Conceptual Design of GIS Database for Heritage Building in Melaka

Shahrul Hapizah Musa
Universiti Malaya
E-mail: fyzadearte@gmail.com

Noor Suhaiza Sauti
Universiti Tun Hussein Onn
E-mail: noorsuhaiza0003@gmail.com

Yahaya Ahmad
Universiti Malaya
E-Mail: yahaya@um.edu.my

Noor Azidah Abdullah
Politeknik Merlimau
E-mail: eiyies@yahoo.com

Fadhilah Mohd Nasir
Politeknik Merlimau
E-mail: hallihdaf@gmail.com

Abstract

Heritage building in Melaka has been gazzeted by Perbadanan Muzium Melaka (PERZIM) and they have been a lot of data and documentation regarding the heritage buildings including Traditional House, Religious Building and Colonial Buildings. Currently all records regarding to heritage buildings in Melaka generally consist of measured drawings, archival photographs and reports. It caters primary knowledge regarding heritage and conservation in architecture which emphasizes on measuring, recording and documenting building in form of drawings using manual and computer aided techniques, report and multimedia presentation of selected building. All the measured drawing data about heritage buildings is increasing and there are no databased have been created to manage all the data in digital archives to accommodate with twenty first century technology. A geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage and present spatial or geographic data. Therefore, GIS technology became a usual tool for heritage managers, conservators, restorers, architects, archaeologists, painters and all other categories of experts involved in cultural heritage activities. Web-based GIS uses the Internet to access and transmit data and the analysis tools to enhance the visualization and integration of spatial data. Before we develop the GIS Web application, the main thing that need to be emphasized is the conceptual design of GIS database regarding heritage buildings in Melaka. The Web GIS application will assist PERZIM and National Heritage Department (JWN) in managing data on heritage buildings and to preserve the heritage for next generation. Beside this application is very meaningful and align with I.R 4.0 where the cyber-physical systems are the basis and enable new capabilities in areas of studies.

Keywords: Heritage Building, Measured Drawing, Conceptual Design Web-Based GIS.

1.0 Introduction

Heritage is our past that been preserved for the present and it will be inherited for the future generations. Heritage itself is conceptualized as the meanings attached in the present to the past and is regarded as a knowledge defined within social, political and cultural context (Graham, B. 2002. Melaka is one of the states in Malaysia which has many heritage buildings and has been recognized by United Nations Educational, Scientific and Organization UNESCO as a world heritage site. Heritage building in Melaka has been gazzeted by Perbadanan Muzium Melaka (PERZIM) and they have a lot of data and documentation regarding the heritage building such as Traditional House, Mosques and Colonial Buildings. Based on The Madrid Document 2011, ICOMOS International Scientific Committee on 20th (ISC20C) Heritage in approaches for the conservation of Twentieth-century Architectural Heritage, more than ever the architectural heritage of this century is at risk from a lack of appreciation and care. Some has already been lost and more is in danger. It is a living heritage and it is essential to understand, define, interpret and manage it well for future generation.

Through an interview with the General Manager Perbadanan Muzium Melaka (PERZIM) Datuk Haji Khamis Bin Haji Abas, he noted that a lot of information related to the heritage buildings in Melaka was through of strategic collaboration between PERZIM and Politeknik Merlimau. This Collaboration involves the collection of data on heritage building in Melaka through a Measured Drawing Project implemented by students and lecturers Diploma in Architecture, Civil Engineering Department Politeknik Merlimau, Melaka. Through this collaboration, 60 heritage buildings consist Traditional Malay House, Colonial Building and religous building have been documented. The documented outcomes in a form of hardcopies drawing papers, report, model and artifacts need to be keep and stored in a gallery so that it can be accessed by others for future references. However, the problem faced nowadays is lack and minimum number of spaces to store everything in a gallery. The disorganized storage also creates a problem whereas, it is hard to search and monitor the document and retrieved the specific location. All the data about heritage buildings in Melaka is increasing and there are no system have been created to manage all the data in digital media to accommodate with twenty first century technology and Industrial Revolution 4.0. Therefore, the used of specific tools or technology help establish preservation standards to consistently store and share materials preserved digitally.

