IT-based Representation and Visualizationof the Batavia City Development from the 16th to Early 20th century

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Abstract

This study represents and visualizes the development of Batavia from the XVI to the early XX century by recognizing the city of Batavia using Kevin Lynch's theory of 5 elements of the city image: edges, paths, districts, nodes and landmarks. The aim is to create an urban image information system that can provide easy information retrieval. It can be used quickly as a source of knowledge, policy making and design direction in the preservation of relics of the past. The approach taken was to analyze the information needs, study the history of Batavia and relate the data to the 5 elements of the image of Batavia from the 16th century to the early 20th century.

The design of the model is done through the acquisition of knowledge, archiving, use case diagrams, data retrieval and testing the success of the system. The application of the knowledge tree based on the 5 elements of the city image produces a system approach interrelated and provides information to different parties. The outcome is a system application that can represent and visualize the development of Batavia from the 15th century to the early 20th century, so as to provide an overview of the development of the city of Batavia through a web-based information technology system, which communicates appropriately, informatively quickly, and easily

***Keyword**: representation system, visualization, city image, Urban Development, Batavia*

Introduction

Recently, cultural heritage has received great attention in the world, and there is a great desire to preserve them. Indonesia is no exception, with various efforts to preserve the past that have been found. One of these is Kota Tua Jakarta, which has been subject to a restoration and preservation program led by the government in cooperation with the parties concerned with preservation. Both the physical and non-physical aspects have been preserved. Kota Tua Jakarta, was taken care of by the government after failing to become a UNESCO World Heritage Site in 2018. There, the physical evidence of the heritage in the form of buildings, and materials, as well as the transport routes of the time, clean water utilities, and foundation timbers have been preserved (Mundardjito, 2008, in Sulistyo, 2015).

In Indonesia, the preservation of cultural heritage is supported by regulations and policies particularly the Law No. 11 of 2010, Law No. 32 of 2009, and the Governor's Regulation of the DKI Province No. 36 of 2014. Indeed, the government continues to implement revitalization programs in collaboration with the JOTRC (Jakarta Old Town Revitalization Corporation) and is likely to propose the same with other stakeholders in order to strengthen the revitalization program (Darian, 2019). Interestingly, there is a trend towards the use of information technology in all aspects of the society, and a similar trend is emerging in the acts of preservation of cultural heritage.

One of these trends relate to the efforts to preserve the historical values of cities, by using information technology. Some of these include:

(1) A meeting in Killybegs attended by the representatives from the University of Ulster and the Donegal Regional Museum to see the St Catherine's complex, with the aims to transform people's experience of outdoor heritage sites through technology, building on the idea of a museum without walls (Polycarpou, 2017).
(2) The Cyprus University of Technology has formed the UNESCO Digital Cultural Heritage Council, whose main scope is to expand the work of the Innovative Digital Cultural Heritage Research Lab (Polycarpou, 2018).
(3) Another form of preservation is the use of information technology on the architecture of the archipelago through a data-based information system of local architectural morphological knowledge, and especially the architecture of the living space of the Madurese community (Hasan, 2013).

There are numerous attempts to employ the information technologies in the field of heritage management. The development of the use of AR (Augmented Reality) to reconstruct colonial buildings (Prabawasari, Madenda, & Suhendra, 2016), the use of AR as a medium to showcase historical attractions (Riadi, 2018), the web-based historical place information systems (Aji, 2016), and the building of cultural heritage with documentation and conservation of Borobudur sites with information systems resulting from reality-based 3D survey data through multi-sensor and multi-resolution (Suwardhi, et al. 2015) are most noteworthy among them. Moreover, there exist examples of parametric historical modelling of buildings based on documentation data and temporal records of cultural heritage site representation by using "as-built" BIM. In fact, photogrammetry and laser scanning data can be used for the reconstruction of the historical buildings based on reverse engineering.

Heritage information modelling including (i) point cloud acquisition, segmentation and geometry extraction, (ii) BIM parametric modelling and (iii) GIS management (Yang, et al., 2016), 3D reconstruction and visualization of the Bronze Age cave of the heritage site "les Fraux" (France), interpretation of archaeological data for the development of studies combining space and time (palaeo-environment, archaeometry, geochemistry, laser scanning, 3D modelling), are approaches where all elements of the archaeological data are involved. The survey of archaeological caves combines terrestrial laser scanning and close-range photogrammetry, which produce images such as sections and elevations, but also for photorealistic perspective displays and visual navigation of the world in 3D environments (Burens-Carozza, et al., 2014).

Information and communication technologies provide powerful tools to address the acquisition, storage, conservation, recreation, reconstruction and digital representation of the cultural heritage (Portal, et al., 2018). They are also actively engaged in this field.

The Kota Tua Jakarta has a high historical value and is still widely found in the form of artefacts/urban structures, infrastructure and architecture. Currently, the government is continuously implementing the improvements and the revitalization programs to protect and preserve the cultural heritage. In an effort to support this preservation, this research aims to unravel an 'image information system' that can be easily arranged and quickly used in policy making, and design as well as for providing preservation information to the public.

Representation Planning and Visualization System Images of Batavia

System planning is designed to facilitate the users in finding information about the development of the city of Batavia from time to time. This system needs to analyze the needs related to collecting, grouping and processing data about the history of Kota Tua Jakarta, and proceed with the design of the representation and visualization system so that a system application is produced for information retrieval and can be used by people for knowledge, policy, urban development, decision making, and the preservation of cultural heritage.

