes (Santosa et al. 2013)[10], as follows:

1. Dutch style (see Fig. 3-3)
   a) The building styles are dominated by the *Nieuwe Bouwen*[a)] style, characterized by horizontal and vertical shapes, flat roofs, and white paint.
   b) Sidewalks are positioned adjacent to the building frontage, creating a shopping arcade.
   c) The presence of trees in general functions optimally as shade and an aesthetic.
2. Modern style (see Fig. 3-4)
   a) The building styles are dominated by contemporary styles, characterized by an irregular building form and the use of various shapes and colors.
   b) The sidewalk position is almost always separated from the building frontage by parking lots.
   c) The presence of trees in general is intended more for aesthetics than for shade.
3. Indonesian style (see Fig. 3-5)
   a) The building styles are divided into two styles, modern and traditional. The building form is characterized by a simple shape, the use of natural materials, and a gable roof.
   b) The sidewalk position is almost always separated from the building frontage by a parking lot or open space.
   c) The presence of trees in general optimally functions as shade and an aesthetic.

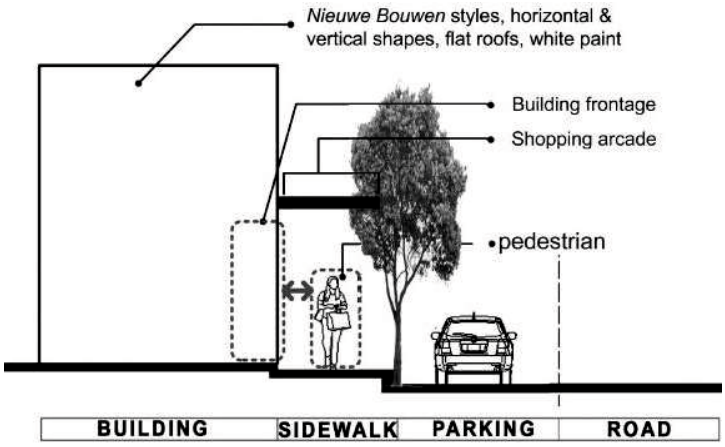

Figure 3-3 Streetscape typology of Dutch style

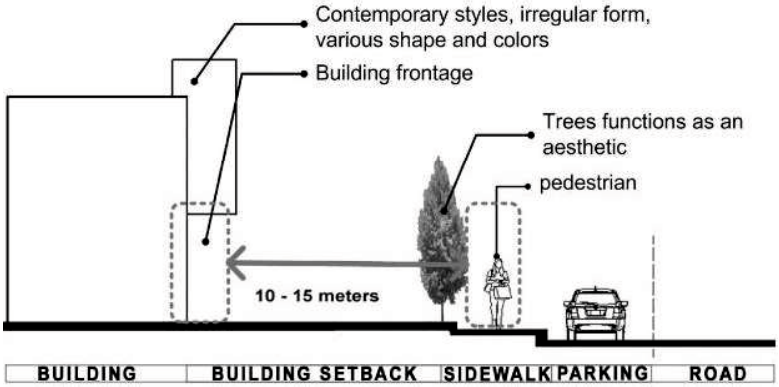

Figure 3-4 Streetscape typology of Modern style

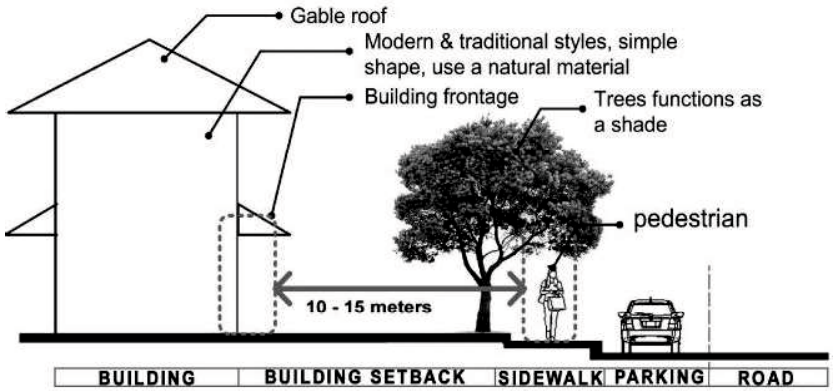

Figure 3-5 Streetscape typology of Indonesian style

The results of this study were utilized as a basis for the 3D visualization that consists of six concepts, i.e., the identification of streetscape elements, determination of 3D object types, geometry optimization, texture selection, division of streetscape areas, and adjustment of the variables. The six concepts of the 3D visualization determined the development of an interactive 3D simulation in order to create constructed interactive types for each of the streetscape elements.

3.4 The Comparison of System Development

The main differences between the developments of the new system with the previous system are the use of 3d shockwave as 3d modeling language and 3d Lingo scripting as 3d programming language in order to develop an effective 3d interactive simulation. Moreover, a proposed system combined a passive simulation and interactive simulation and developed multi/ hierarchical interface (see table 3-1).

	No.	Variable	Previous System *)	Proposed System
Main tools	1	Modeling languages	VRML	Shockwave 3D
	2	Programming languages	JavaScript	3D Lingo Script
	3	Main software	Internet Explorer	Adobe Director
	4	Supporting software/plugin	Cosmo player	Shockwave player
3D Visualization	5	Types of visualization	Virtual Environment	Animation & Virtual Environment
	6	Types of simulation	Interactive simulation	Passive & Interactive simulation
	7	Geometry detail	Low polygon	Medium polygon
	8	Texture	Solid, color and photo image mapping	Solid, color and photo image mapping
The Changes of Streetscape Elements	9	Element of Private Zone	Building height	Building height
			–	Building setback
			Building color	Color of building façade
			–	Building removal
	10	Element of Public Zone	–	Sidewalk material
			Tree height	Tree height
			–	Street lighting
			–	Street advertising
			–	Street profiles (4 types)
User Interface Design	11	Number of user interface	single interface	Multi/Hierarchical interface
	12	3d simulation	two screens	one screen
	13	Button panels	text button	text & image/symbol button
	14	Interaction guidepanel	–	provided
Advanced operation	15	Reset model	provided	provided
	16	Save model	–	provided (shockwave 3d)

*) Based on the research of M. Koga, S. Ikaruga, K. Tadamura, A. Ohgai, and M. Matsuo: Study on Image Sharing Support Method in Landscape Planning Using Information Technology [7)]

Table 3-1 The comparison of system development against the previous system

3.5 Method of System Development

3.5.1 The concept of 3d visualization

The 3D visualization concepts consist of six basic 3D modeling construction concepts to guide the development of the 3D simulation. Each of the concepts are defined as follows:

1. Identification of streetscape elements

   Streetscape elements were divided into primary and secondary elements. The primary element is the main 3D object for the simulation, while the secondary elements are the supporting objects of the simulation.

2. Determination of 3D object types

   This concept divides 3D objects into adjustable (non-fixed) and non-adjustable (fixed) objects. The determination was based on the targeted object of the simulation.

3. Geometry optimization

   The geometry was optimized by reducing the number of polygons (low polygons) and constructing a single entity for each object. This strategy reduces the file size and

affects the access and interaction speed.

4. Texture selection

Texture types were divided into fixed and non-fixed textures. Fixed textures are permanent texture that cannot be changed, while the non-fixed textures are changeable.

5. Division of streetscape area

Because of the complexity as well as the vast area of the simulation, it was necessary to divide the streetscape area into two types: the division of the streetscape into public and private zones and the division of the Kayutangan street into three zones (zone 1, zone 2, and zone 3).

6. Adjustable variables

The alteration or adjustments of 3D objects are categorized into three types, namely the changes in position, height, and texture.

3.5.2 Development of 3D simulation

Almost none of the participants will be familiar with the system, and therefore, well-designed visualizations and interactive tools can help improve their participation in the urban planning processes (Wu et al., 2010)[14]. The development of effective navigation in a 3D simulation can also help determine a strategy, direction, and course (wayfinding) to achieve a desired goal (Volbracht and Domik, 2000)[13]. Moreover, the user interaction capability of navigation is essential for assessing the spatial qualities of a 3D simulation. Therefore, the development of various navigation and 3D simulations was designed to ease understanding and improve the ability of the user to interact.

Given the diversity of understanding and ability to interact with a 3D simulation as well as fostering familiarity with the system, three types of 3D simulation were developed in order to stimulate a rich understanding and interest the public. The three types of 3D simulation were categorized at three levels of interaction, characterized by the capability of the simulation to interact with the user (see Fig. 3-6). The three categories are as follows:

1. Type 1: Basic interactive level

The basic interactive level is the lowest level of user interaction with the system. The 3D simulation at this level is passive observation. It offers a walkthrough animation of various of streetscape compositions, and users observed the model during the predefined animation. Users could score the animation on a scale of 1–7.

2. Type 2: Intermediate interactive level

The intermediate interactive level is the second level of user interaction with the system. The 3D simulation at this level is active navigation. It offers a VR of various streetscape compositions. Users perform a walkthrough and affect their motion in the

virtual environment through navigation aids. Users can also score the simulation on a scale of 1–7.

3. Type 3: Advanced interactive level

The advanced interactive level is the third level of user interaction with the system. The 3D simulation at this level is active interaction. It offers a VR for various streetscape compositions. Users perform a walkthrough, affect their motion, and interact with 3D objects in the virtual environment through navigation aids and a number of provided control panels. The user can save the results of modifications to a file for the benefit of decision-making.

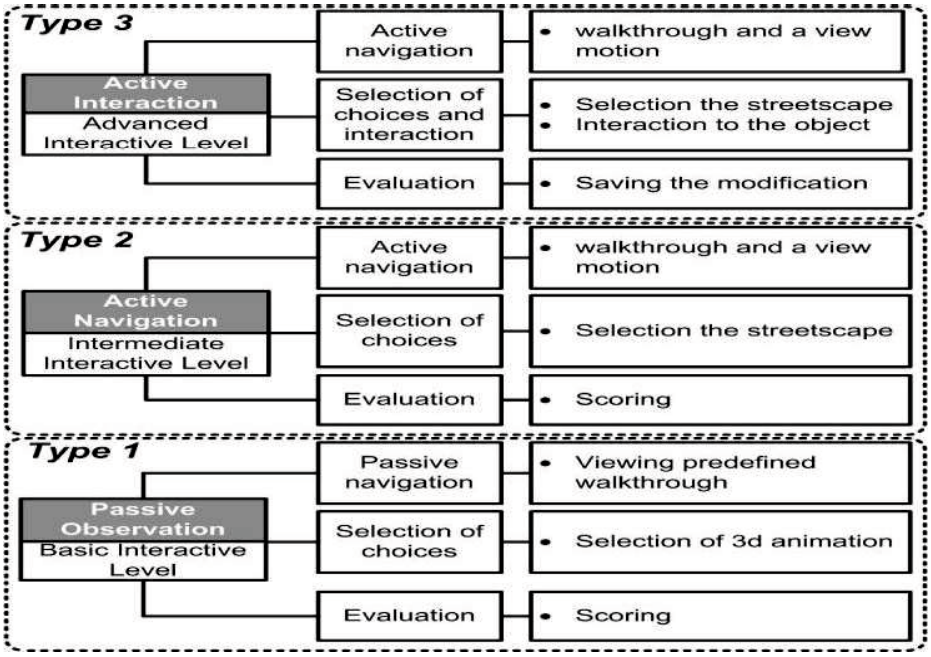

Figure 3-6 A three types of 3d simulation

The system development utilized three software applications[b)] consisting of 3D modeling software, 3D visualization software, and a multimedia application authoring platform. The 3D modeling software was used to produce various types of 3D modeling. The 3D visualization software was used to produce a predefined walkthrough animation. Both types of data, 3D modeling and animation, were processed using a multimedia application authoring platform (see Fig. 3-7).

The multimedia application authoring platform has an advantage in that in the design of the graphical user interfaces is supported by a scripting language that can interact with external files. In addition, this application is able to work with 3D objects (shockwave 3D)[d)] using a scripting 3D language[c)] that can import, manipulate, display, and interact with 3D objects.

The graphical user interface that combined the external data of the passive 3D simulation with the 3D interactive simulation formed the prototype system called the

Landscape Planning Support System. This system can be published as a standalone executable or as Hyper Text Markup Language (HTML) files on the web. The overall system development process is shown in Fig. 3-7.