The evolution of digital technologies, together with the interdisciplinary approach to the matter of cultural heritage, have also encouraged the design and development of information systems for the storage, management, and quality checking of the data, which, going beyond mere archiving, opened significant scenarios for an active, dynamic, and constructive use of such devices (Vacca.G, 2018). A geographic information system (GIS) is a system designed to capture, store, manipulate, analyze, manage and present spatial or geographic data. Therefore, GIS technology became a usual tool for heritage managers, conservators, restorers, architects, archaeologists,

painters and all other categories of experts involved in cultural heritage activities. More and more central and local authorities responsible for cultural heritage embarked on creating complex and integrated information systems, having GIS as one of the main infrastructure component (Florian, 2007).This application is very meaningful and in line with I.R 4.0 where the cyber-physical systems are the basis and enable new capabilities in areas of studies. The essence of IT and OT convergence revolves around data upon data models and data mapping across the mentioned end-to-end product life cycle and value stream within this invention. Web-based GIS uses the Internet to access and transmit data and the analysis tools to enhance the visualization and integration of spatial data (Z. Duran, 2004) GIS greatly facilitates the mapping, recording, and management of spatial and non-spatial historical data. (Z. Duran, 2004).

Therefore this study will produce a GIS conceptual design for heritage building in Melaka before we proceed to develop web GIS database application. Conceptual designs are produced in the form of ER-Diagram containing components including entities, attributes and relationships between entities. Entities refer to heritage buildings that include traditional houses, colonial buildings, monuments and religious building that has been gazette by Perbadanan Muzium Melaka (PERZIM).The development of this database application is very crucial to the building's present status and its reconstruction project indicated and how digital close-range technology contributes to measured drawing, reconstruction and restoration projects is presented. In other words this study can assist the challenge in handling heritage and conservation aspects in Malaysia as gazetted by National Heritage Act 2005.

2.0 Literature Review

2.1 Heritage Building

Cultural heritage is inheritance of physical artefacts and intangible attributes that includes tangible culture; intangible culture; and natural heritage (UNESCO, 2018). Heritage building which falls under the category of tangible culture can be divided into few types of building typologies comprises residential; colonial buildings; religious buildings; shop houses; and public buildings. Heritage or historic building according to Hong Kong Heritage and Conservation (2018) signifies the value of historical interest; architectural merit; group value; social value and local interest; authenticity; and rarity. Heritage buildings are subjected to process of degradation which may structurally decay, not functioning for which it was built, or left abundant. Sometimes, there is also the need to improve the conditions of existing buildings in order to adapt with its new functions. In most developed countries, the awareness to maintain or preserve existing old buildings grows together with the technology to document architectural heritage buildings.

Melaka has developed over 500 years of trading and cultural exchanges between East and West in the Straits of Malacca. The influences of Asia and

Europe have granted Melaka with specific multicultural heritage that is both tangible and intangible. The unique architectural and cultural townscape of Melaka comprises with residential, government buildings, religious buildings, and fortifications. Melaka demonstrates both early stages of its history originating in the 15th-century of Malay Sultanate; the Portuguese and Dutch periods which begin in the early 16th century; and also the traditional Melaka Malay house which feature unique intervention between local and foreign culture. Most heritage buildings in Melaka are under the supervision of Perbadanan Muzium Melaka (PERZIM); Jabatan Muzium Malaysia; and Jabatan Warisan Negara (JWN). There are 26 museums; 11 galleries; and numerous individual buildings that were under the accountabilities of Perzim alone (Perbadanan Muzium Melaka, 2018). With the numerous number of heritage buildings within Melaka the challenge to document, conserve, preserve and protect the raw or hardcopy materials were crucial. Therefore, the web-based GIS using the internet as medium to access and transmit data could be an excellent approach in visualizing and integrating spatial data of the Melaka architectural heritage.

2.2 Measured Drawing

According to McGraw-Hill Dictionary of Architecture and Construction (2003), "Measured Drawing is an architectural representation drawn to the scale of an existing building". It caters primary knowledge regarding heritage and conservation in architecture which emphasizes on measuring, recording and documenting building in form of drawings using manual and computer aided techniques, report and multimedia presentation of selected building. The documented outcomes in a form of hardcopies drawing papers, report, model and artifacts need to be keep and stored in a gallery so that it can beaccessed by others for future references.

