

A CONTRIBUTORY WEB-BASED APPLICATION
FOR DOCUMENTING HISTORIC RESOURCES:
FRENCH COLONIAL ERA ART DECO ARCHITECTURE IN HANOI

by

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LIST OF ABBREVIATIONS

| | |
|---------|---|
| API | Application Programming Interface |
| CIDOC | Documentation Committee of the International Council of Museums |
| CIPA | International Committee for Documentation of Cultural Heritage |
| CMS | Content Management System |
| CRGIS | Cultural Resources Geographic Information System |
| CRM | Conceptual Reference Model |
| CSS | Cascading Stylesheets |
| CSV | Comma Separated Values |
| DSLR | Digital Single Lens Reflex |
| EXIF | Exchangeable Image File Format |
| FEMA | Federal Emergency Management Agency |
| GIS | Geographic Information System |
| GLAM | Galleries, Libraries, Archives, and Museums |
| GLONASS | GLOBAL NAVIGATION Satellite System |
| GPS | Global Positioning System |
| GPX | GPS Exchange Format |
| HDR | High Dynamic Range |
| HTML | Hypertext Markup Language |
| ICOM | International Council of Museums |
| ICOMOS | International Council of Monuments and Sites |
| JSON | JavaScript Object Notation |
| KML | Keyhole Markup Language |

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| KMZ | Zipped KML File Format |
| PaaS | Platform as a Service |
| PPSR | Public Participation in Science Research |
| RDF | Resource Description Framework |
| RDM | Reference Data Manager |
| SaaS | Software as a Service |
| SHPO | State Historic Preservation Office |
| SKOS | Simple Knowledge Organization System |
| SQL | Structured Query Language |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| USC | University of Southern California |
| UX | User Experience |
| W3C | World Wide Web Consortium |
| XML | Extensible Markup Language |
| ZIMAS | Zone Information and Map Access System |

ABSTRACT

This thesis project consists of the development of a contributory web application to display and gather information on French Colonial era Art Deco architecture in Hanoi, Vietnam. The goal of this application is to create the foundation for a web-based spatial inventory of existing French Colonial era buildings. The inventory is meant to advise policymakers and heritage organizations on priority resources to protect the existing base of resources as well as to create a historic record of the historic urban landscape. This is important because the push to modernize infrastructure in emerging nations often leads to the destruction of the colonial heritage fabric in urban areas. An inventory of what currently exists, and possibly what existed in the past, will help to digitally record these sites, despite what occurred or may eventually occur in the physical places. Also as part of its purpose, the application seeks to engage the general public, including interested heritage professionals and scholars, by incorporating the ability to contribute information through the correction and enhancement of current entries. The web application will incorporate the minimum data standards for inventory of cultural heritage as specified in the *Core Data Index to Historic Buildings and Monuments* (Thornes and Bold 1998). The initial dataset for the application is based upon data collected during fieldwork in June 2012 and covers a self-defined area of the French Quarter district of Hanoi. As a secondary purpose, the web application was developed to be replicable by others who might choose to take and adapt the web application model for their own heritage conservation-related purposes. As such, the web application employs easy-to-use, relatively inexpensive, cloud-based tools and services, such as CartoDB, MapBox, Persona, Heroku, Bitbucket, and various Google products. In order to use many of these services together, the web application was purpose-built using the well-documented and flexible Python web development framework, Pyramid, in conjunction with the templating

system, Jinja2, along with the standard HTML, CSS, and JavaScript programming languages. After instructional documentation is written and further development occurs as specified in the application's roadmap, the code, which is currently stored in a private repository on Bitbucket will be opened for download and collaboration by others wanting to use and improve the application model.

CHAPTER ONE: INTRODUCTION

1.1 Motivation

The economic growth of Southeast Asia, fueled by capital investment originating from outside of the region, particularly from China, Japan, South Korea, and Australia, is rapidly modernizing its urban landscapes, irreparably changing the character of its cities. For example, in 2010, the construction of the South Korean-owned \$1.05 billion Keangnam Hanoi Landmark Tower was underway in Hanoi's new central business district, and plans for “the second tallest building in Asia after the Burj Kalifa” were being circulated, prompting concern over the effects on Hanoi's fragile architectural heritage (Stokes 2010).