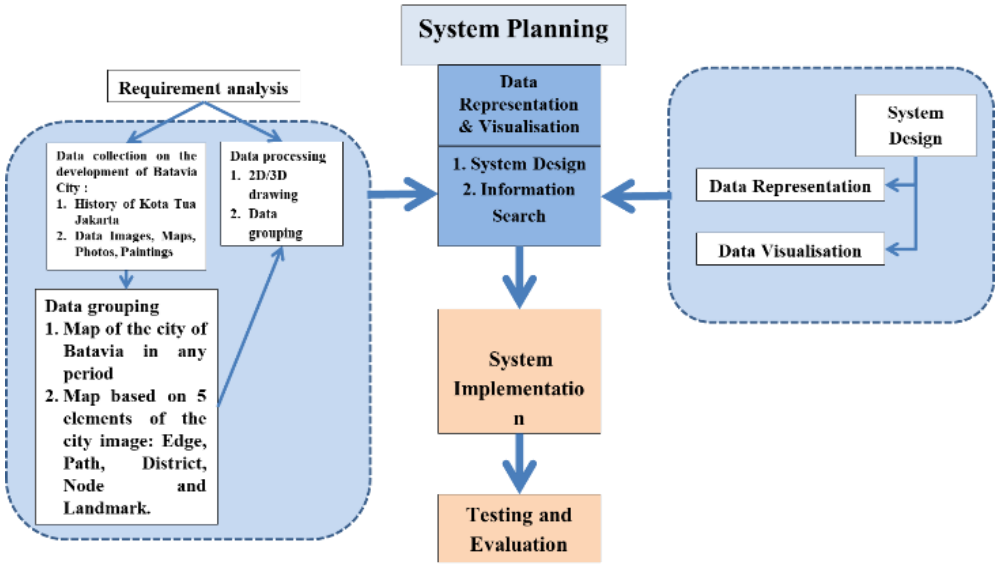


Fig. 1: Representation and visualization system framework
Source: Author

Needs Analysis

The results of the analysis are answers to information needs that are closely related to the historical data that has been periodized based on the development of the city of Batavia. This will enable the results of the information processed in the system to be used by the public.

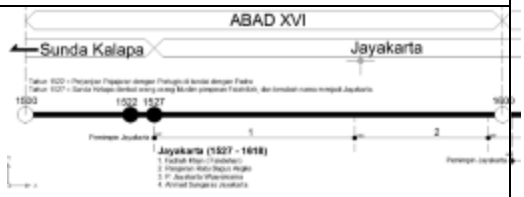
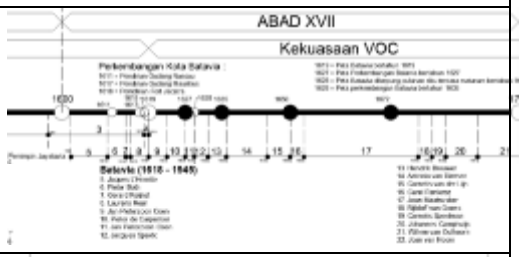
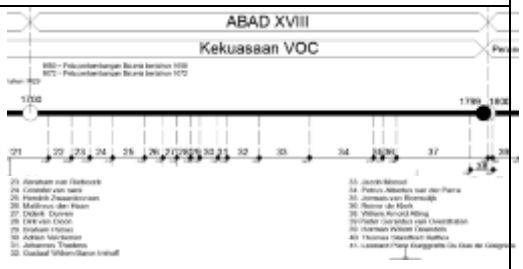
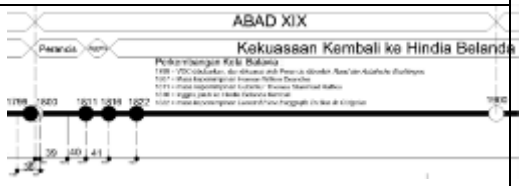
Table 1: Division of Batavia City period: period 1 – 5
Source: Author

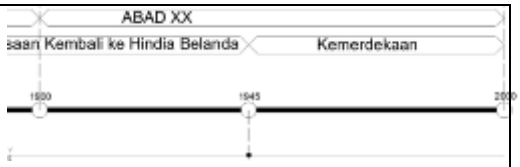
Problems	Expected Outcome	System Functional Requirements
Periodical division	Information about the development period of the city of Batavia, based on the time period and the important information in each period.	Batavia city change information system from each period
Historical data of the city of Batavia	Historical information about the development of the city	Historical data about the development of Batavia
City development data	Information about the development of the city in terms of the 5 elements of the city's image, in order to recognise changes in the city from each period.	Planning model representation and visual development of the city with if the map sesusi theme 5 elements of the city image and information in the form of text and voice

Periodization is a sequence of temporal development and can be interpreted as a classification of time when a story is related to the level of temporal development. The process of preparing the stages of periodization will facilitate the discussion and understanding of a past

historical event or occurrence. Based on this description, periodization can be concluded as a grouping of historical events related to centuries, epochs or periods that have certain characteristics or features (Kurniasih, 2021).