For centuries, measured drawings have been the major communication medium to acquire an understanding of the built environment and to deliver ideas of construction and design (Serra, 2017). He also stated the value of measured drawings as educational tools to learn about the architectural context as well as signifiers of the cultural values have transcended the importance of these two-dimensional illustrations as ephemeral deciptions of building forms and materials. The increasing use of advanced technologies in architectural documentation system from the desire to provide a seemless process of data gathering and production with minimfajal human intervention in data transcription and translation (Warden and Woodcock, 2005). Based on National Archieves of Australia Digital archiving in The 21st century (2006), In the 21st century the overwhelming majority of newly created information is digital. The digital collections of collecting institutions such as archives, libraries and museums consist of either digitised or 'born digital' content.

Based on the conclude research by Serra (2017), during documentation, architects delineate as much as possible that can be gained from studying the physical environment, while relating to the distinct forms and values embedded in the architectural context. Either formulating projections of plans, sections, and elevations to depict the architectural form

and space, or augmenting interpretive drawings to portray an intangible quality of the built environment, the aim of crafting the measured drawings is to develop a better understanding of the cultural heritage and to take the viewers to the heart of the architectural context. The thick measured drawings, in this context, are graphical inscriptions of the essence of the cultural heritage, but morphed through the architects' understanding of the built environment as well as the drawing conventions of the time. Those are the vital aspects that measured drawing should be critically enhanced and evolved in built environment as well as heritage and conservation studies. It is an indisputable reality that the most important thing for transmitting cultural heritage to posterity is a sensitive documentation such like measured drawing documentation. Up to the present there have been many developments in documentation of cultural heritage by developing technology, and contemporary documentation techniques have progressed speedily. As mention by Yilmaz et. Al (2007), modern methods have become preferable to conventional methods in architecture generally in the existent state and in determination of deformations and preparation of measured drawing projects of historical edifices. Digital and 3D data, rich visual images obtained by digital close-range photogrammetry, and orthophoto images of edifices, are governed and shepherded in documentation and future conservation projects. Also, these methods supply much ease, precision and time-saving in measured drawing projects when compared with conventional methods.

According to Thomas et al. (2006), a great advantage of measured drawings over the more ubiquitous and commonly known "blueprint" style of drawing is that a measured drawing takes into account and reflects any changes made to the building or structure subsequent to the initial construction period. Measured drawings are used by a variety of people for a wide range of tasks. They are used for rentable space calculations, real property legal records, facilities management databases, historic structure records and emergency access plans among others. For example, an obvious user is an architectural or construction firm that wishes to ensure a particular building or site was constructed according to the architectural blueprint or design plans.

2.3 GIS Database Design

According to Batini et. al (1992), database design plays an important role in the System Development Life Cycle. In this study, the database includes spatial data and attribute data. The database design is shown through Entity Relationship Diagram (ER-Diagram) introduced by Chen (1976) to model spatial data and data attributes and relationships between each such data. According to Shika (2012), ER-Diagram is one of the best methods for designing logical databases. Database development is carried out by involving the spatial data entry that requires data conversion activities to a format that supported by the system. The process of entering attribute data is to convert the periodic monitoring record of historic buildings to database table format. According to K. Elangovan (2006), a combination of spatial data and attribute data in GIS in standard formats

that allow the user to update, share, back up, manipulate and analyse data. Database modelling needs to be done to represent objects in the complex real world into the form of database objects in order to be easy to understand. There are four stages in implementing the database design phase of conceptual design, logical design, physical design and implementation of databases. The first phase of the conceptual design is to create a database conceptual scheme to describe the contents of the database information and to represent all data requirements that should be stored in the database.