Indeed, the push to become part of the developed world has the potential to create an atmosphere in which the cultural heritage resources of the area are at risk of demolition or significant alteration. In Asia, this pattern of sacrificing cultural heritage in the wake of modernization is seen most prominently in Shanghai, where many of the city's Art Deco vernacular buildings were razed in order to build larger contemporary buildings (Girard 2007). In the 1990s, approximately 600 of Beijing's historic hutongs were destroyed in order build new developments (Kaiman 2012).

As a result of the perceived threat to these resources, in 2012, the author of this thesis project traveled to Southeast Asia to try to document what French colonial era buildings were left. Because the region is fairly large, the informal field survey was limited to small areas in several key cities, including Vientiane, Hanoi, and Phnom Penh. It consisted of taking photos and recording geographic coordinates in order to create an eventual set of geo-referenced photos

of potentially significant buildings from the French colonial period.

Away from the field, each building was assigned a building style based on visual inspection of the photograph and the initial assessment in the field. However, no other information exists for each building documented. The purpose of this project, then, is to establish a web application that facilitates the gathering of additional essential information for a subset of the Hanoi photoset. This additional information will be defined by best practices in regards to web-based geospatially-oriented cultural heritage inventories. However, before delving into determining the requirements for the application, background information on cultural heritage inventories and also French colonial era architecture in Hanoi are presented.

1.1.1 Cultural Heritage Inventories

In this section, the concept of a cultural heritage inventory is introduced, including definitions, a discussion on why inventories are important in conserving cultural heritage resources, and an outline of the challenges to creating and maintaining inventories.

1.1.1.1 Definitions

The conservation and management of built cultural heritage is dependent on adequate documentation, primarily in the form of an inventory, of the actual heritage resources. One of the most basic definitions of an inventory is "an itemized list of current assets" (Merriam-Webster.com, 2015). However, an inventory can also refer to the process of creating this list in the form of a survey (Merriam-Webster.com, 2015, 2). Both definitions are relevant for the purpose of this project because a survey often determines what information is included in the inventory list. (From this point forward, "survey" will be used for the process and "inventory" will be used for the resulting list.) For example, in its *Guidelines on Cultural Heritage*, the Council of Europe (an international human rights organization consisting of 47 European

member states) uses the survey definition of an inventory and defines it as "an official research activity for the preliminary recording and documentation of cultural heritage assets. It provides the basis upon which an evaluation may be made to: (1) determine whether or not the asset should be legally protected; and (2) prepare a plan for its conservation whereby its value may be permanently secured" (Council of Europe 2012, 19). This definition contains an imperative that defines the contents of what information should be collected in a survey and hence, the eventual inventory. In other words, in the cultural heritage field, an inventory may not be sufficient if it does not provide sufficient information to evaluate a cultural asset or resource.

This project focuses on immovable cultural heritage, primarily in the form of buildings. Immovable cultural heritage resources are literally resources that cannot be reasonably moved from their respective locations and include architectural structures, archaeological structures and features of cultural landscapes (Council of Europe 2012, 19). This highlights the importance of geospatial information for such resources as location is intrinsic to their value as cultural heritage. For example, the US National Register of Historic Places establishes a cultural resource's integrity through the evaluation of seven qualities: location, design, setting, materials, workmanship, feeling and association (National Park Service 2002). Two of these – location and setting – are geospatial in nature. In the case of location, the geospatial information consists of the actual location of the resource. In the case of setting, it refers to the resource's location relative to its environment.

While a cultural heritage inventory is not explicitly geospatial in nature, it is implicit that to be effective in its purpose (i.e. the conservation of cultural heritage resources) it requires geospatial information for each resource. To fully utilize this and other data, a cultural heritage inventory should be housed in some kind of geographic information system (GIS).

1.1.1.2 Importance of Cultural Heritage Inventories

Because a cultural heritage inventory contains information on what is considered a cultural heritage resource and also sometimes, what is not, having a complete inventory of an area, city, region or country is one of the first steps for conservation. For example, in the case of the US, legal protection against the demolition or destruction of the historic integrity of a historic site cannot usually be enabled unless the site is listed on a heritage register (a type of cultural heritage inventory) at either the local, state or national level. In other words, policymakers and heritage organizations cannot save resources that are not legally recognized as being worthy of protection (Logan and McKay 2013, 10).