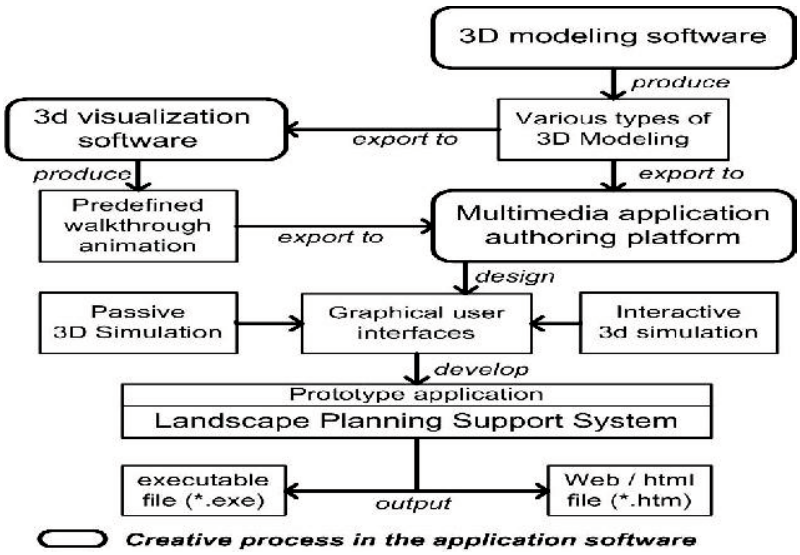

Figure 3-7 Scheme process of system development

During the development of the interactive 3D simulation, 3D navigational aids were developed as a user interaction tool in the virtual environment. System navigation strategies should consider the type of user interaction required in the virtual environment. The system must be easy to use, should not confuse the user, and must be customized for user interaction.

3.5.3 Development of user interface

According to many studies on web applications, user interface design is highly important for successful user interaction. Some principles of good user interface design are user compatibility, task compatibility, workflow compatibility, consistency, familiarity, and simplicity. The lack of understanding about adequate user interface design undermines a user's desire to interact with a system. The Indonesian language is one part of the culture of communication[g] in the Malang community and was used in all of the instructions and user interface information. Thus, the system was expected to be more easily understood and operated by users in Malang.

The user interface integrates passive and interactive 3D simulation into a complete prototype application. It was designed to be a media solution and communication tool for users. With an appropriate user interface, the system was expected to attract public interest and elicit more contributions and input into urban planning.

Because of the large number of buildings and variable settings for each element, the interface panels constitute many interactive panels and navigational aids. Clearly, this

will create a reluctance to operate the system. Therefore, the interactive panel and navigational aids should be made more simple, interesting, and easy to understand. Moreover, in order to create a system that is easy to run, the user interface was divided into three zones of the Kayutangan streetscape (see Fig. 3-8), and also separated between the public and private zones, especially at the advanced interactive level.

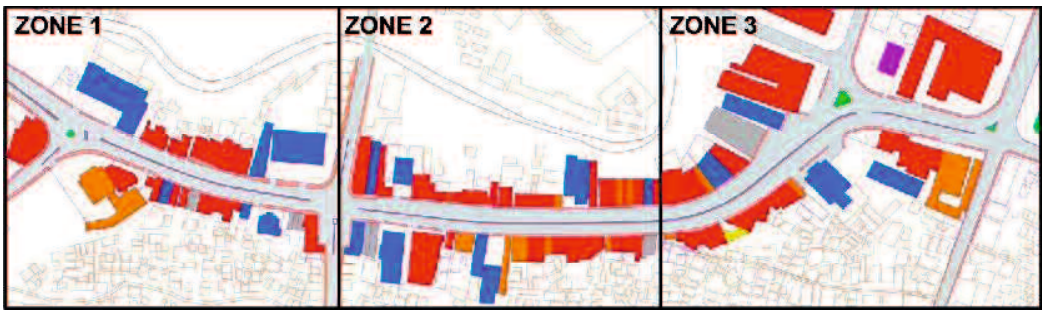

Figure 3-8 Zoning of Kayutangan streetscape

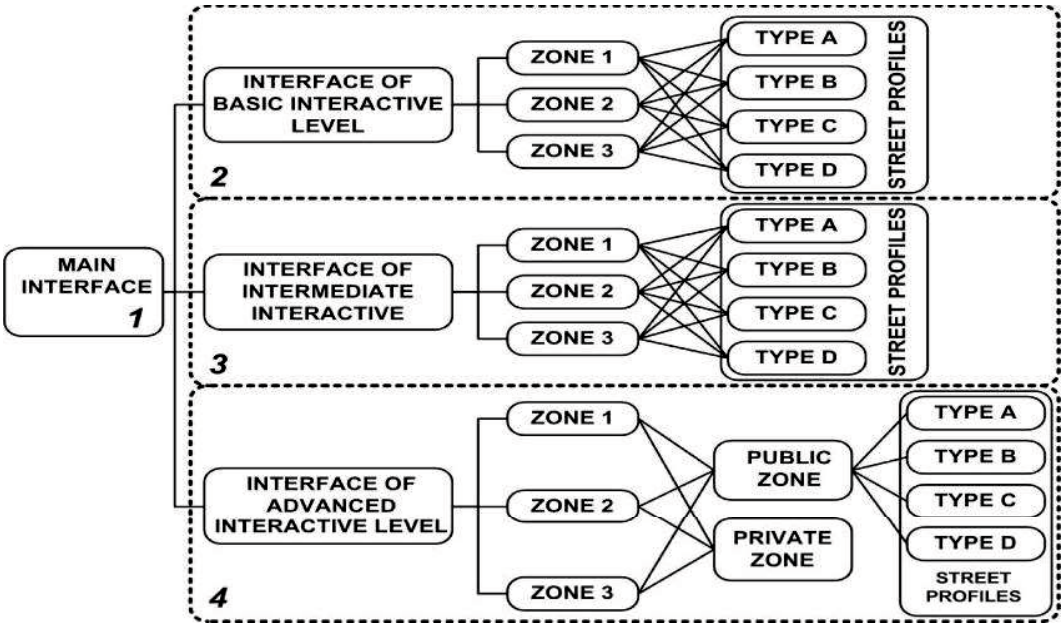

Figure 3-9 Scheme of user interface design and diagram of interactions

The user interface was divided into four primary sections (see Fig. 3-9) as follows:

1.Main interface

The main interface functions as a gateway to the system that contains introductory information.

2.User interface of basic interactive level

At the basic level, the user interface is divided into four sections consisting of a 3D

simulation panel, guidance map, street profile type selection button, and scoring panel (see Fig. 3-10). The 3D simulation panel shows a predefined walkthrough animation of the Kayutangan streetscape. This animation was categorized as a passive interaction or observation[4] because the user only observes the various simulated types of streetscapes as a movie. On the right panel, there are four types of street profile that can be selected and linked to the 3D simulation panel as follows:

1. Type A: the existing street profile of Kayutangan Street characterized by the presence of a sidewalk, on street parking, and street divider.
2. Type B: the street profile characterized by a setting of the sidewalk, small garden, and on street parking as a unified design.
3. Type C: a street profile characterized by the integration of greenery in the street median.
4. Type D: a street profile that combines types B and C.

The guidance map panel gives directions to the streetscape zone position on Kayutangan Street. To evaluate each type of streetscape choice, a scoring panel is provided at the bottom into which a user can input a score. The range of scores from 1 to 7 indicates agreement to disagreement.

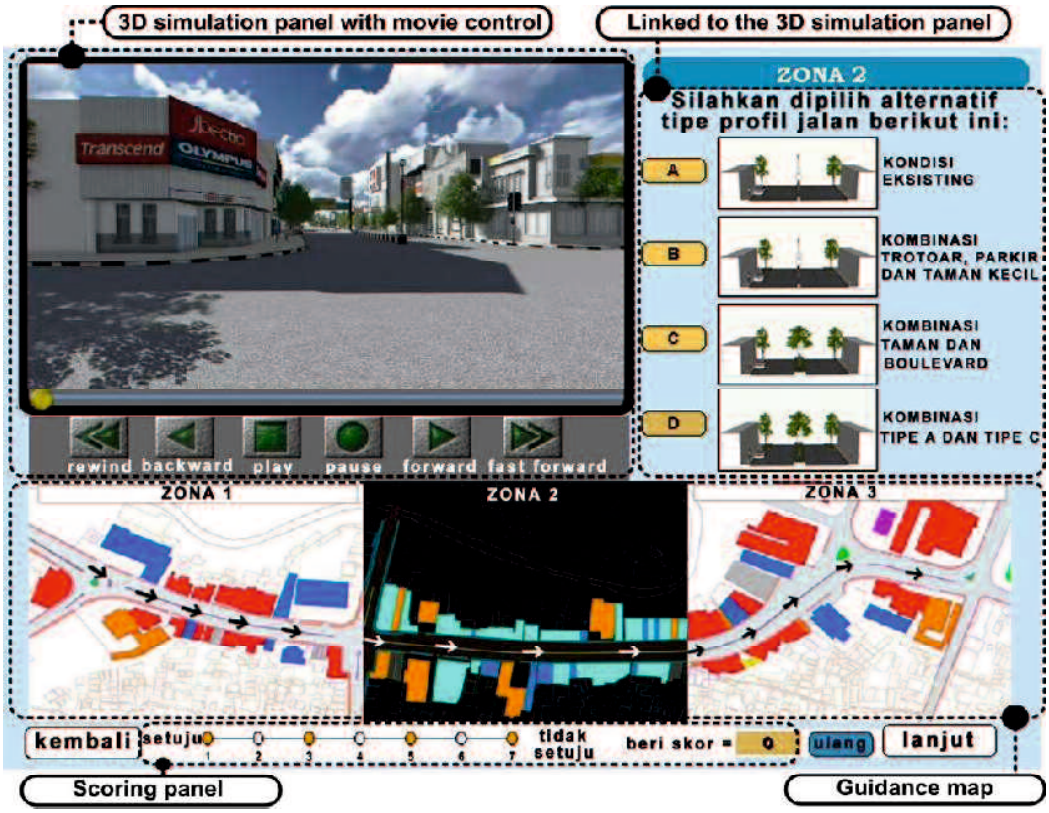

Figure 3-10 User interface of basic interactive level in zone 2

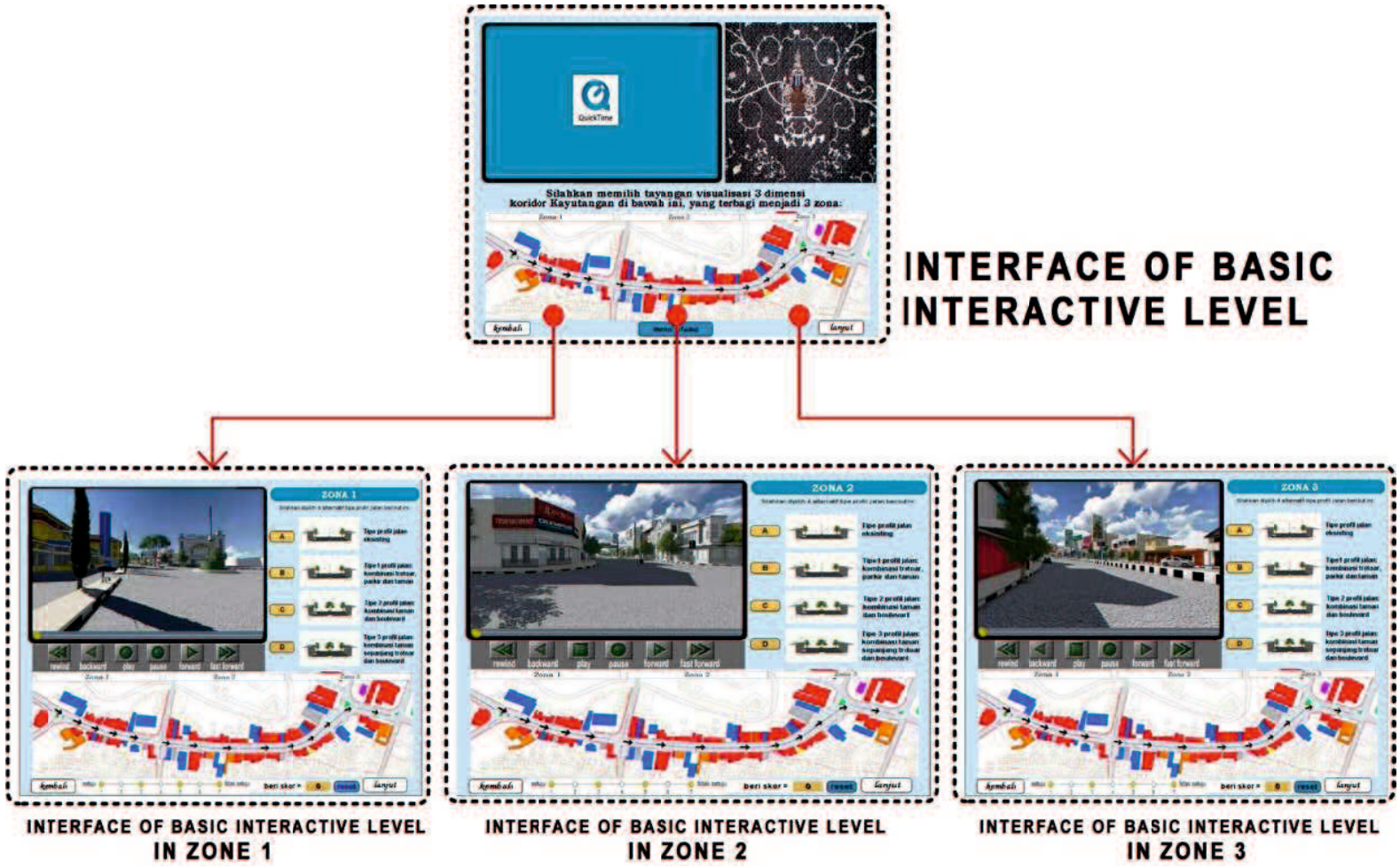

Figure 3-11 User interface design of basic interactive level

3. User interface of intermediate interactive level

At the intermediate level, the user interface is divided into four sections consisting of a 3D simulation panel, interaction guide, selection panel for 3D simulation types, and a scoring panel (see Fig. 3-12).