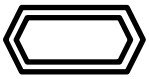
2.3.1 Conceptual Design

Defining a conceptual framework or architecture for a GIS system prior to its implementation is critical to success. A conceptual design is valuable because it describes, at a high level, key components of the system including relevant technologies, databases, organizational practices, and tools or applications. These same system components were used as an organizing framework in the first phase of this project, the situation assessment. The design concept is the level of logical structure used in development applications. This level is required as it enhances the application of quality and efficiency, reduces data cost and reduces redundant data. It involves database designation, modeling and data management systems and plan management (Nasir Nayan, 2006).

In this study, a conceptual database model for managing the measured drawing historical building will be designed for PERZIM application.

Conceptual design aims to build an abstract database representing more realistic real-world objects (Batini et al, 1992). Therefore, the methodology used to model geographic data in this study was the Entity-Relationship Diagram (ER-Diagram) introduced by Chen, P. (1976). This modeling is based on the components of the entity referring to the real world objects, attributes or characteristics of each true world object as well as the relationship between the objects. Each component has a specific graphical symbol and there is a set of rules for building an ER-Diagram database model using three basic symbols. Entities are presented as rectangles; relationships are represented by the diamond form and the attributes of the entity as an ellipse. Geographical data modelling has a different approach in terms of presentation of entities, relationships and attributes of geographic data. The relationship between the spatial entities is encoded as a topology, the relationship between spatial entities of points, lines and polygons as shown in Table 1.

Table 1: Spatial relationship in GIS

Spatial relationship	Relationship description	GIS operation	Operation description	ER-Diagram symbol
Connectivity	Connect, Link	Topology	Node-link data structure	
Contiguity	Adjacent, abut	Topology	Arc-polygon data structure	
Containment	Contained, containing, within	Coordinate operation x, y	Point-arc and polygon-polygon overlay operation	
Proximity	Closet, nearest	Coordinate operation x, y	Distance between 2 or more location	
Coincidence	Coincident coterminous	Coordinate operation x, y	Polygon –polygon overlay operation (part/all)	

2.4 GIS Database in Heritage/Conservation

There are various numbers of research that covers GIS Database in Heritage and conservation aspects includes Documentation using GIS techniques in conservation of a World Heritage Site, a case study of "The Old City of Jerusalem" by Husseini (2015). This research acknowledge that The Old city of Jerusalem, and as a UNESCO World Heritage Site 1 is a living city especially with its great wealth of historic structures, including places of worships for the three monotheistic religions, significant monuments, and whole historical residential neighbourhoods. As stated in the paper, applying GIS in the work of the Old City of Jerusalem Revitalization Program (OCJRP) had a great impact in documenting the history of such a unique city and making sure information is been collected and archived for current and future generations.. In addition, as GIS is a wide application with various functions, the OCJRP team has been able to benefit from this system to improve the work they daily conduct as well as introducing new processes to achieve a better outcome benefiting the Old City community. The original OCJRP "Project Document" included the establishment of the information and documentation centre that would create a comprehensive database for the Old City of Jerusalem as well as carry out the publication of books, booklets and documents. By the year 1999, OCJRP owned the first geographical information system for most of the buildings and monuments inside the Old City of Jerusalem, in which several informatical layers were created. The database outputs were initially created to be used to determine the priorities of restoration interventions inside the Old City, but the results were later used for further wider goals for the benefit of Architectural Conservation as well as for the benefit of the Old City Inhabitants and users.

Additionally, Wan Nor Faaizah (2014) on her research; Geospatial Database for heritage Building Conservation stated that with the development of information system and data collection technique, it is

possible to create a 3D digital model. This 3D information plays an important role in recording and documenting heritage buildings. 3D modelling and virtual reality techniques have demonstrated the ability to visualize the real world in 3D. It can provide a better platform for communication and understanding of heritage building. Combining 3D modelling with technology of Geographic Information System (GIS) will create a database that can make various analyses about spatial data in the form of a 3D model. This 3D model will be exported to the GIS format in order to develop a database for heritage building conservation. In this database, requirements for heritage building conservation process are included. Through this research, a proper database for storing and documenting of the heritage building conservation data will be developed. By applying geographic information system (GIS) technology to the Hongcun Cultural Heritage Conservation planning, data of building and social economy were collected, because data had spatial feature, data was saved and managed by GIS database. Based on spatial database of GIS, thematic maps were plotted, building value was evaluated, and mode of building conservation was determined; information of each building was created in conservation planning. The technical route based on GIS for the investigation and planning method was established, and the existing method of the conservation planning was changed. And moreover, the administrative department can effectively monitor and manage the cultural heritage by the spatial information database of GIS.