Table 2: Division of Batavia City periodesation: period 1 – 5

No.	Periods	Century	Time Line
1.	Period 1	XVI Century Beginning of the XVI century (1527) the struggle for economic power from the port of Sunda Kalapa to the port of Jayakarta (power of the Hindu kingdom to the Muslim kingdom). Jayakarta city pattern Javanese Islamic pattern	
2.	Period 2	XVII Century Early XVII century (1619) Perbutan power from Jayakarta to VOC (native power to colonial rulers (VOC)) Development of the city of Batavia from a lodge to the formation of the city of Batavia with a grid pattern formed by canals and roads.	
3.	Period 3	XVIII Century The heyday of Batavia was with the title "Queen of the East" because of the beauty and splendour of the city of Batavia. The period of the destruction of the VOC was with the title "Dutch Graveyard City" because of the poor face of the city after the uprising and the murder of the Chinese, as well as the appearance of cholera, bubonic plague and malaria. Cities did not take the climate into account. At the end of the XVIII century, the VOC was dissolved (1799) and the power was passed to the Dutch East Indies. Afterwards, Batavia was controlled by France.	
4.	Period 4	XIX Century Batavia changed hands 3 times, from France to England and back to the Netherlands. Improvement of the city of Batavia from a city within the city walls to an open city took place: the castle and the city walls were destroyed and the city began to make in Weltevreden. Batavia entered a period of peace. This time Batavia influenced the spread of the post-French Revolution with imperial style (Le Style Empire) with neoclassicism. The the end of the XIX century, the city of Batavia entered the peraliahah period in a modern city with the use of technology.	

5.	Period 5	Early XX Century The development of the city and architecture was greatly influenced by professional architects who came to the Dutch East Indies and received formal architectural training. Batavia became a modern city and in 1930, a modern colonial city (een modernekolonial stad) came into being. Many modern buildings were erected (Eclectic, Art Deco, Typical Dutch Model Architecture, New Art, Art Nouveau, Imperial).	

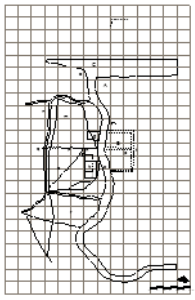
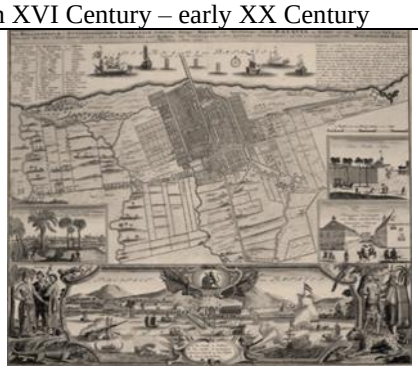
Source: Data processing results, 2022

Data Collection

Data collection is needed to accurately reflect the process of changing the city from time to time through:

a. Historical studies
   Historical events arise from everything that is thought, spoken, done, felt and experienced by every human being (Kuntowijoyo 1995 in Abdurahman, 2007). History is the study of the past based on the relics in the form of writing or images (Sumalyo, 2003).
b. Urban planning review
   The city is visualized in three dimensions and is formed by buildings as architecture and open space (Simons, 1983 in Syamsudin, 1889). Urban planning of a city is a reflection of the community (Budihardjo, 1984 in Syamsudin, 1889).
c. Cartographic studies
   Utilization of maps based on the time of its development. These can be used by means of the superimposition method. This method is like Mundardjito who said this term with "patching " is a method of superimposition or overlay of old maps and aerial photographs from the satellite images (Sinagga & Kamis, 2007).

Table 3: Map data of the city of Batavia from XVI Century – early XX Century

		
PERIOD 1 XVI Century Batavia in 1607 (Source : redrawn from Breuning, 1981;15, Fig. 1 in Bank Indonesia, 2008;14)	PERIOD 2 XVII Century Batavia in 1650 (Source: Surjomihardjo, 2000 & Heuken, 1997)	PERIOD 3 XVIII Century Batavia in 1733 (Source : Dinas Kebudayaan dan Permuseuman DKI Jakarta & Jakarta Culture & Heritage, 2007)

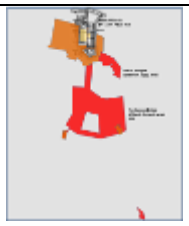
	
PERIOD 4 XIX century Batavia in 1853 (Source : Merrillees, 2000)	PERIOD 5 early XX century Batavia in 1930 (Source : https://digitalcollections.universiteitleiden.nl/view/item/812549)

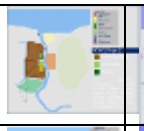
Data Processing into Models

The data were then processed by digitization of the maps based on the theory of the 5 elements of urban imagery (Zahnd, 1999), namely:

a. Edge map with boundary information, orientation and expansion.
b. The map of the paths associated with the paths of the circulation/movement.
c. The map of the districts related to land use/zoning.
d. The map of the nodes.
e. The map of the landmarks that gives the impression and character of a city that can be recognised from near or far.

Table 4: Division of Batavia City periodesation: period 1 – 5

No.	5 Elements of the Image of the City	Period 1 XVI century	Period 2 XVII century	Period 3 XVIII century	Period 4 XIX century	Period 5 early XX century
1	Edge					
2	Path					
3	District					

4	Node					
5	Landmark					

Source: Map digitisation result

Conceptual Model and Design Representation and Visualization

The conceptual model and the conceptual model design are a framework stage to represent and visualize the data obtained and planned into a knowledge base so that the users can understand the data and information they need.