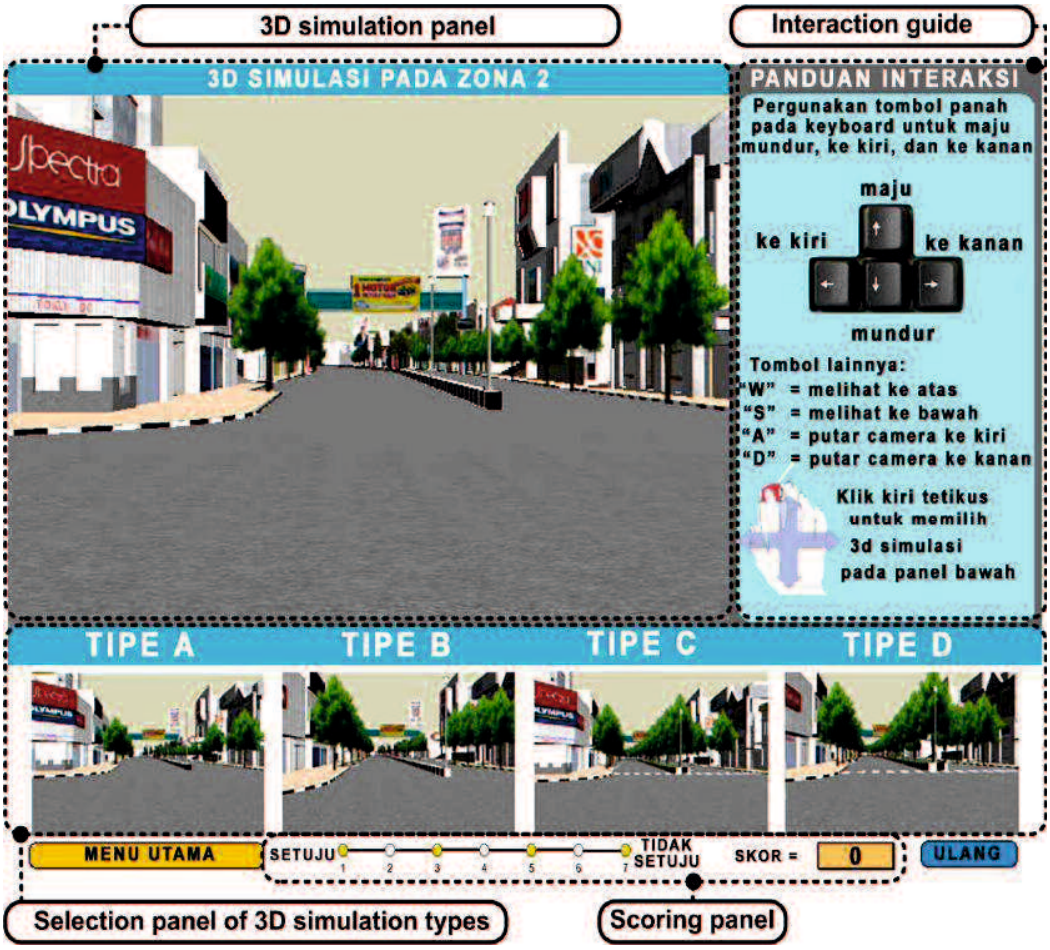

Figure 3-12 User interface of intermediate interactive level in zone 2

The 3D simulation panel presents the virtual environment of the Kayutangan streetscape. This simulation is categorized as an active navigation because the user has the opportunity to visually observe various simulation types of the Kayutangan streetscape. On the right, there is a guide that describes the use of a keyboard and mouse to assist the user's navigation through the 3D simulation. Meanwhile, the selection panels of the 3D simulation types present choices based on the four types of street profile. For the evaluation, a scoring panel was also provided at the bottom of the interface which a user can input a score. The range of scores from 1 to 7 indicates agreement to disagreement.

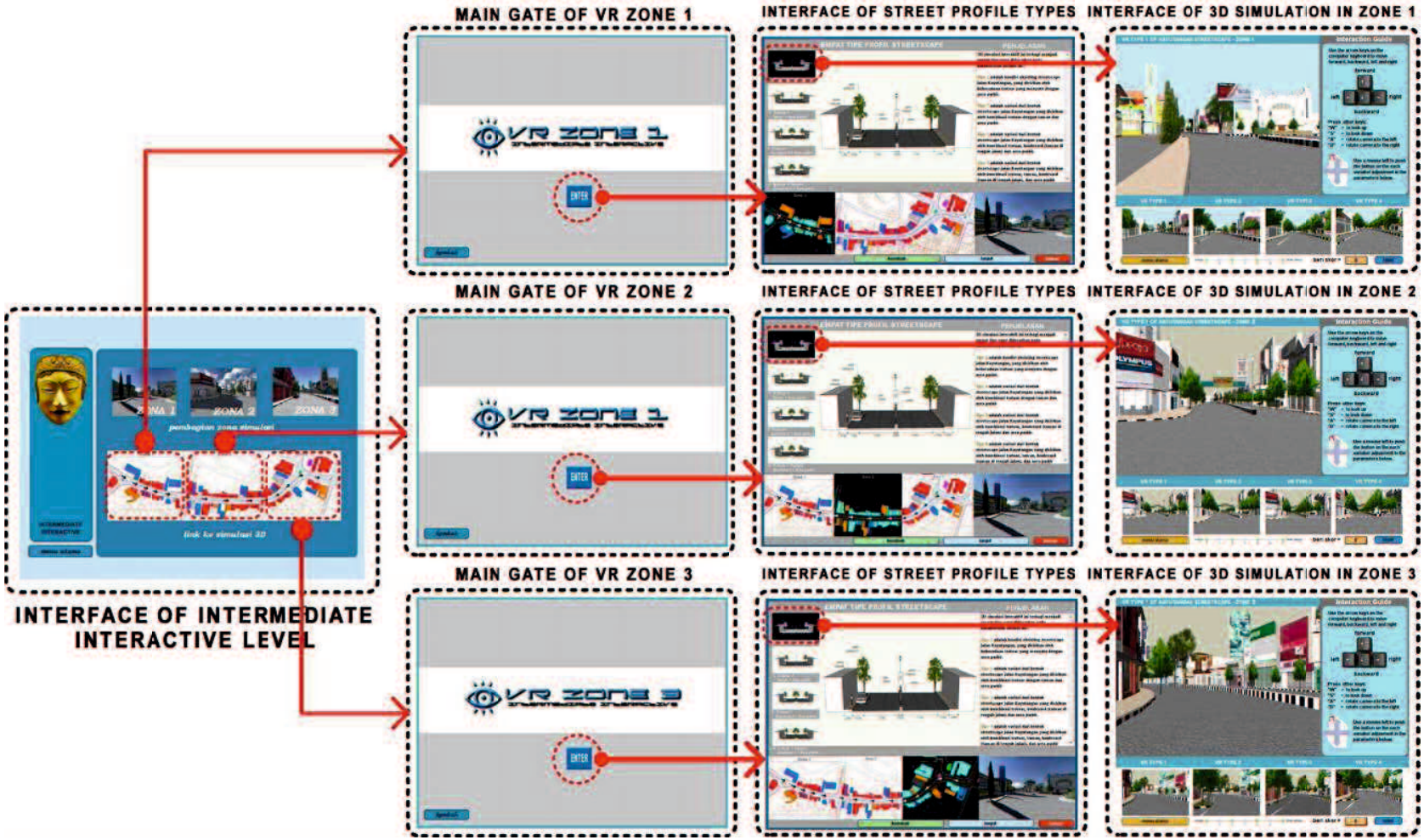

Figure 3-13 User interface design of intermediate interactive level

4. User interface of advanced interactive level

At the advanced interactive level, the user interface is divided into two groups, namely interactive 3D simulation in a public zone, and interactive 3D simulation in a private zone. Both simulations are categorized as active interactions because the user has the opportunity to visually observe as well as interact with a number element in the virtual environment.

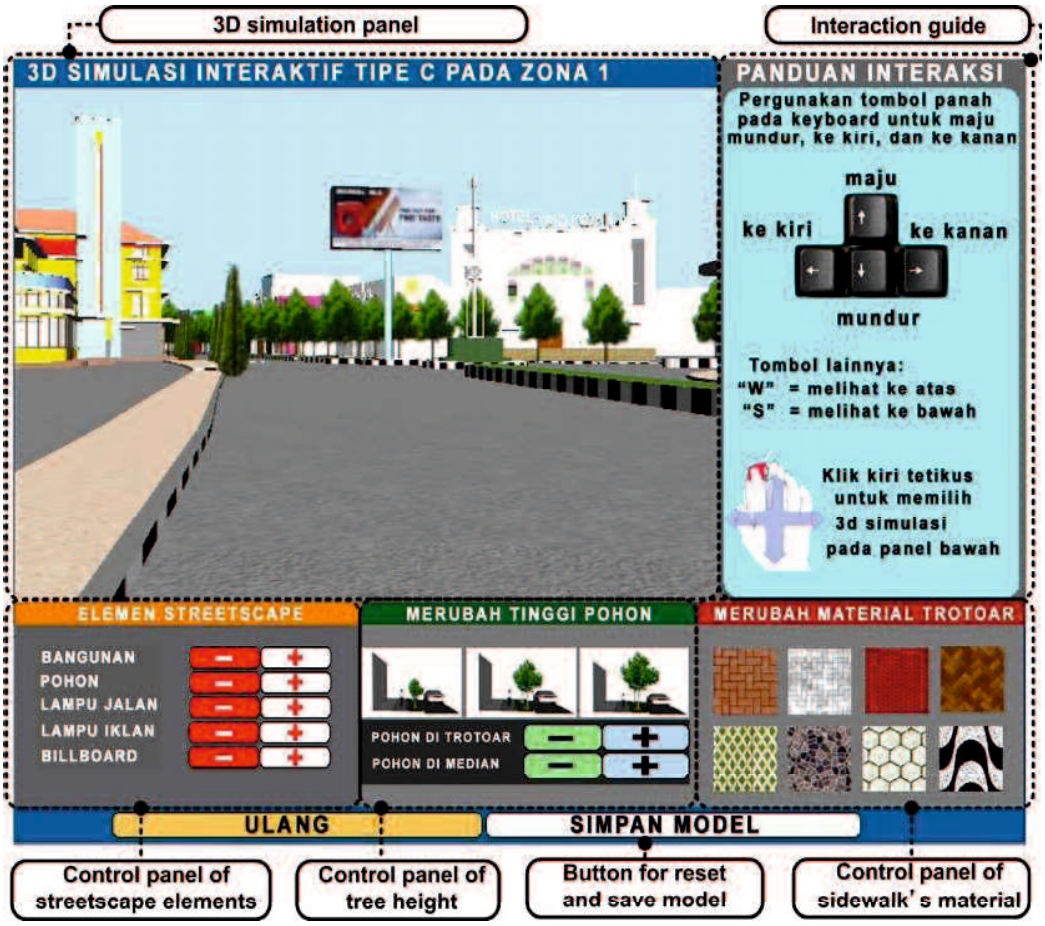

Figure 3-14 User interface of advanced level in public zone

The user interface of the public zone is divided into five sections consisting of a 3D simulation panel, interaction guide, streetscape element control panel, tree height control panel, and sidewalk material control panel (see Fig. 3-14). The 3D simulation panel presents a virtual Kayutangan streetscape. On the right side there is a guide that describes the use of a keyboard and mouse to assist the user's navigation and how to alter streetscape elements using the control panel. Using the control panels, the user can easily hide or show streetscape elements, change tree height, or change sidewalk material.