3.0 Methodology

In general, methodological research activities involve the process of obtaining information from the analysis of user requirements and making it in a structured format. The results of these activities will be GIS data model and functional specifications for the GIS system.

3.1 User Requirement Analysis

User requirement analysis needs to be implemented at an early stage to ensure the successful development of a system. At this stage existing data or information, the supporting data, hardware and software used, the user background and level of expertise and other relevant information will be identified. The interview method was conducted with PERZIM to collect information on the management activities of the drawing for heritage building as well as the existing system used. The problems encountered can be identified and the objectives and scope of the study are determined from interviews and research on existing systems. The list of building that have been documented are categorized accordingly to type of building such as traditional houses, colonial buildings, religious buildings or Monuments. Table 2 shows a list of heritage buildings by categories under PERZIM which has been documented by students of Diploma in Architecture Politeknik Merlimau throughout the strategic Collaboration period between PMM and PERZIM since 2012.

Table 2: List of heritage building by categories has been documented by students of Diploma in Architecture, Politeknik Merlimau

No	Building Category	Total Buildings have been documented
1.	Religious Buildings	14
2.	Traditional House	20
3.	Colonial Building	26

3.2 Preparing GIS Data Model

A data model is a formal definition of the data required in a GIS. The data model is a structured list and an entity-relationship diagram. The purpose of the data model, and the process of specifying the model, is to ensure that the data has been identified and described in a completely rigorous and unambiguous approach and that both the user and GIS analyst agree on the data definitions. The data model is then the formal specification for the entities, their attributes and all relationships between the entities for the GIS. As a result from the user requirements analysis, the entity and attribute data that have been identified for database development in this study are as in the Table 3.

Table 3: Entity and attribute data for measured drawing for heritage building in Melaka database

Entity	Attributes
Monument	ID, Register Number, Name, Address, Picture, Video
Colonial building	ID, Register Number, Name, Address, Picture, Video
Traditional house	ID, Register Number, Name, Address, Picture, Video
Religious building	ID, Register Number, Name, Address, Picture, Video
Road	ID, Name
River	ID, Name
City	ID, Name
Bounty	ID, Name, Area, Perimeter
District	ID, Name, Area, Perimeter
Malaysia	ID, Name, Area, Perimeter
Monitoring Schedule	Code, Status, Start date, End date, Note

The main spatial data involved in this study are historic buildings including of traditional houses, colonial buildings, monuments and religious house located in Melaka. The monitoring schedule entity is non-geospatial data that contains information on monitoring record for historical building on a regular basis. Supporting entities comprises of spatial data including roads, rivers, towns, bounty, districts and Malaysia.

3.3 ER-Diagram Development

Geographical data describes entities with locations. The geographic data includes the location information and other information about the entity known as attributes of the entities. Data modeling describes relationships between entities in addition to a clear and concise definition of entities and their attributes. An example of a relationship between a bounty and the traditional house would be "contain". Therefore, a bounty contain a traditional house. Relationships may be bi-directional, thus traditional house place in a bounty. An important aspect of a relationship is "cardinality," that is if the relationship is between only one of each entity or if either entity may be more than one. For example, a bounty usually contains many traditional houses whereas one traditional house place in a bounty. The possible cardinalities are one-to-one; one-to-many; and many-to-many. Thus bounty has many traditional house but, traditional house place in a bounty. A diagrammatic representation of the example would be as follows:

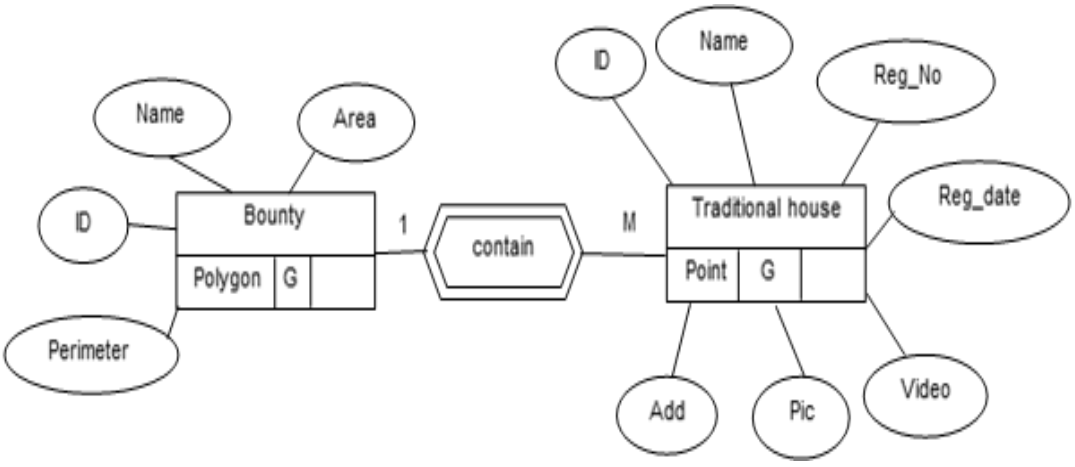


Figure 1: Diagramming a spatial relationship between bounty and traditional house entity including entities attributes

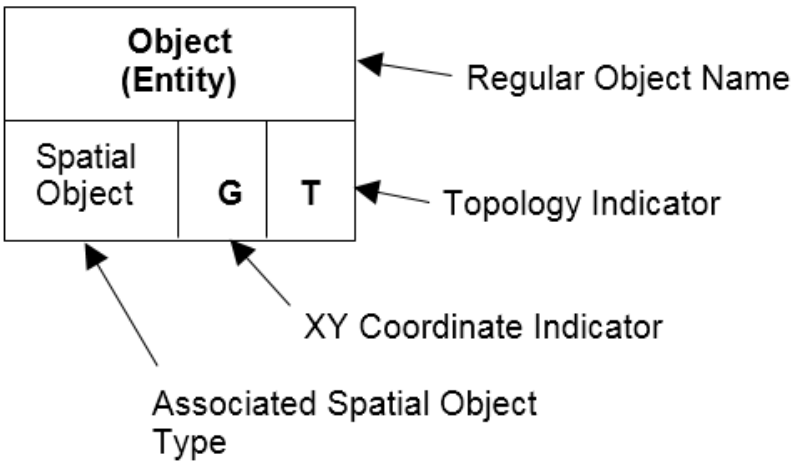


Figure 2: Entity symbol for spatial objects

The process of constructing an E-R diagram involves taking an entity from the list one at a time and placing each one on the diagram. For each new entity, any relationship with any entity previously entered shall be included. The relationship is found by examining the Application Description and determining whether the GIS process requires certain operations. Since each entity is included in the E-R diagram, the attribute list needs to be reviewed and checked to determine whether attributes are appropriate for the entity, not duplicating any attributes or other entities.

4.0 Results and Discussion

As a result of preliminary studies and user requirements, a conceptual design model in the form of ER-Diagram comprises the entities, entities and relationships of each entity in the measurement drawing of heritage building database has been developed. The ER-Diagram for geospatial database model for measuring drawing of the heritage building a shown in Figure 3.