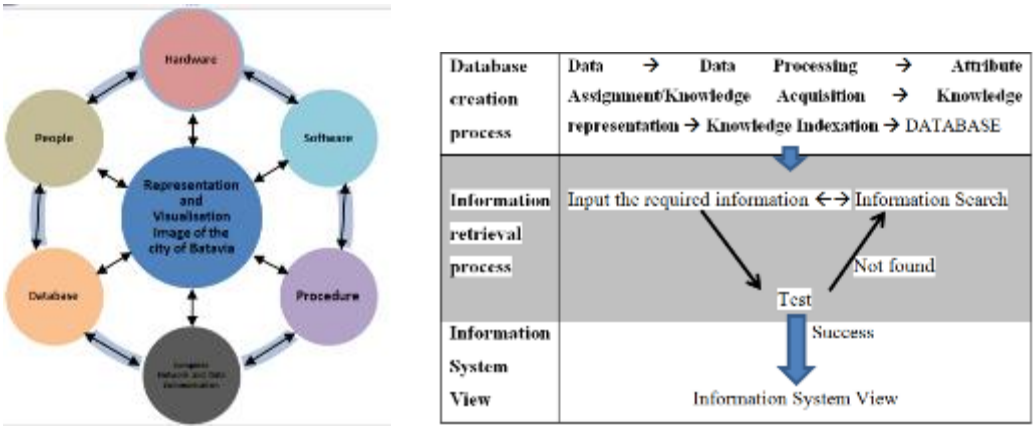


Fig. 2: Concept model & stages of representation and visualization design
Source: Author

The conceptual model results from the analysis of the needs and requirements of the users, either as administrators or as users are as follows:

a. People: parties or people who use the information systems: the users and administrators.
b. Process: an information system that functions as a database with a knowledge-based model.
c. Product: application results that can be used by the user or administrator to run the application.

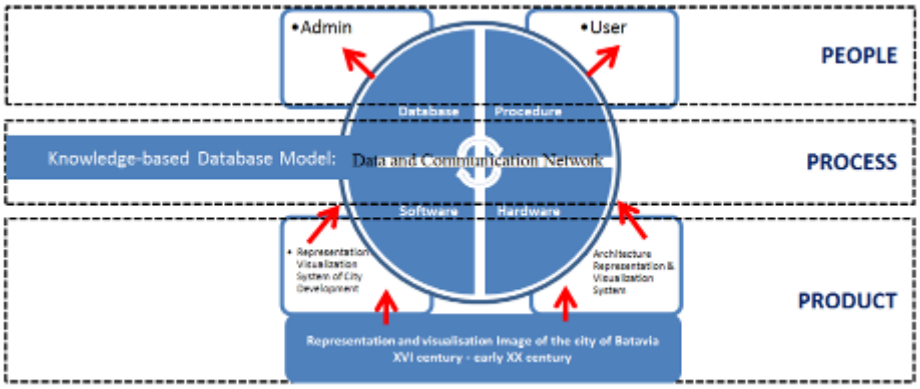


Fig. 3: Conceptual model of information systems
Source: Analysis result

Results and the Discussion

The implementation process in building a knowledge-based representation and visualization system can be as follows:

a. Knowledge Acquisition

Knowledge acquisition is part of the expertise in incorporating, building, adding or developing knowledge in the knowledge base. Knowledge can be obtained from experts, literature, research, databases, and images (Jones, 1990). To plan and build a representation system and visualize the development of the city of Batavia, historical data is required, be it images, photographs, paintings, written data, or videos. The results of the data obtained are then classified based on the information needs to be developed into the main information, namely the development of the city of Batavia in the XVI century - early XX century which shows changes to the image of the city.

Table 5**: Levels of importance of importance in knowledge acquisition**
Source: Author

Level 1	Periodicity (5 periods)
Level 2	Urban development
Level 3	City Image
Level 4	Edges, paths, districts, nodes and landmarks

b. Knowledge Representation

Knowledge representation is a method to display the knowledge-base obtained from knowledge acquisition and then put into a system that is conceptualized into relationships between data, thus helping the experts to create expert systems (Randall 1993, in Hasan, 2014). The process of forming the results in a knowledge tree from the universal relationships between attributes and will become more specific, where the attributes are connected by lines from the general to the more specific attributes such as branches, and twigs and so on.