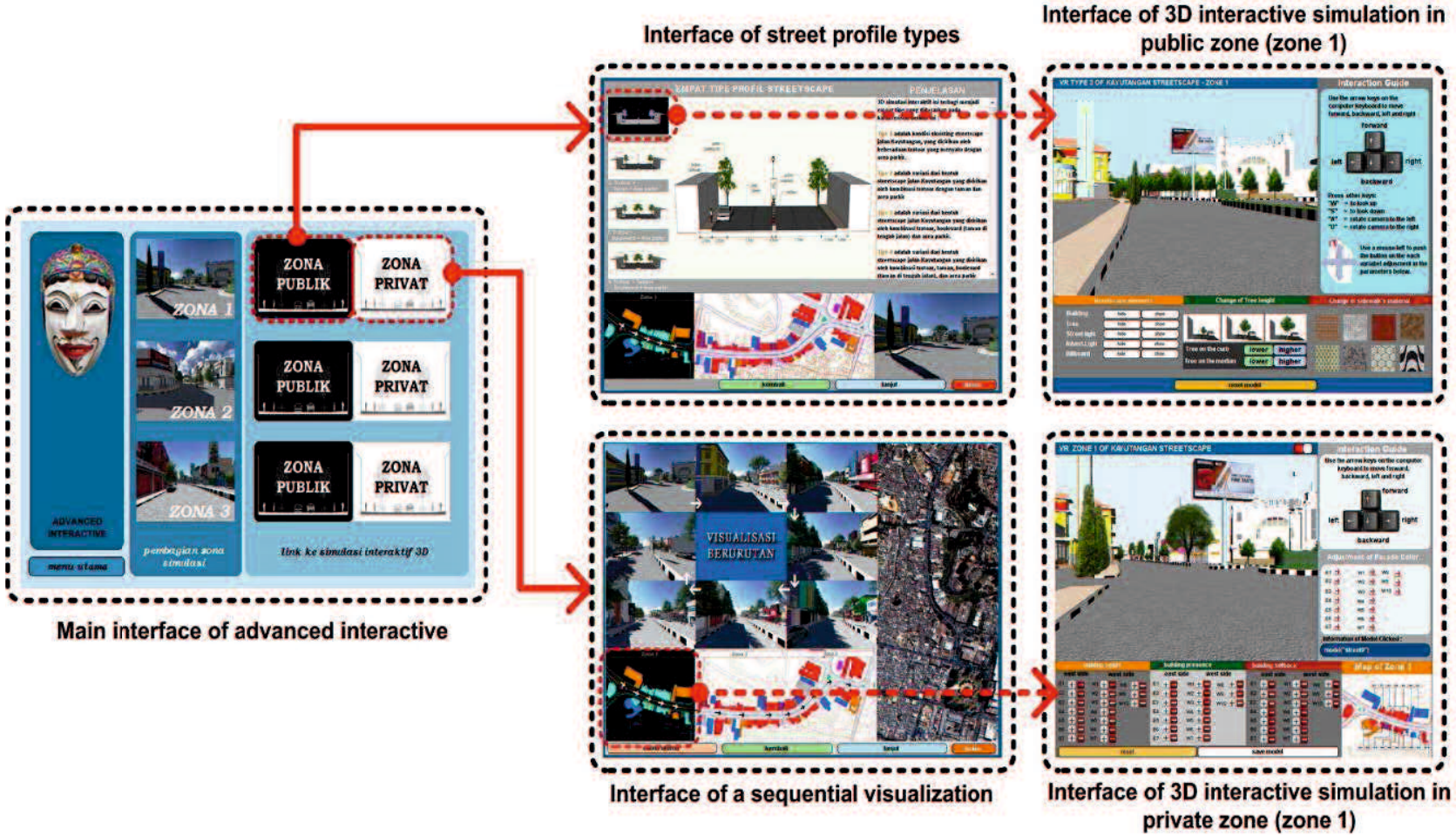

Figure 3-15 User interface design of advanced interactive level

Meanwhile, the private zone user interface is divided into nine sections consisting of a 3D simulation panel, interaction guide, link for editing façade color, building code information, building height control panel, building presence control panel, building setback control panel, a button to reset or save the model, and a guidance map (see Fig. 3-16). The 3D simulation panel presents the virtual Kayutangan streetscape. Using the control panels, the user can easily adjust the building height, presence, and setback as well as the façade color.

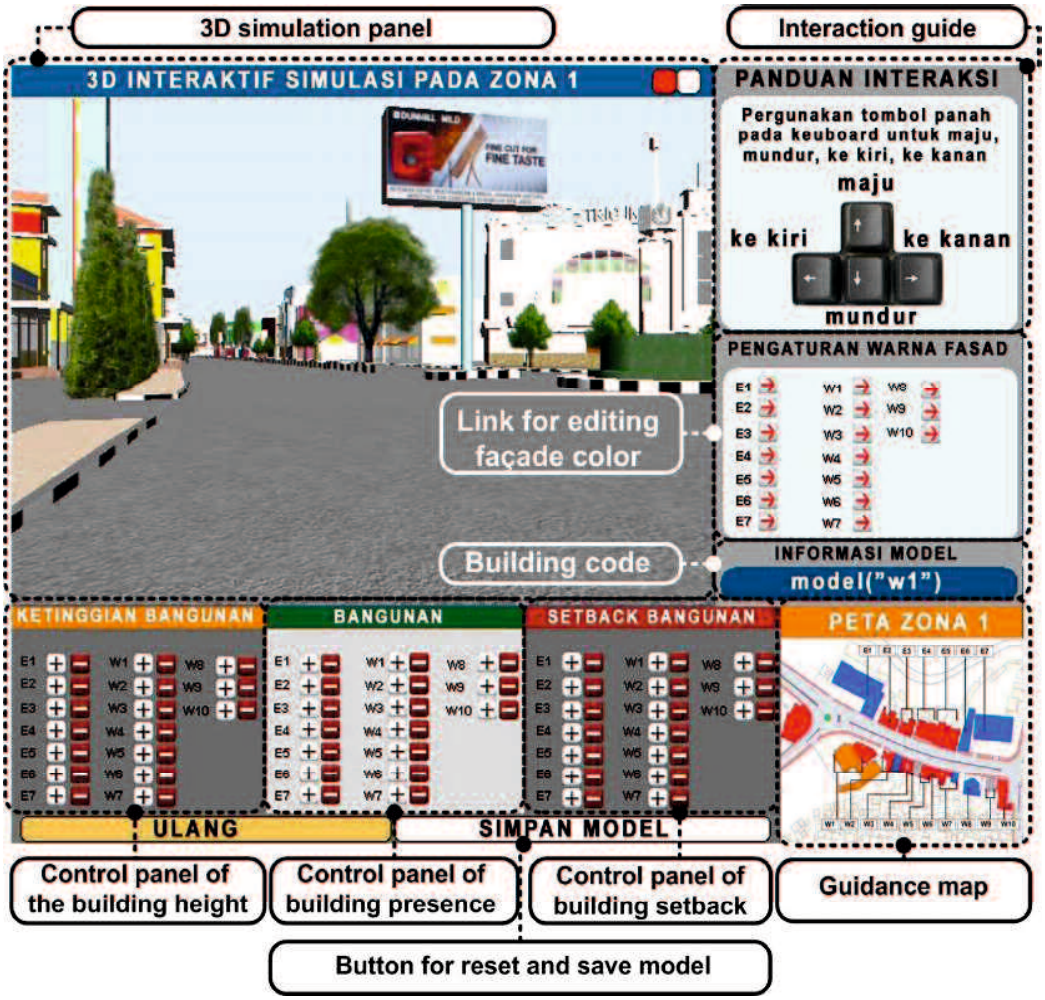

Figure 3-16 User interface of advanced level in private zone

Especially for the adjustment of façade color, there is a separate control panel that links to the other interface. A user can easily set the color on each building façade. That interface provided a three variations of color combinations, namely Dutch color, Indonesian color, and Modern color. User can easily perform the color settings on each building in accordance with the color groups (see Fig. 3-17)

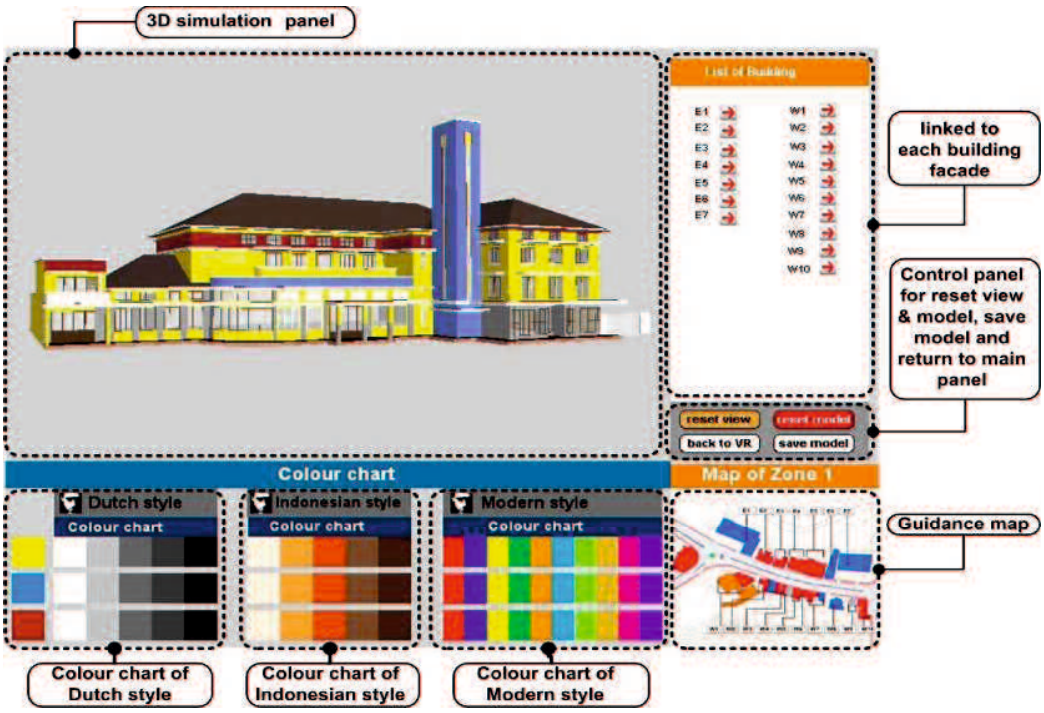

Figure 3-17 User interface design for color settings of building façade

3.6 Testing the System through the Workshop

In order to test the system, a workshop was conducted in Malang, Indonesia. A total of 22 people participated. The participants consisted of a lecturer, undergraduate and master students from the Architecture and Urban Planning Department of Brawijaya University, as well as experts and the public. The composition of the workshop participants is listed in figure 3-18.

No.	Participants	%
1	Lecturer of Architecture and Urban Planning Department	40.91
2	The Experts (Architect)	9.09
3	Head of Indonesia Institute of Architects in Malang	4.55
4	Private bussinessmen	4.55
5	Public	4.55
6	Undergraduate & Master students	36.36

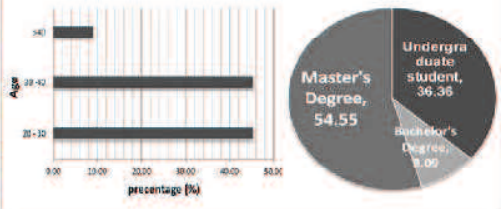

Figure 3-18 The composition of the participants and some documentation

The workshop involved several events consisting of a lecture, site investigation, clarification of issues, system operation, and evaluation (see Fig. 3-19). This series of activities was devised to provide an understanding of the issues at the site before system operation and evaluation.

First, a lecture presented the history and development of Malang City from the Dutch colonial period to the latest developments. It also described the experience of using the landscape planning support system and technical details of the system operation.

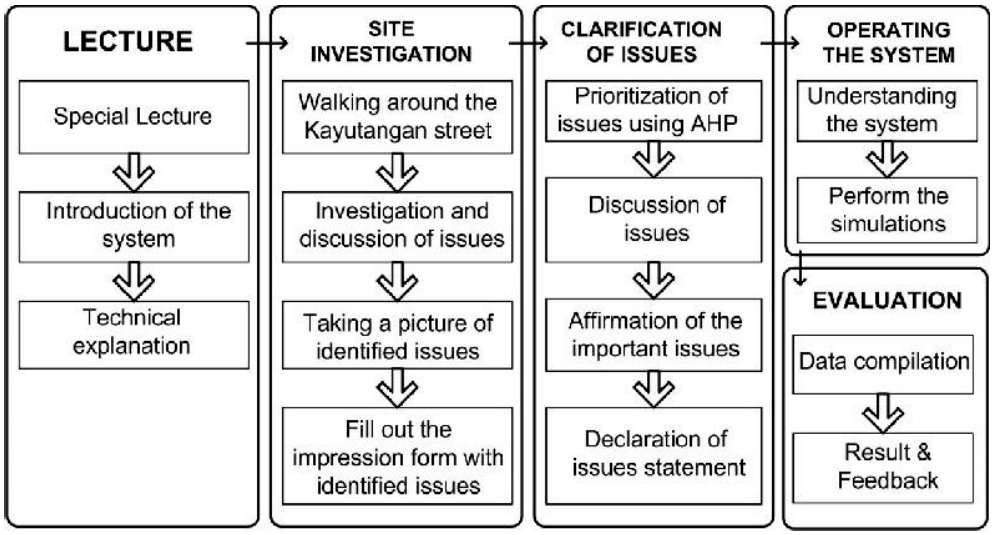

Figure 3-19 Workflow of the workshop

Second, participants divided into three groups and investigated the site. Each participant investigated the issues and filled out a questionnaire regarding their impressions as well as any issues identified during the site investigation. The questionnaire was adjusted according to the method of Analytic Hierarchy Process (AHP)[e] and intended to help participants determine the importance level of emerging issues. This questionnaire was divided into two categories: public and private zones. The private zone consisted of building height, setback, materials, advertising, and colors. The public zone consisted of street width, street median, sidewalk width, sidewalk materials, street lights, banners and billboards, trees and plants, and the parking area. The questionnaire was completed in two stages. First, participants determined beforehand the criteria that they considered more important between two choices. Then, participants determined the importance level on a priority scale. The priority scale was divided into nine categories, from 1 to 9 (equal to extreme importance).