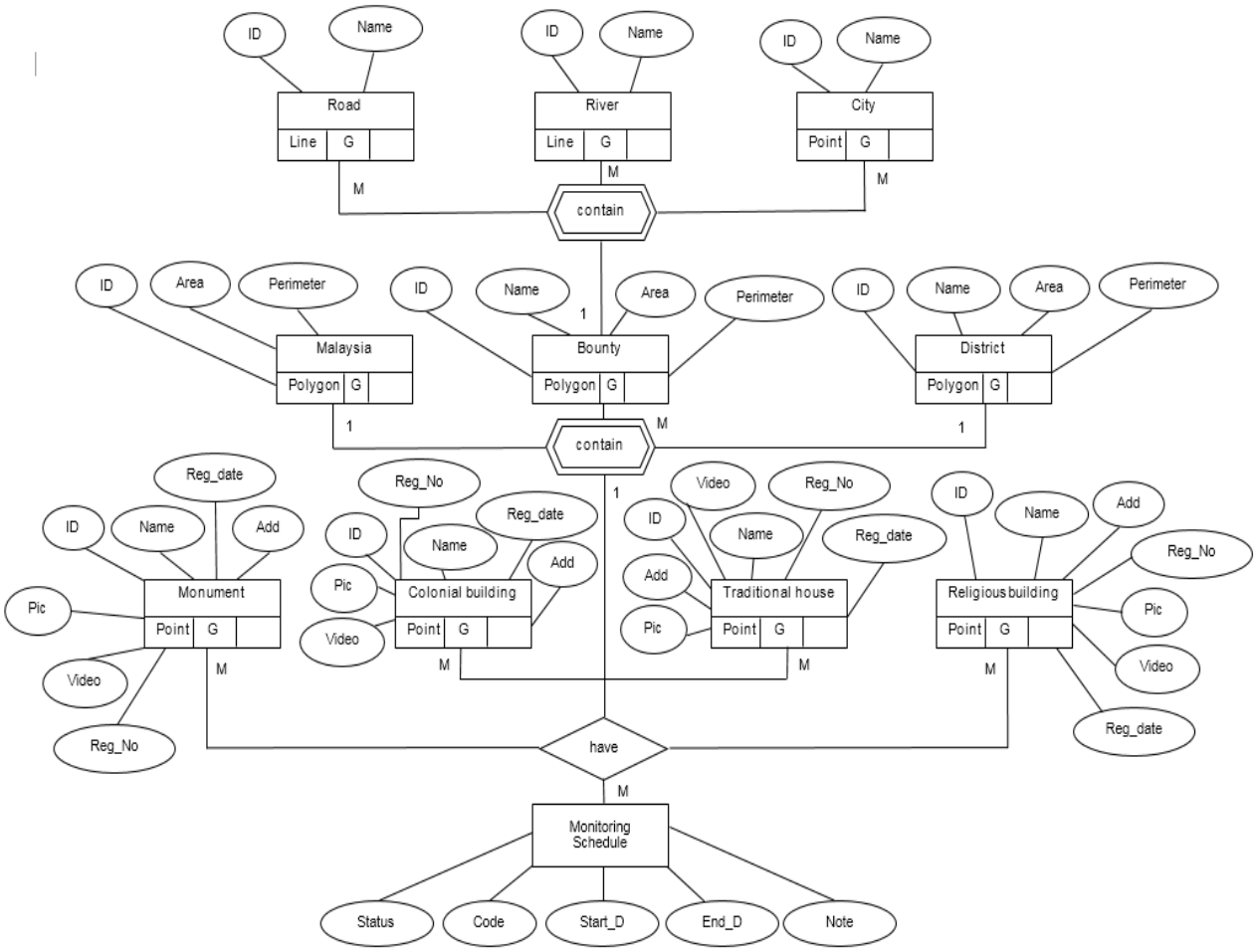


Figure 3: ER-Diagram for geospatial database model for measuring drawing of Melaka heritage building

The result of ER-Diagram developed contains 11 entities and 10 relationships. Attributes of each entity that has been identified for each entity is also included in the diagram.

Based on conceptual design of GIS database, information of each building was created and requirements for heritage building conservation process are included. Through this research, a proper database for storing and documenting of the heritage building conservation data will be developed. Hence this method is one of the most effective medium to highlight and promote the architectural heritage in the context of Digital Documentation in order to align with twenty-first century technologies and it was also able attract a new generation to appreciate our heritage.

5.0 Conclusion

In conclusion, the conceptual design of the GIS is primarily an exercise in database design that includes formal modeling (preparation of a data model) of the intended GIS database. The ER-Diagram development in conceptual database design for measured drawing for heritage buildings in Melaka is an important stage that needs to be implemented at the initial

stage of the development of a GIS system. It begins with the identification of the needed data and goes on to cover several other activities collectively termed the data life cycle- identification of data in the needs assessment, inclusion of the data in the data model, creation of the metadata, collection and entry of the data into the database, updating and maintenance, and, finally, retention according to the appropriate record retention schedule. A complete data plan facilitates all phases of data collection, maintenance and retention and as everything is considered in advance.