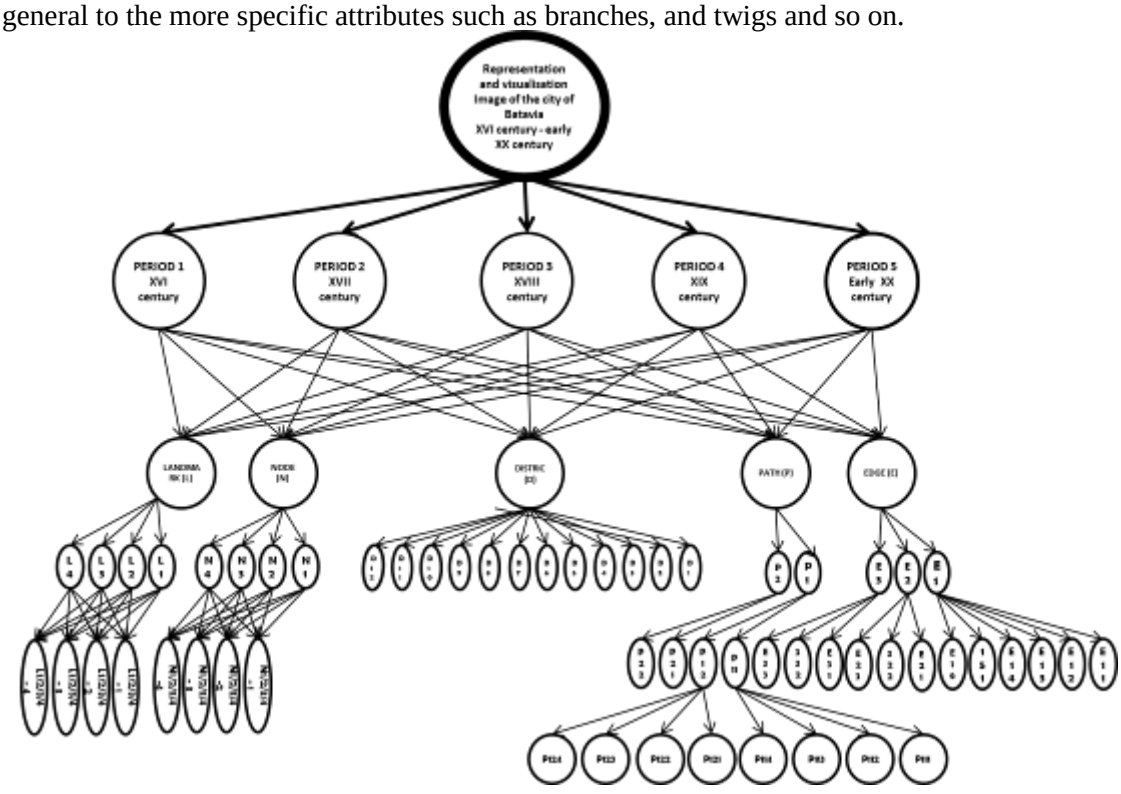


Fig. 4: Representation of knowledge about the development of the city of Batavia
Source: Author

The first step in designing the development of the Batavia City development retrieval application is to create a use case diagram that describes the interaction of the system with actors. The involvement between the users and the application can be seen in the flowchart where there are 2 groups of users, namely (1) Admin, (2) Users, and (3) Users.

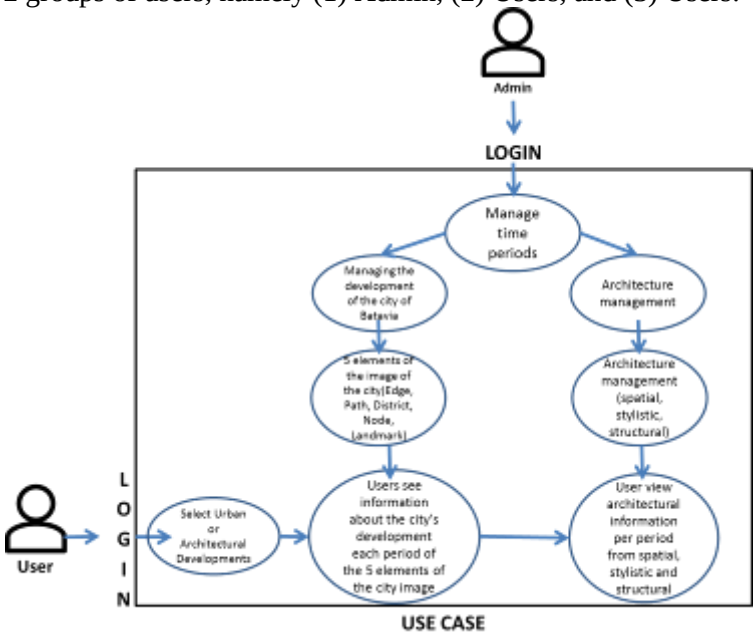


Fig 5: Use Case Diagram
Source: Author

c. Information Retrieval Process

The model design stage is a computer data processing module that contains image information of Batavia city in each period which is then processed and stored in the database. Searching for information to see changes in the city from each period must be done sequentially, but users can also search randomly based on the information needs of each period.

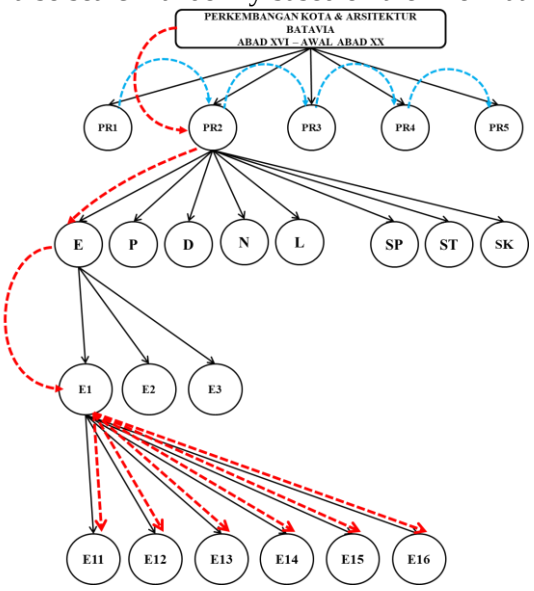


Fig. 6: Tree for searching for information on the BFS
Source: Author

The first information search as an example Fig. 6

Period 2	PR2
EDGE	E
Surface area	E1

The area can be seen from the boundary forming region:

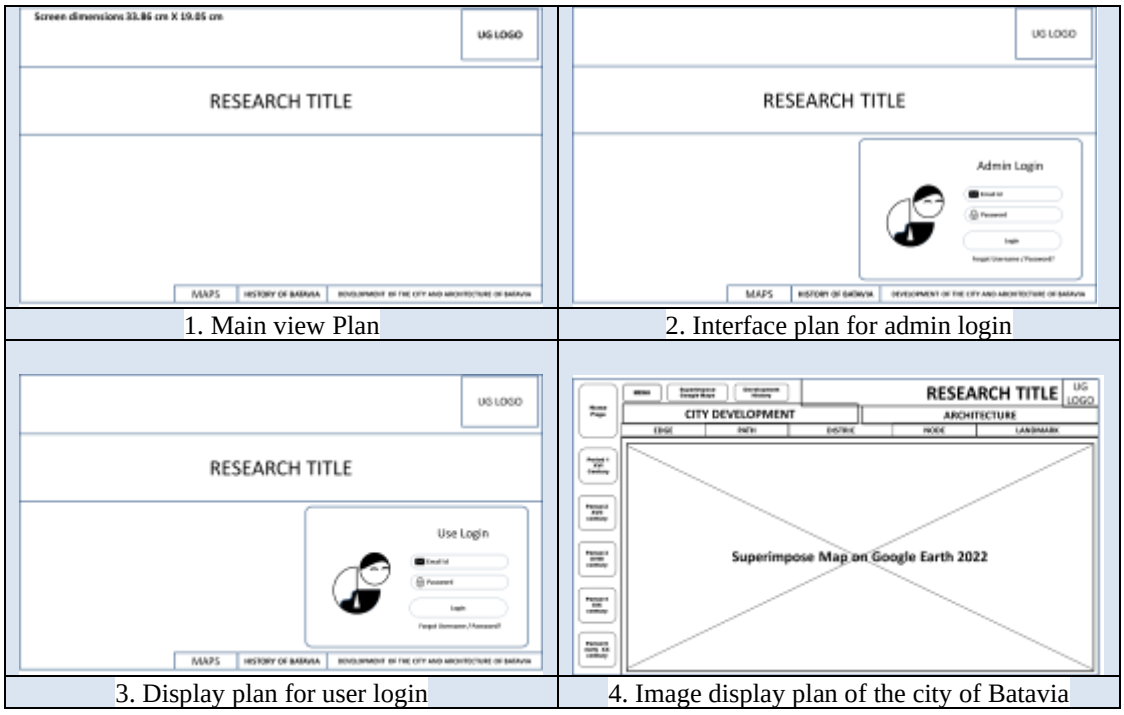
Beach	E11
Wall	E12
Railway lines	E13
River	E14
Road	E15
Buffer zone	E16

Explanation of the diagram:

a. The first search is to select PR 2 (period 2), the period selected is the XVII century.
b. The next step is to select E (Edge), one of the 5 elements of the city image, namely the EDGE associated with the regional boundary. The next step is to search for information about the EDGE in period 2, which forms the boundaries of the region.
c. The search for more specific information from the changes/developments of the city can be done sequentially from PR1→ PR2→ PR3→PR4→PR5

Interface design and system implementation

The result of the design of this system is a web design that can represent and visualise the image of the city of Batavia from the XVI - early XX century.



1. Main view Plan | 2. Interface plan for admin login

3. Display plan for user login | 4. Image display plan of the city of Batavia

Fig. 7: Interface display map
Source: Author

Implementation Results for the Development of Batavia City

If the user chooses to search for the Batavia City Development tool (Fig. 8), then the user can continue by selecting tools in the 5 elements of the city image. If one wants to know the changes in the city of Batavia in each element, one must select each period in sequence. After selecting the period, a map display will appear superimposed with the map according to the choice of the 5 elements of the city image, after which the user can select an image in the

position of the overlapping map to obtain information in the form of images, text and audio. The following are the results of the display stages of finding information about the development of the city of Batavia from the 5 elements of the city images in each period.

1. EDGE

Here, the users can search for edge information. In this interface, the users will find a display to select tools for periods 1-5 and there is information from the edge in the form of text and audio. After a user selects each tool per period in sequence, they will get an overview of the development of the city of Batavia, which contains boundaries, orientation and expansion patterns from the beginning of Batavia to the Weltevreden area. Fig. 8 shows that there are 6 stages in the sequential search. In this view, users can also select other tools randomly, but to get information about the development of the city clearly, tools must be selected sequentially from one period to the next. The following are the steps to search for edge information:

Step 1: The user will see the Edge Tools display. Then the user can select sequentially to see the development of each period.

Step 2: After selecting the tools of the period 1, a map of the boundaries of Jayakarta city before it was controlled by the VOC in the XVI century will appear, which is superimposed on the current map. The next step is for the user to select the image at the position of the Jayakarta city map with a single selection. The interface will display the Jayakarta city boundary map more clearly accompanied by text and sound.

Step 3, 4, 5, 6: The user can perform the steps as in the step 2 to obtain information sequentially from the periods 1 – 5