Based on the results of investigations in the field, some important issues were resulted from observations and discussions in each group. The issues are divided into two parts, as follows:

a) Issues on public zone

1. Maintain the continuity of pedestrian comfort along sidewalk and minimize elevation changes of sidewalk surface that reduce pedestrian comfort.
2. Some placements of trees are no longer appropriate to the size of the available sidewalk. Setting areas is recommended as a public open space around the tree.
3. Parking area along the sidewalk is not comfortable anymore. Many cases were shown that the position of car took over the sidewalk area. This fact interferes with the comfort and continuity of pedestrians along the sidewalk.

b) Issues on private zone

1. Some buildings have a contrasting character and not in harmony with the character of the building in the early development of the Kayutangan streetscape.
2. Character composition of vertical and horizontal plane of building façade could be used as an element of harmony to the building character along the Kayutangan streetscape.
3. Sarinah and Gramedia are new commercial buildings that considered having a harmonious characteristic.

Thirdly, participants clarified issues through prioritization using the AHP software. In this software, all the choices and priority scales were inputted and automatically evaluated for consistency of values or choices. The AHP software also calculated priority scale issues. The results in each group were compiled and are listed in Table 3-2.

Table 3-2 AHP scores based on the percentage of priority

Zone	No.	Issue	Weights (%)		
			Group 1	Group 2	Group 3
Private zone	1	Building heights	18.8	6.1	15.8 (3)
	2	Building setback	25.3	44.4	43.2 (1)
	3	Building material	14	9	23.6 (2)
	4	Building advertisement	21.3 (2)	13.3 (3)	5.6
	5	Building colors	20.7 (3)	27.2 (2)	11.8
Public zone	1	Street width	9.2	9.3	11.6
	2	Street median	12	3	5.4
	3	Sidewalk width	26.2 (1)	14.6 (3)	20 (2)
	4	Sidewalk material	5.1	5.2	6.8
	5	Street lighting	5.2	7.8	12.3
	6	Billboard	14.3 (3)	5.8	3.8
	7	Tree/ Greenery	8.7	28 (2)	16.5 (3)
	8	Parking	19.4 (2)	26.2 (1)	23.6 (1)

Notes : 1 = 1st priority, 2 = 2nd priority, 3 = 3th priority

Table 3-3 The result of AHP based on the priority ranking of issue

Zone	Rank	Issue		
		Group 1	Group 2	Group 3
Private zone	1	Building setback	Building setback	Building setback
	2	Building advertisement	Building colors	Building material
	3	Building colors	Building advertisement	Building heights
	4	Building heights	Building material	Building colors
	5	Building material	Building heights	Building advertisement
Public zone	1	Sidewalk width	Tree/ Greenery	Parking
	2	Parking	Parking	Sidewalk width
	3	Billboard	Sidewalk width	Tree/ Greenery
	4	Street median	Street width	Street lighting
	5	Street width	Street lighting	Street width
	6	Tree/ Greenery	Billboard	Sidewalk material
	7	Street lighting	Sidewalk material	Street median
	8	Sidewalk material	Street median	Billboard

It can be seen from both table (table 3-2 and 3-3) that building setback, advertisement, and colors are the important issues in the private zone, while the sidewalk width, parking, and greenery are the important issues in the public zone.

Fourth, each group operated the system while discussing decision making. Every decision was tested using the system to observe the changes in the quality of the streetscape (see Fig. 3-21 up to Fig. 3-26). The evaluation of the interactive 3D simulation system was accomplished by testing the system through interactive variables. Testing the system was performed by featuring a choice of four types of street profiles as shown in figure 3-20.

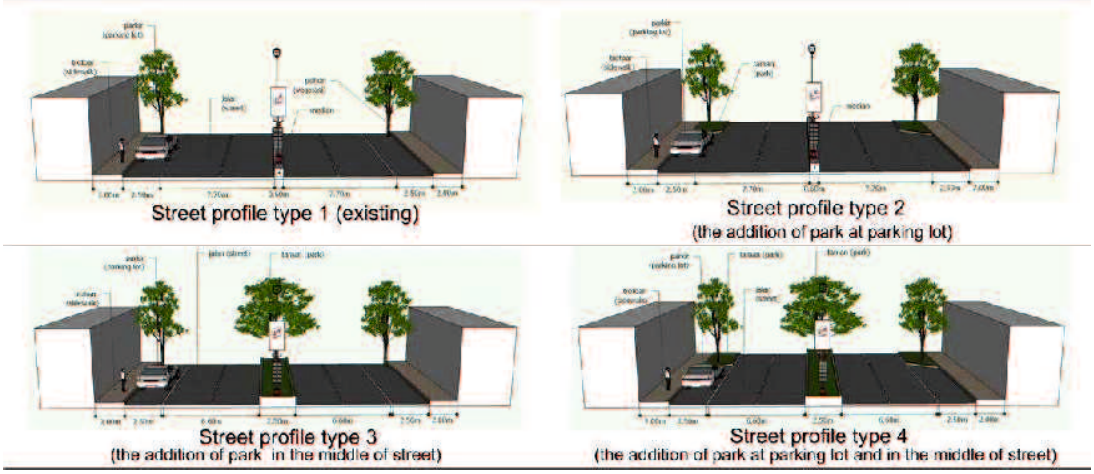

Figure 3-20 Four types of street profile

Group 1 : Public Zone

- In order to overcome the problem of the vehicle parking that interfere with pedestrian, then on-street parking is eliminated and replaced with a central parking at one or two area along the Kayutangan Street.
- Elimination the presence of billboards and all kinds of advertisements that cross into the street and disturbing view of Kayutangan streetscape.
- A spacious of street median is important to separate the vehicle lanes properly.
- Widening the street median should be accompanied by the addition of the building setback, because the width of Kayutangan street is narrow.
- Setting plants in the street median is proposed using short plants or shrubs.

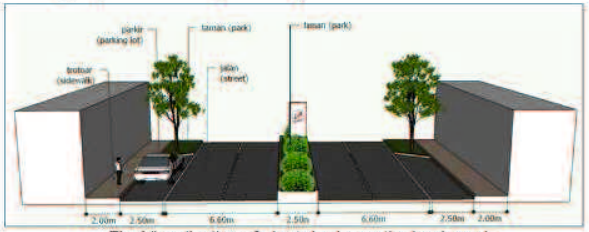

Fig. Visualization of plant shrubs on the boulevard

- Sidewalk material selection should be strong and durable as well as having good artistic value.

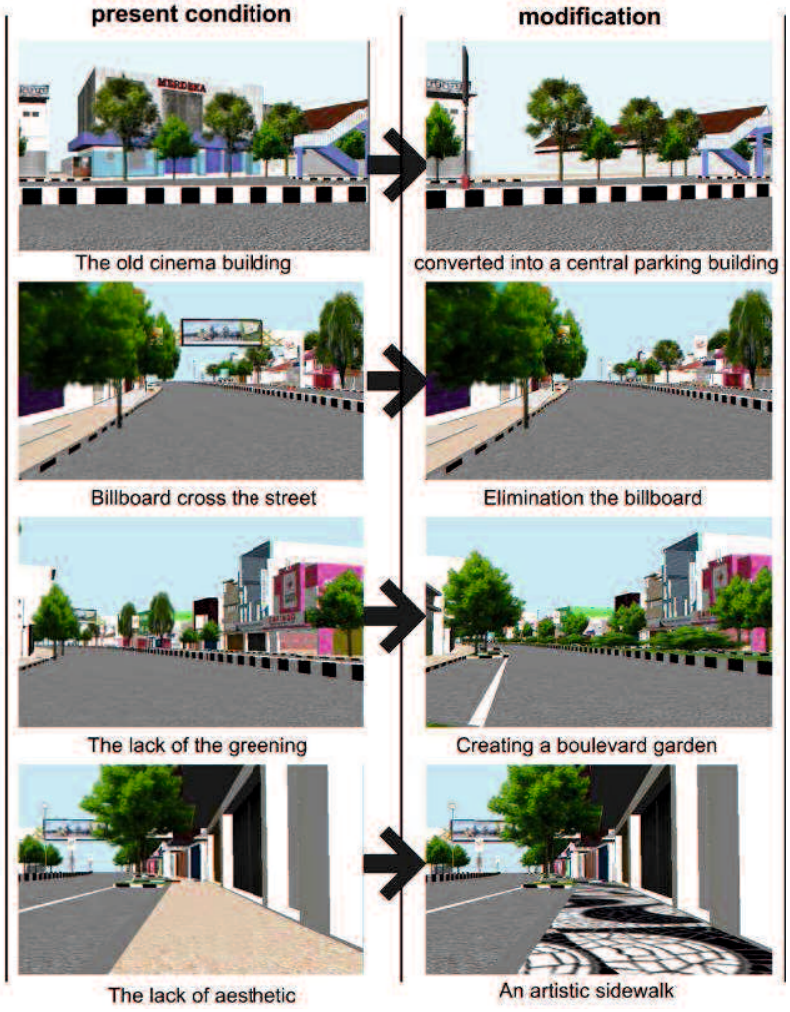

Figure 3-21 The operation of the system on the public zone by group 1

Group 1 : Private Zone

- The addition of the building setback and widening sidewalk at once.
- The addition of the building setback must be continuous along the sidewalk.

- For the sake of the preservation of Kayutangan as a historical district, the color of the building should be adjusted in monochrome colors.

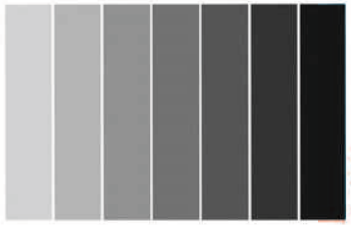

Fig. Color chart of monochromatic gray color

- The old buildings in the Kayutangan Street ranged from one to two floors, so the height of new buildings need to be adjusted.

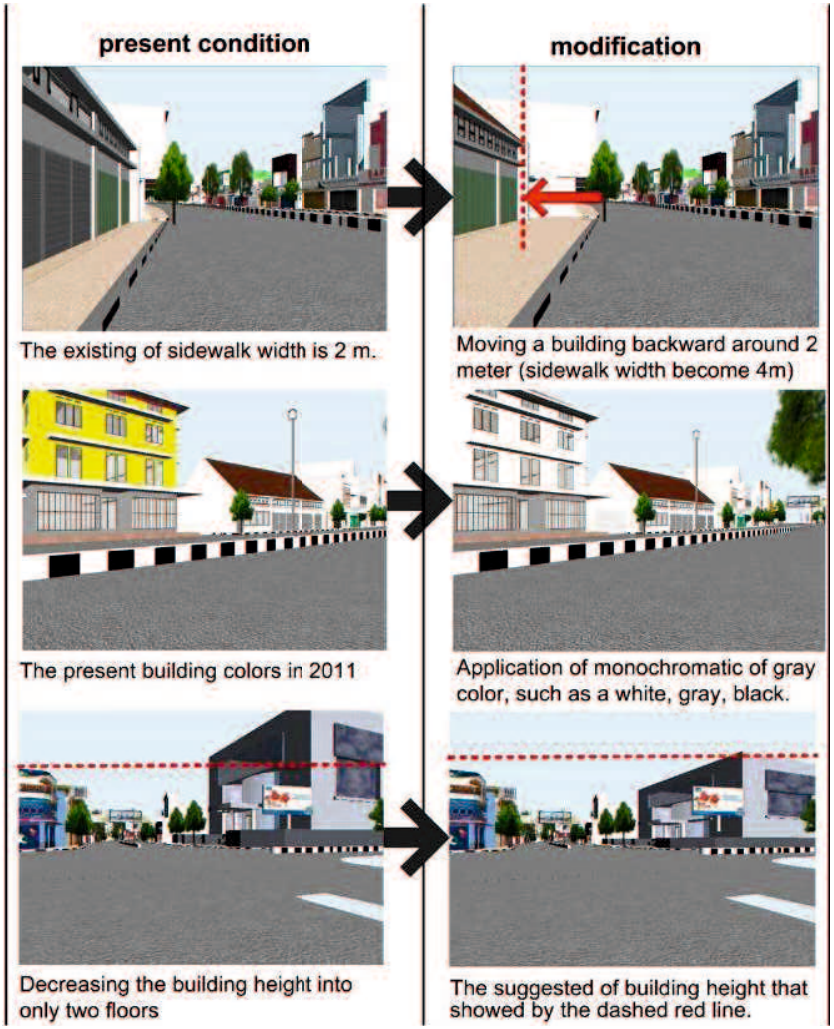

Figure 3-22 The operation of the system on the private zone by group 1

Group 2 : Public Zone

- There are two suggestions on plant arrangements in Kayutangan streetscape.
- The first option is a combination of a small park integrated with the existing trees along the sidewalk.