References

Addison, Alonzo C. "Visualized Architectural Heritage: New Tools and Techniques." IEEE
APT Bulletin 40: 5-10.

Batini, C. S. Ceri and S. Navathe. 1992. Conceptual Data Modeling: An Entity- Relationship Approach. California: The Benjamin / Cummings Publishing Company.

Burns JA. 2004a. "Measured Drawings." In: Burns JA (ed) RecordingHistoric Structures. Wiley.

Chen, P. 1976. The entity-relationship model: Toward a unified view of data. ACM Transactions on Database Systems. Vol. 1(1) page 9-36.Congress, Istanbul, Turkey

Cyril M. Harris, Dictionary of Architecture and Construction. 4th Edition (2003) McGraw-Hill

Duran, Z., Dogru, A. G., Toz, G. (2004). Web-Based Multimedia GIS for Historical Sites. 20th ISPRS
for Architectural Education," Landscape and Urban Planning 73, no. 2-3(2005): 110–19

Graham, B. (2002). "Heritage as Knowledge: Capital or Culture". Urban Studies, Volume 39,

H.M Yilmaz, M. Yakar, S.A. Gulec, O.N. Dulgerler (2007) Importance of Digital Close-Range Photogrammetry in Documentation Of Cultural Heritage. Journal of Cultural Heritage. Science Direct. Volume 8, Issue 4, Pages 428-433.Heritage, Madrid Document.

Hong Kong Heritage and Conservation. (2018). Historic buildings @ Heritage conservation. In H. K. H. a. Conservation (Ed.), *Conserve and revitalise Hong Kong Heritage*. Hong KOng: Hong Kong Heritage and Conservation.

ICOMOS (2011), Approaches for the conservation of Twentieth-Century Architectural

K. Elangovan, 2006. GIS: Fundamentals, Applications and Implementations: New India Publishing. New Delhi.

Lyn F and Dulaney R. 2009. “A Case for Drawing.” Enquiry 6: 23 https://doi.org/10.17831/enq:arcc.v6i1.4

Mingxing Hu, "The application of GIs technology in cultural heritage conservation planning - A case study of Hongcun," 2011 International Conference on Electric Technology and Civil Engineering (ICETCE), Lushan, 2011, pp. 6937-6940.Multimedia, November/December 2003, pp. 32-41

Nasir Nayan (2006). Sistem Maklumat Geografi dalam Perancangan Pembuatan Keputusan Perniagaan. Tanjung Malim: Penerbit Universiti Pendidikan Sultan Idris.Nos 5-6, PG. 1003-1017

Paul A. Thomas, Trevor J. Vigoren, Sean Vikoren (2006), System for Creating Measured Drawings: United States Patent.

Peng, Zhong–Ren, Tsou, Ming–Hsing (2003), Internet GIS: Distributed Geographic Information

Serra Akboy-İlk, Crafting the Architectural Measured Drawings. The Plan Journal 2 (1): 39-61, 2017

Services For The Interenet And Wireless Netwoks, John Wiley & Sons, Inc, New Jersey, USA

Shika Bagui and Richard Earp, 2012.Database Design Using Entity-Relationship Diagrams,Second Edition.CRC Press Taylor and Francis Group.

Wan Nor Faaizah Basir, et. al (2014), Geospatial Database for heritage Building Conservation, IOP Conf. Ser.: Earth Environ. Sci. 18 012087

Warden R. 2009. “Towards a new Era of Cultural-Heritage Recording and Documentation.”

Warden, Robert and David Woodcock. "Historic Documentation: A Model of Project Based Learning

UNESCO. (2018). Definition of the cultural heritage. Retrieved from http://www.unesco.org/new/en/culture/themes/illicit-trafficking-of-cultural-property/unesco-database-of-national-cultural-heritage-laws/frequently-asked-questions/definition-of-the-cultural-heritage/

Perbadanan Muzium Melaka. (2018). Latar belakang Perzim. Retrieved from http://www.perzim.gov.my/ms/perzim/info-perzim/background-of-perzim/