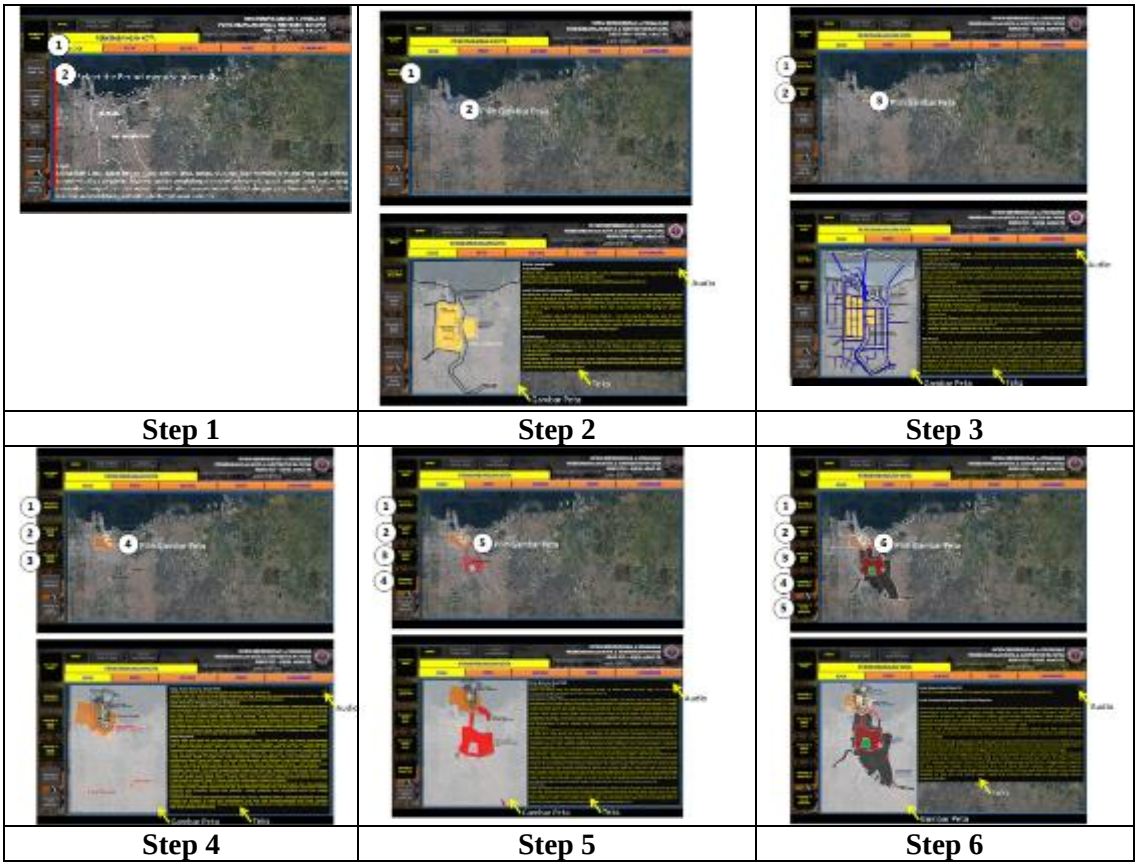


Fig. 8: The step brings up Edge information from the periods 1 - 5 by selecting tools per period
Source: Google Earth Base Map and Implementation of map digitisation results in the system

2. PATH

Users can search for Path information by performing steps such as Edge Search, but before searching, users must first select the Path tool and then search in each period. This Path contains information about the circulation paths created from the XVI century - early XX century in the form of rivers as the main transport route, which have later developed into land routes (roads, horse trams, steam trams, electric trams, and trains). The search stages can be seen in the Fig. 9. Explanation of the steps are the same as in the Edge section.

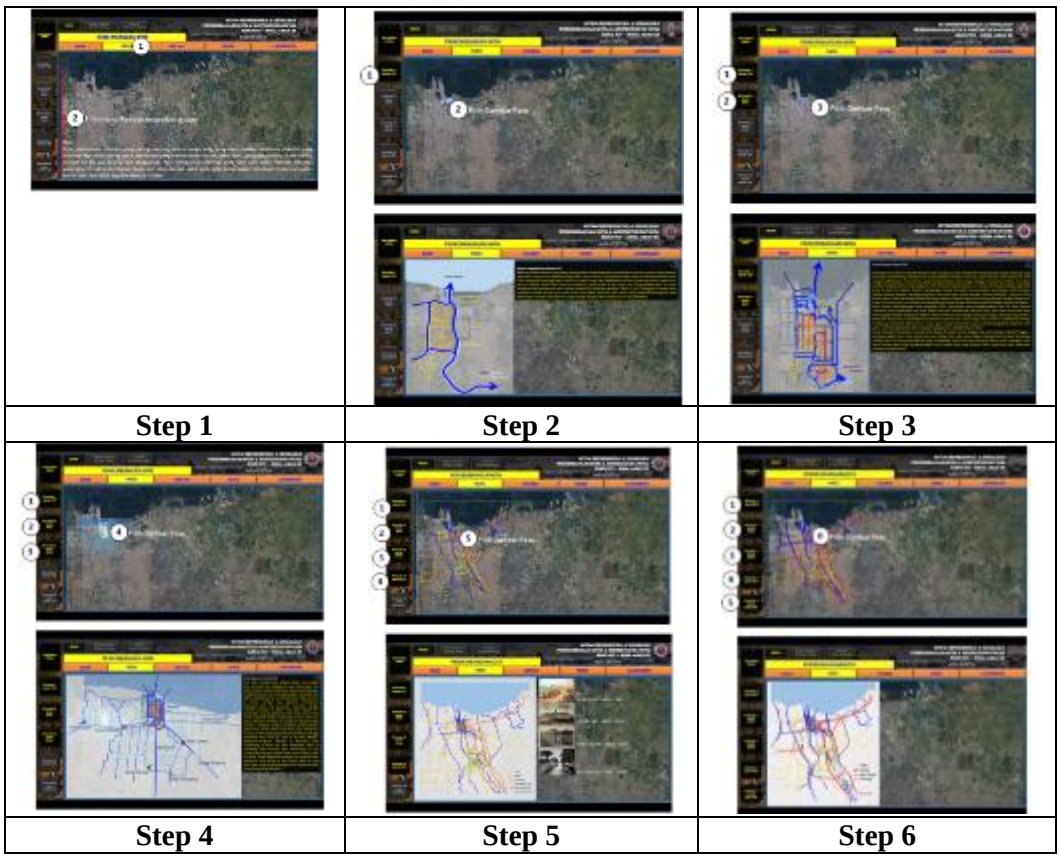


Fig. 9: The step brings up path information from periods 1 - 5 by selecting tools per period.
Source: Google Earth Base Map and Implementation of map digitisation results in the system