Fig. Visualization of small park adjacent to the sidewalk

- The second option is a combination of greenery boulevard as a street median and a small park along the sidewalk.

Fig. Visualization of greenery boulevard as street median

- A spacious street median will reinforce the vehicle lane as well as providing a good scenery.
- The presence of a spacious street median will narrow the street.
- Elimination the commercial sign board that covered the building façade.
- Widening the sidewalk towards the street about 1 meters up to 2 meters.
- Widening the sidewalk and the presence of boulevard will increasingly narrow the road.

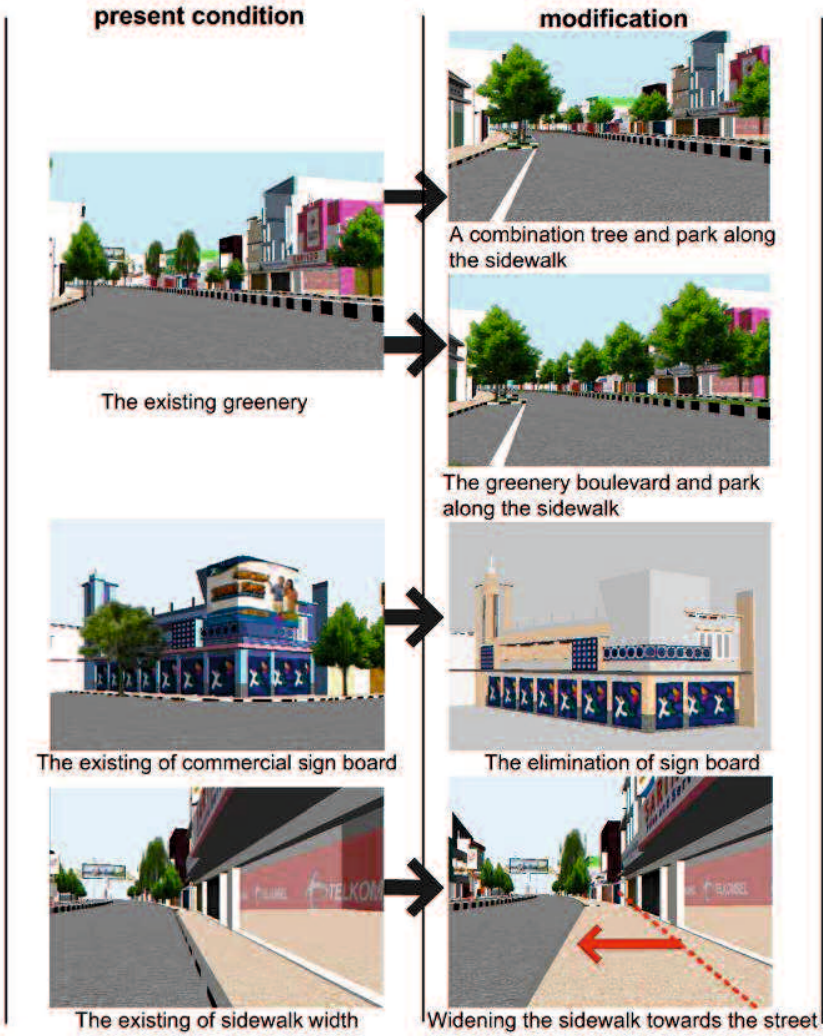

Figure 3-23 The operation of the system on the public zone by group 2

Group 2 : Private Zone

- Widening the sidewalk towards the street up to 1 - 2 meters.
- Widening the sidewalk should be accompanied by the elimination of on street parking.
- Group 2 recommended the use of combination colors between the modern colors (the present condition) and Indonesian colors (brown colors combination)

Fig. Color chart of variant brown colors

- The average height of buildings in the streetscape Kayutangan is around one and two floors. Changes or construction of new buildings have to adjust to the maximum building height of two floors.
- The building height that over than two floors should be perform the color changes according to the recommended colors.

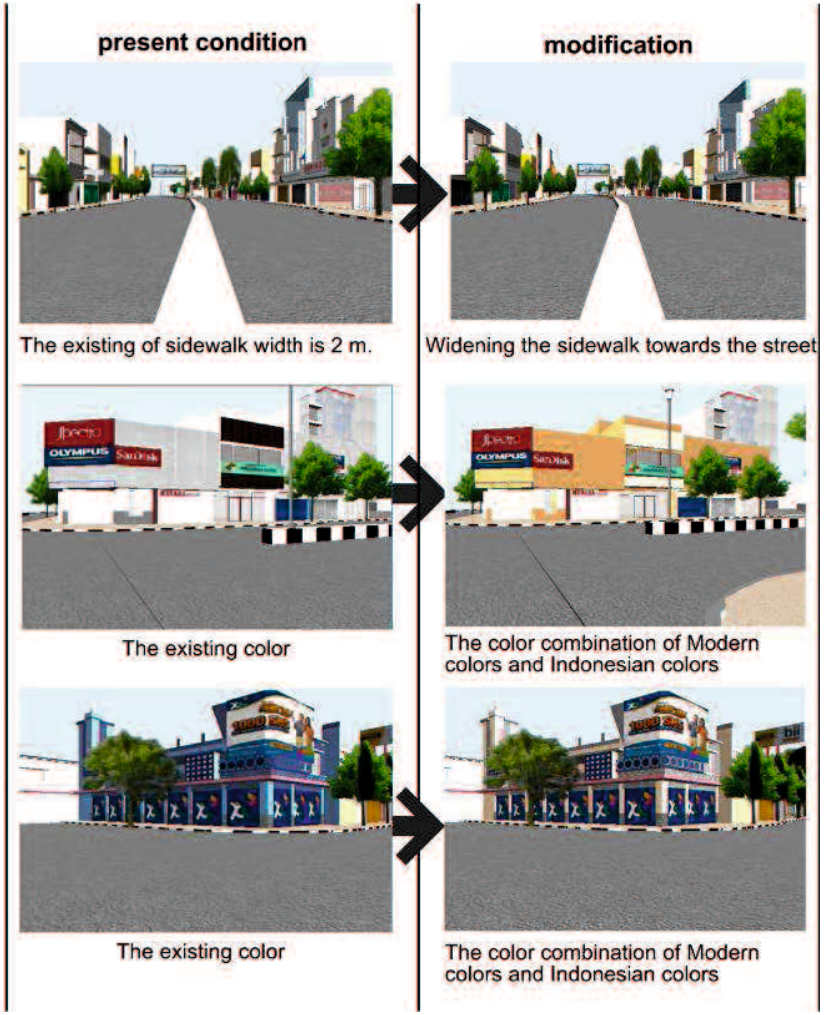

Figure 3-24 The operation of the system on the private zone by group 2

Group 3 : Public Zone

- The prohibition of on-street parking, in order to overcome traffic jam, except for non-motorized vehicles.
- The placement of a special area for central parking.
- The function of on-street parking is converted into the widening sidewalks
- Trees is suggested not obstruct the appearance of the building.
- Widening the street median and combined with plants, street lighting, and advertising.

Fig. Visualization of street profile

- The design of billboards must be regulated, in order not to disrupt the urban image of Kayutangan Street.
- Sidewalk material is recommended using materials that are safe, comfortable, and attractive.

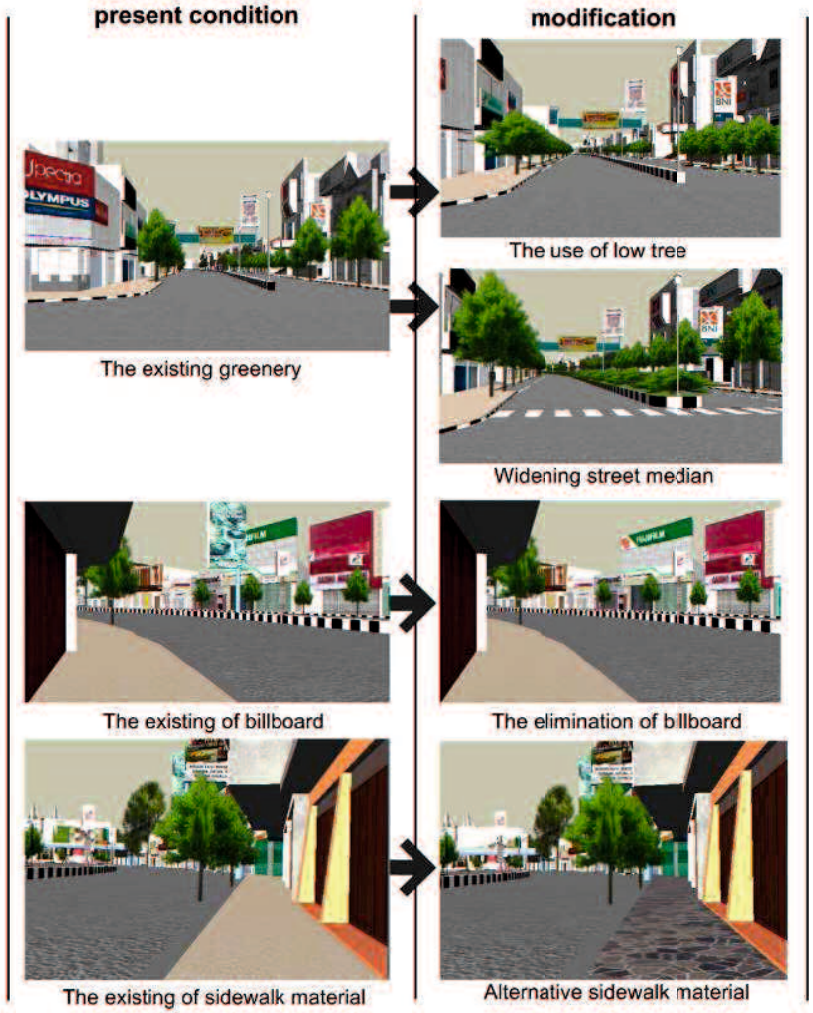

Figure 3-25 The operation of the system on the public zone by group 3

Group 3 : Private Zone

- The addition of building setback will cause the widening the sidewalk.
- The addition of the building setback is suggested only performed on first floor only, due to the limited land area.
- Old building facade needs to be restored to its original form without covered by other material, while the new building facade can follow the development of the modern style.
- The height of the old building will be maintaned while the new buildings can follow the development of the city.
- Group 3 recommended two kinds of combination color.
- First, the application of the monochromatic color of brown color.

Fig. Color chart of monochromatic brown color

- Second, the use of combination color between the Dutch color style and vintage color, like white, gray and brown.

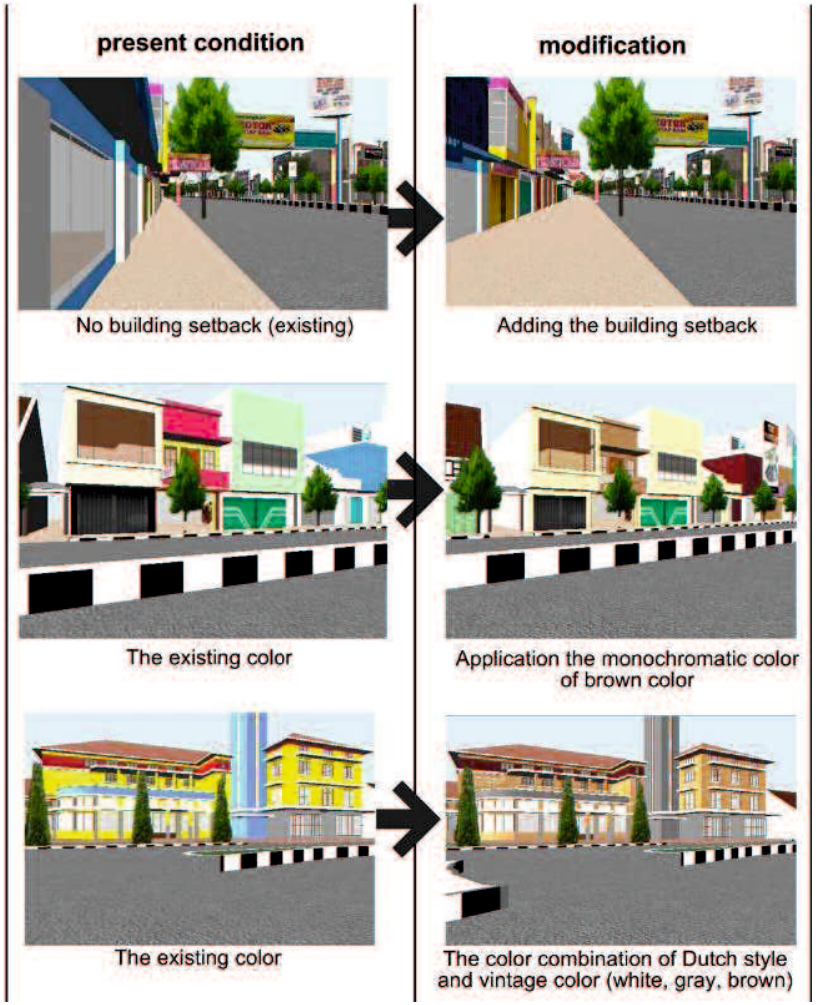

Figure 3-26 The operation of the system on the private zone by group 3

After system operation, there was a presentation and discussion in order to review the performance of the system as well as other variables outside the system that were associated with improvements of the Kayutangan streetscape.

Group discussion concluded the streetscape typology according to the assessment of each group (see Table 3-4). The comparison of the three groups expressed significant similarities of opinion, as follows: tree height (medium), leaf density (medium), and façade detail (ornament). The two groups showed significant similarities of opinion on some building streetscape elements, as follows: wide sidewalks (> 2m (3-4 m)), facade shape (simple), facade color (monochrome-three colors), color facade's theme (analogous-complementary), sign shape (text and image), and sign placement (integrated). Two groups stated that the formation of the architectural style of the building should be the combination of Dutch style with Indonesian style or Modern Style.

Table 3-4 Typology of the streetscape based on group discussion

Elements of Building Streetscape		STREETSCAPE TYPOLOGY		
		Group 1	Group 2	Group 3
Façade Style	Architecture Style	Mix Dutch-Modern Style	Mix Dutch-Indonesian-Modern Style	Dutch Style
Building Profile & sidewalk	Building setback	2 - 4m (>2 m)	no	> 4 m
	Profile shape	canopy	prominent-canopy	no
	Sidewalks width	>2m (3-4 m)	>2m (3-4 m)	>2m (3-4 m)
Tree	Tree shade	provide shade	no	provide shade
	Tree height	medium	medium	medium
	Leaf density	medium	medium	medium
Façade form	Façade shape	simple	simple-various shape	simple
	Façade detail	ornament	ornament	ornament
	Façade texture	smooth	smooth-rough	rough
Façade Finishing	Material finishing	painted	painted-combination	natural stone
	Façade color	monochrome-three colors	monochrome-three colors	monochrome
	Façade color's theme	analogus-complementary	analogus-complementary	analogous
Sign	Sign shape	text & image	text + image + lighting sign	text + image
	Sign placement	separated	integrated	integrated

The result of group discussion was compared to the preferences of building owners from Kayutangan Street (see Table 3-5). The result of comparison indicate that there are similar preferences between building owners and the workshop's participants on some elements of streetscape and building facade, as follows: tree height (medium), leaf density (medium), façade shape (simple), façade color (monochrome), and façade color theme (analogous). The comparison also show the emergence of three different preferences on the façade style, as follows: building owners prefer to Indonesian style, the two groups prefer to style combination, and one group prefer the Dutch style.

Table 3-5 Comparison the preferences between building owners and workshop participants

Finally, the system was evaluated using a semantic differential scale[6] to measure attitudes regarding system evaluation. The scale consists of a series of semantic difference bipolar characteristics, from negative to positive. Each participant assessed each variable on a scale from 1 to 7. Scale 1 indicated a negative rating whereas scale 7 indicated a positive rating. The evaluation consisted of two types, namely the evaluation of system usability and the evaluation of variable adjustment.

Table 3-6 The evaluation of the system by semantic differential scale

Variable	measurement of rating scale (negative- positive)	mean			total average	graph 1 2 3 4 5 6 7
		Group 1	Group 2	Group 3		
General assessment						
1 system understanding	very difficult - very easy	5.43	6.00	5.14	**5.52**	
2 system usability	very difficult - very easy	5.43	5.50	5.14	**5.36**	
3 language and symbols	very unclear - very clear	5.29	4.67	5.14	**5.03**	
Operation of the system						
1 system start up	very difficult - very easy	5.43	5.00	5.29	**5.24**	
2 terminate	very difficult - very easy	5.43	6.17	5.00	**5.53**	
3 interaction	very difficult - very easy	5.14	5.17	4.43	**4.91**	
4 interaction accuracy	very imprecise - very precise	5.00	5.00	5.00	**5.00**	
5 speed	very slowly - very fast	5.57	5.33	4.14	**5.02**	
Quality of visual elements						
1 text	very low - very good	5.43	5.00	4.29	**4.90**	
2 image	very low - very good	4.86	5.17	4.14	**4.72**	
3 simulation and animation	very low - very good	5.29	5.17	5.00	**5.15**	
4 button	very low - very good	5.14	5.17	5.00	**5.10**	
User interface design						
1 visual interface	very unattractive - very attractive	5.29	5.00	4.57	**4.95**	
2 design layout interface	very unclear - very clear	5.29	4.83	4.29	**4.80**	
3 manual availability	very unclear - very clear	5.14	4.67	4.43	**4.75**	

Notes : Measurement scale of evaluation using a scale of 1 to 7 (from negative value to positive value)

The evaluation variables for system usability consisted of four groups and 15 variables, as follows:

1. General assessment

   General assessment relates to the basic assessment of the operating system. This assessment consists of three aspects: system understanding, system usability, and language and symbols.

2. Operating the system

   Operating the system consists of five aspects: system start up, termination,

interaction, interaction accuracy, and speed.

3. Quality of visual elements

   The quality of the visual elements consists of four aspects: text, image, simulation, and button quality.

4. User interface design

   The quality of the user interface design consists of three aspects: visual interface, design layout interface, and manual availability.

The 22 participants completed the measurement and the results were compiled and tabulated (see Table 3-6). According to this table, the average value of each variable group ranged from 4.72 to 5.52. This result indicates that the system is easily understood, easy to use, has a good quality visuals, and has a clear and attractive interface.

The variable adjustment evaluation was intended to measure the difficulty of adjusting each variable (see Table 3-7). This measurement related to the seven adjustment variables, namely building height, façade color, building setback, trees and plants, billboards, sidewalk material, and street profile. The measurement consisted of five levels: very difficult, difficult, normal, easy, and very easy. The 22 participants measured these variables according to their respective experiences operating each one.

Table 3-7 Evaluation of the difficulty level in the variable settings

Variable	number of participants on each category (%)					
	very difficult	difficult	normal	easy	very easy	
Adjustment the building height		15.79	26.32	26.32	31.58	5
Adjustment the façade color		15.79		47.37	36.84	2
Adjustment the building setback	5.26	10.53	5.26	42.11	36.84	3
Setting of tree and plants		21.05	10.53	36.84	31.58	4
Adjustment the billboard		10.53	21.05	52.63	15.79	1
Adjustment the sidewalk's material			5.26	52.63	42.11	
Selection type of street profile		15.79	15.79	47.37	21.05	2

Notes : 1 = 1st majority, 2 = 2nd majority, 3 = 3th majority, 4 = 4th majority, 5 = 5th majority

Based on the tabulated results, the categories for which the highest percentage of participants considered the adjustments easy or very easy are in the following order:

1. Billboards and sidewalk material
2. Façade color and street profile selection
3. Building setback

4. Tree and plants
5. Building height

According to this evaluation, it concluded that almost all variable settings can be operated easily by participants.

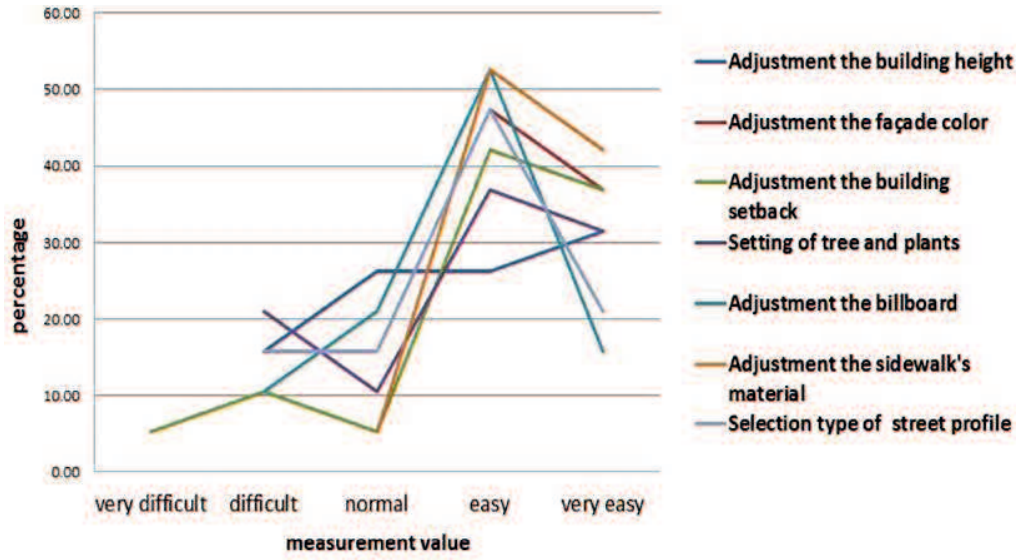

Figure 3-27 Graph the easiness of variable settings

Table 3-8 The opinion on the capability and originality of the system

Criteria	number of participants on each opinion (%)			
Original system in Malang, Indonesia	Never seen before	94.74	Ever seen a similar	5.26
The system capabilities in supporting the landscape planning and design	Highly capable	63.16	capable	36.84

Another questionnaire was also given to determine the opinions and capability of the system as support tools for landscape planning and design. Almost all participants stated that this system had never been used in Malang. Moreover, the participants believed that this system was highly capable of supporting landscape planning and design (see Table 3-8).

3.7 Recommendation for Advanced Workshop

Three stages of workshops is recommended to be performed by inviting more interested parties such as City officials, District officials, NGOs, community leader and the local communities from various backgrounds.

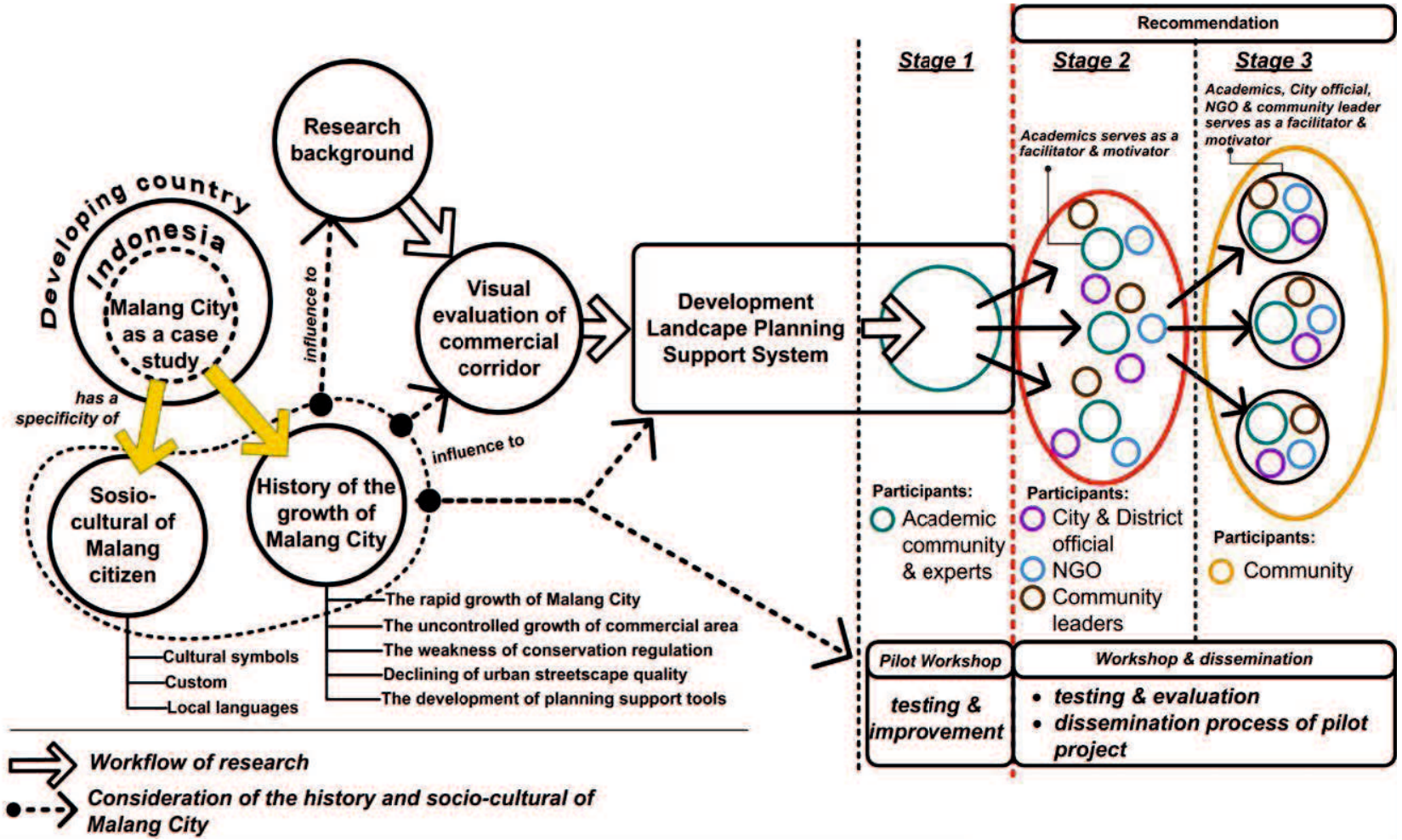

Figure 3-28 The strategy recommendation of the advanced workshop

3.8 Conclusion and Future Work

In summary, the contribution of this paper is the development of landscape support system that uses interactive 3D visualization for the improvement of the Kayutangan streetscape. The combination of an appropriate user interface and interactive 3D simulation by embedding a various types of 3D simulation is a strategy proposed to enhance the public interest in landscape planning, especially in Malang, Indonesia.