3. DISTRICT

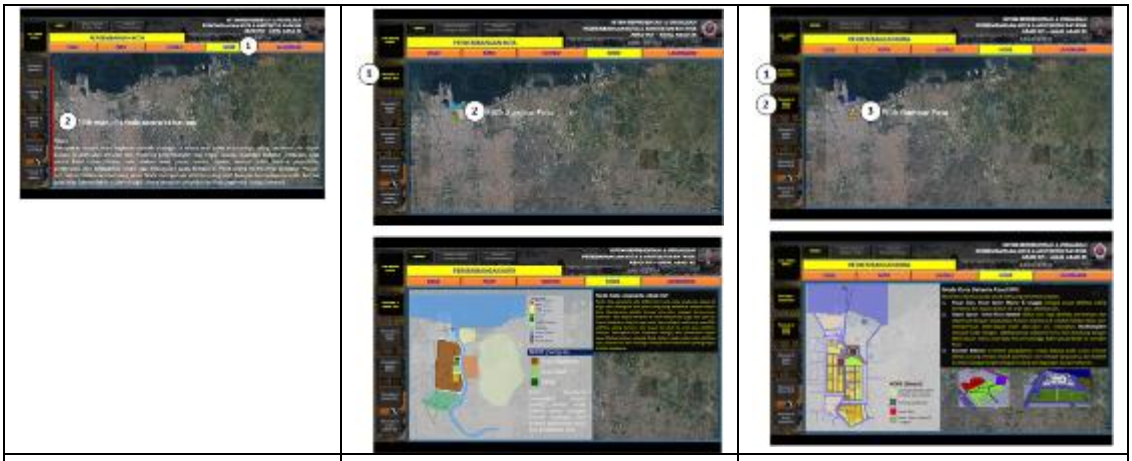
For information in the district section, the users can search with the same steps as the Edge and the Path. Previously, the users still had to select the Tools district to select the tools per period. This district contains information about the designated zones formed from the period 1 to the next period. For the period search can be seen in the Fig. 10, the steps 4, 5 and 6 are still the process of collecting data from the various sources and creating digital maps in each zone of the XVIII, XIX and early XX centuries. Judging from the zoning pattern with a larger area, the zones formed will be more complex.

Step 1	Step 2	Step 3

Fig. 10: The steps to bring up District information from Period 1- 2 by selecting tools per period
Source: Google Earth Base Map and Implementation of map digitization results in the system

4. NODE

For information in the node section the users can search with the same steps as the previous element, but they still have to select the Node tool first and then continue searching for the information sequentially in each period. This node contains information about the nodes formed in the city of Batavia from each period. The search stage can be seen in the Fig. 11. For stages 4, 5 and 6. The data collection and digitization process is still ongoing in order to provide the information for the periods 3, 4 and 5.



Step 1	Step 2	Step 3

Fig. 11: Step brings up node information from period 1 - 2 by selecting tools per period.
Source: Google Earth Base Map and Implementation of map digitization results in the system

5. LANDMARK

Landmark information is the 5th element of the city image to recognize the City of Batavia. When searching for information, it has similarities with the previous elements, but users still have to select the Landmark tool first and then continue to select tools in each period in sequence. This landmark contains information about the identity or characteristics that can be recognized from the city of Batavia from each period. For the stage search, see Fig. 12. For stages 4, 5 and 6. The data collection and digitization process is still ongoing to provide information for the periods 3, 4 and 5.

Step 1	Step 2	Step 3

Fig. 12: Step-by-step display of landmark information from period 1 - 2 by selecting tools period
Source: Google Earth Base Map and Implementation of map digitization results in the system

The display of information on each element in the form of a map image accompanied by text and audio is expected to make it easier for the users to understand from the explanation of the image in each period. The users can also read the text that appears on the display.

Testing stage

Testing is an important stage in building this system. It ascertains whether it is successful or is experiencing obstacles. It will indicate whether it will fail or require system improvements to suit the needs of the users and administrators so that information will be obtained about the development of the city of Batavia in the XVI century - early XX century.

Conclusion

The development of Batavia city from the 5 elements of the city image are as follows:

a. Edge: Batavia experienced territorial expansion from the periods 1 to 5 due to the direction of development and expansion from an area of 1.5 ha to 3,610. 53 ha.
b. Path: Batavia periods 1, 2, & 3 have rivers as the main transport. In the periods 4, and 5, land lines exist as the main transport: road, mass transport: horse tram, steam tram, electric tram and train.
c. District: The allotment area in Batavia in its development until Weltevreden was formed from the warehouse / kasteel and then semain complex as a city: central government zone, residential zone, trade and service zone, warehouse and industrial zone, etc.
d. Nodes: The nodes in Batavia from the periods 1 - 5 can ditemuka form: Alun-alun kastel, town hall front field, market, in Weltevreden field, market and road nodes.
e. Landmark: Batavia has a town hall, a church, a castle, and a palace as landmarks that can be found in each period.

Urban development database model:

a. This research has produced a database application: a representation & visualization system of urban development and architecture of Batavia century XVI-early XX century, through the process of data collection, analysis and digitization in the form of map data, image data, text and audio.
b. This application results from the application of knowledge representation. 5 elements of the urban image and architectural morphology of Batavia in each period exist.
c. A structured database model in knowledge representation describes the hierarchical relationships between the attributes.
d. Digital data stored in the system are then searched using the BFS (Best First Search) model, which moves from the general data as branches to more specific data as branches in sequence and produces data searches in the order designed according to the needs seen in the application results.

Author Contributions

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