The testing of the system through a pilot workshop is an initial stage of system dissemination. The workshop involved lecturers, students, experts and the public to evaluate and assist the improvement of the system. This workshop also introduced the Landscape Planning Support System to the Malang academic community. Considering that the system is relatively new, several further workshops that include even more interested parties such as city government, stakeholders, and members of the local communities from various backgrounds are recommended. In future, this system should be piloted and made available online to the local communities of Malang, Indonesia.

Finally, we conclude that this system is not completely easy to understand and operate by the public in Malang. This pilot workshop was useful to spread the idea of a new system to the academic and expert community in Malang. The main purpose was to obtain feedback and suggestions for system improvements to produce an adequate system for the Malang community in the future.

For further research, first, the quality of real-time visualization in the 3D interactive simulation still needs to be improved in order for the system to be properly understood. Second, although the effect of cultural symbols in the user interface was not examined deeply in this study, their use (including the use of the local language) is expected to facilitate the user's understanding of the system. Therefore, it is important to conduct further research related to the effect of cultural symbols on the development of the system.

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Notes

a) Nieuwe Bouwen is regarded as a pioneer of building style of International Style, which emerged after the 1920s. Nieuwe Bouwen is a term for a several international architecture and a radical innovation of planning between 1915 until about 1960. Nieuwe Bouwen style was characterized by the use of flat roofs, horizontal gevel, the building volume of a cube-shaped, as well as the use of white color.

b) The system development utilized three applications software consisting of SketchUp Version 8 for 3d modeling, Lumion 3D Version 3.0.1 for 3d visualization, and Adobe Director Version 11.5 for multimedia application authoring platform.

c) Adobe Director software provide a 3D Lingo scripting language instantly, which provides convenience for the user in applying the instant behavior on 3D object and button behavior.

d) Shockwave 3D is a 3D object format used in the Adobe Director software. 3D file sources can be developed from a variety of 3D modeling software, but the file must be converted into a w3d format.

e) AHP is a decision support models developed by Thomas L. Saaty. This decision support models describe the problem of multi factor or multi-criteria complex into a hierarchy. Through the hierarchy, a complex problem can be decomposed into their groups and organized into a hierarchical form.

f) Semantic differential is a type of a rating scale designed to measure the connotative meaning of objects, events, and concepts. The differential scale is a scale to measure attitudes. The scale consists of a series of semantic difference bipolar characteristics (two poles), between a negative to positive attitudes.

g) The presence of culture will influence the interaction of people with computers. User will assimilate the patterns of thinking, acting and communicating from a specific social environment when performing tasks to the computer. The culture will predetermine a person's communication preference and behaviors. Thus, the user interface should facilitate users with the familiar communication styles.

Chapter 4

CONCLUSION

Chapter 4
CONCLUSION

4.1 Conclusion of Each Chapter

4.1.1 Conclusion of chapter 1

Recently, the uncontrolled development of new commercial buildings has brought the major changes in the city streetscape. The lack of City planning regulations for conservation areas causes the degradation in urban streetscape quality. The improvement of the historic streetscape should reflect on the historical urban space that could be a useful basis for planning and designing better cities for the future.

The important of the research purpose is the development of the 3D interactive visualization system to support decision-making in order to improve the quality of the Kayutangan streetscape, as one of the historic streetscapes in Malang City. The steps of research were performed according to the three groups that illustrated in the research's framework, and also divided into two main research activities. Several previous research that related to the following issues also studied as follows: urban image, aesthetic experience, visual evaluation, conservation of historic building, transitional space, computer visualization, 3D visualization strategy, spatial multimedia, navigation and user interaction in a Virtual Environment, 3D Lingo scripts, user interface design, cultural symbols, and public participation.

Based on previous studies, this study performs a people preference method that combined with field survey in order to investigate the visual quality of the urban commercial streetscape. According to the use of the virtual environment on decision support system in city planning, many studies have developed, tested and proved various visualization models including a web-based interface. Almost all user interface appears directly focused on the interactive 3D simulation that fulfilled a wide range of interaction's panels from simple to complex. However, it seems no one has emphasized the need for adequate design of the user interface that integrated with the development of interactive 3D visualization, especially in a deal with varying levels of user knowledge in developing countries. Therefore, it is necessary to develop strategies in designing the user interface which can accommodate different levels of knowledge and improve the public's interest in interacting with the 3D simulation in a Virtual Environment.

4.1.2 Conclusion of chapter 2

The study concluded three kinds of typology for the commercial building streetscapes in Malang, typology of Dutch style, Indonesian style, and modern style. According to the correlation analysis, it might be concluded that building use influences preferences.

Owners of commercial buildings with similar functions appear to have preferences similar to the characteristics of the commercial building streetscapes. It might correspond with Nasar (1998), as cited in Michelson (1976): "Groups of individuals of similar cultural or socioeconomic characteristics share common meanings and evaluative images."

Three types of judgment also implied from the comparison of the field survey and the building owners' preferences:

1. Coincident

   The preferences of building owners coincide with the existing of streetscape, especially in the facade detail, facade texture, facade finishing, and the shape of commercial signs.

2. Incongruity

   The preferences of building owners have no coincident with the existing of streetscape, especially in tree height, leaf density, the facade style, facade shape, facade color and color themes, and placement of commercial signs.

3. Similar opinion

   Most of the building owners imply a similar opinion to the existing of streetscape, especially in the tree height, facade style, facade form, facade detail, facade texture, facade finishing, the color theme of facade, shape of commercial signs, placement of commercial signs.

All building owner preferences for the Kayutangan Street area nearly accord with the existing conditions. The interesting preferences from the Kayutangan and Kawi respondents show that the majority of respondents prefer the Indonesian facade style. This result may lead to the assumption that the building's owner is considered to have a substantial role in the changing conditions of the Kayutangan streetscape formation.

Significant differences also appear in the respondents from Soekarno-Hatta Street. The three characteristic elements of the facades show that the existing facades in the Soekarno-Hatta corridor mostly use varied shapes, a variety of colors, and a blend of complementary colors. In contrast, the majority of building owners prefers a simple form and the use of two colors with a blend of analogous colors.

4.1.3 Conclusion of chapter 3

The development of a decision-making system for the improvement of the urban streetscape through the development of interactive 3D visualization is essential for public participation. The combination of an appropriate user interface and interactive 3D simulation through the embedding a various types of 3D simulation is a proposed strategy to enhance the public interest in participation on landscape planning,

especially in Malang, Indonesia.

The use of interactive 3D visualization to facilitate public participation in Malang is most likely a genuinely new approach and has not been widely applied in Indonesian countries. The testing of the system through the pilot workshop performed as an initial stage of dissemination of the system development. The pilot workshop involved more lecturers, students, and the experts from Architecture and Urban Planning in order to assist the evaluation and improvement of the system, as well as for the initial dissemination of Landscape Planning Support System to the academic society in Malang.

An advanced workshops recommended be held by inviting more interested parties such as City officials, District officials, NGOs, community leader and the local communities from various backgrounds. The overall workshop is intended to obtain the feedback and suggestions for improving the system and to producing an adequate system for Malang community in the future.

This study shows several results as follows:

1. The development strategy of utilization a user interface and embedding various interactive levels of 3D visualization is capable of providing the easiness for participants to utilize the system.
2. The user interface is recommended to facilitate users with the familiar communication styles. The use of a local language and various cultural symbols of Malang are perceived to have capabilities to develop the principle of familiarity with the local culture and community life.
3. The combined use of the 3D modeling software, 3D visualization software, and multimedia application authoring platform are reasonably capable of producing and delivering a prototype application system form Landscape Planning Support System.
4. According to the feedback of the pilot workshop, it can be considered that the system is easy to understand and operated. Moreover, the participants believed that this system is highly capable of being applied for supporting the city landscape planning.

4.2 Research Summary

Malang is the historic cities having numerous historic buildings as heritage of Dutch colonial. One of the historic commercial building streetscape located in Kayutangan Street. The rapid development of commercial industry had influenced the presence and development of the streetscape. Commercial buildings grew uncontrolled and spread rapidly throughout the entire city. The spreading of commercial buildings grew along with the development of new street corridors and also entered into a conservation area corridor. Due to the lack of the law enforcement of the preservation of historic buildings, there were many historic buildings transformed into a new commercial building. The

rapid and uncontrolled development of new commercial street corridor had created the streetscape visual exclusively intended to the economic interest and disregard to the urban image. Hence, two stages of studies were performed to investigate the visual evaluation of the commercial building streetscape and develop the landscape planning support system supporting decision-making in public participation.

In the first stage, the study performed the investigation of the growth of the existing streetscape characteristic of commercial buildings in Malang city, by comparing two types of case studies that located on the conservation area streetscape and the new streetscape corridor. A field survey method was combined with a people preference method to compare building owners' judgment regarding the streetscape characteristics of commercial buildings. This study analyzed the emergence of three architectural styles and compared the characteristic typologies of the commercial streetscapes in three street corridors, namely Kayutangan, Kawi, and Soekarno-Hatta. The investigating of owners' preferences conducted by interview and questionnaire on the site. The results of both approaches were categorized and compared based on visual characteristics. According to the field survey, the study concluded three kinds of typology for the commercial building streetscapes in Malang, typology of Dutch style, Indonesian style, and Modern style. Meanwhile, the result of the owner's preferences implied three types of judgment according to the physical characteristic on streetscape, namely the coincident, incongruity, and the similar opinion. The study also generated some conclusions as follows: owners of commercial buildings with similar functions appeared to have preferences similar to the characteristics of the commercial building streetscapes, all building owner preferences for the Kayutangan Street area coincided with the existing conditions, and yet the majority respondents of three streets preferred to the Indonesian facade style.

The second stage of the study concentrated to the development of 3D interactive visualization system to support decision-making in order to improve the quality of the Kayutangan streetscape. This study was grounded to the fact that Indonesia country was one of the developing countries that advisable required expert help and better techniques to create and design a city plan more effectively and appropriately. The conventional method of urban planning that involved direct meetings with the public perceived as incapable of following the rapid growth of Malang. On the other hand, the development and advancement of computerized technology and 3D visualization through the Virtual Environment (VE) had spread quickly. Utilization of VE technology for the benefit of urban planning and design has been used extensively by the developed countries. This phenomenon was an opportunity to implement the similar technology on the developing countries.

The development of VE in planning support systems required a user interaction to perform observation and navigation. The user interaction capability of navigation was an essential for assessing the spatial qualities in 3D simulation. Moreover, The utilization of user interface-based 3D visualization to facilitate public participation in Malang was most likely a genuinely new approach. This system had not been widely applied in Indonesian country. Hence, in order to provide the easiness for participants utilizing the system, a strategy was proposed for performing an interactive 3D simulation through the embedding a various types of 3D simulation from passive observation, active navigation and active interaction.

The system developed three types of 3D simulation in order to stimulate the richness of knowledge and enhanced the public interest as well as overcome the diversity of the understanding and interaction to the 3D simulation and also fostering the familiarity to the system. Three types of simulation were categorized in three levels of interaction characterized by the level of simulation capabilities to perform interaction with the user, namely basic interactive level, intermediate interactive level, and advanced interactive level. The combined use of the 3D modeling software, 3D visualization software, and multimedia application authoring platform are reasonably capable of producing and delivering a prototype application system for Landscape Planning Support System.

The system tested through the pilot workshop involving lecturers, students, and the experts from Architecture and Urban Planning. The workshop was intended to assist the evaluation and improvement of the prototype application system, as well as for the initial dissemination of Landscape Planning Support System to the academic society in Malang.

4.3 Recommendation for Further Study

Based on the study that has been performed on the development of decision support system for the improvement of Kayutangan streetscape, there are some suggestions for improvement and recommendation for the future development of the system, as follows:

1. The representation quality of visualization that closer to the reality will help improve the proper understanding of the system. Therefore, further studies are still needed for the improvement of the quality of real-time rendering in the 3D interactive simulation.
2. Although the effect of the use of cultural symbols in the user interface is not examined deeply in this study, but the use of cultural symbols, including the use of the local language, was perceived able to help facilitate the user's understanding of the system, especially in developing countries. Hence, it is necessary to conduct further studies related to the effect of cultural symbols on the system development.

3. Later, this system is recommended be piloted and applied online to the local communities in Malang, Indonesia. Several workshops should be held by inviting more interested parties such as City government, stakeholders and the local communities from various backgrounds in order to provide an adequate system for Malang community in the future.

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