In addition, heritage inventories that are publicly accessible help to provide awareness and support for conservation of cultural heritage. If a society recognizes that a resource is historically important and part of its cultural identity, conservation of the resource perhaps becomes an obvious and expected outcome by all stakeholders. For example, the Tower of London has such cultural weight in the UK that the idea of demolition or alteration would probably be considered a form of national sacrilege. By giving a resource some form of cultural weight by inclusion, inventories help to conserve cultural heritage resources from one of the largest sources of cultural heritage destruction – human development.

It should be noted, however, that publicly accessible heritage inventories can also create problems for long term cultural heritage conservation management. If a resource becomes too popular or if its material worth becomes known, then the problems of unsustainable tourism, looting, or malicious destruction might become viable threats. For example, the UNESCO World Heritage List is an inventory of the world's most important cultural heritage sites. For cultural heritage tourists, the listed sites can become much sought after destinations, contributing

to unsustainable tourism. The Angkor Archaeological Park World Heritage site in Cambodia receives more than 2 million visitors per year, and the resulting pressure on the site is causing harm to the centuries-old structures (Sharp 2008). The publication of a heritage inventory can also form a shopping list of sorts for looters, who seek to profit from illegally obtained portions of a site. Alternatively, a heritage inventory can serve as a target for opposition forces during an armed conflict. For example, immediately prior to the Croatian War of Independence, Croatia submitted a list of important sites to be protected as required by the 1954 Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict, and those sites were intentionally and maliciously damaged by the Serbian opposition as "cultural property was targeted as part of a political strategy" (Stone 2013, 15).

However, in these and other cases, inventories of at-risk heritage act to counter any of the unintended damage from the unsustainable tourism, looting or malicious destruction as well as other threats. For example, the World Monuments Fund publishes a World Monument Watch list biannually to draw attention to cultural heritage resources that are at risk from "the forces of nature and the impact of social, political, and economic change" (World Monuments Fund 2015). UNESCO also maintains The List of World Heritage in Danger to draw attention to at-risk World Heritage sites. For nations that do subscribe to the Hague Convention, heritage inventories can serve as lists of places to avoid and/or actively protect during an armed conflict. Usually, armed conflicts present a list of priorities for which heritage conservation is usually not a consideration; however, recently, military strategists have discovered the use of cultural heritage protection in combat and occupied areas as a "force multiplier", which makes their work easier in regards to stabilizing the local area (Stone 2013). Cultural heritage

inventories, in this way, can become part of their positive strategic planning, and prevent needless harm to cultural heritage resources.

Regarding natural disasters, existing heritage inventories facilitate recovery and decrease the impact (McCarthy 2013) on cultural heritage resources during and after events. In the case of Hurricane Katrina, the Federal Emergency Management Agency (FEMA) was required by law, specifically the 1966 National Historic Preservation Act, to consider how its response, particularly in dealing with properties deemed as unsafe, might affect sites that are eligible for the National Register. However, a geospatial inventory of such properties did not exist at the time, so working with the National Park Service's Cultural Resource GIS Facility (CRGIS), a methodology was established so that surveyors could record potential National Register-eligible properties (McCarthy 2013). This process led to the addition of 55,000 cultural heritage resources to the GIS of the Louisiana State Historic Preservation Office (SHPO), demonstrating how important it is to have an existing geospatial heritage inventory before a disaster occurs. In addition, this information could have been used as a benchmark from which to measure the damage sustained by an area affected by a natural disaster. During and after a natural disaster, baseline inventory documentation allows decision makers to make better choices and allocate appropriate resources to the conservation of heritage sites.

1.1.1.3 Challenges to Creating and Maintaining Cultural Heritage Inventories

While heritage inventories are generally seen as essential to cultural heritage conservation, there are several challenges to both creating and maintaining them. First, often there is a lack of funds to support a comprehensive and useful inventory. The costs associated with field surveys and then the technical infrastructure to house an inventory might be too expensive for many heritage organizations and governments. Second, the creation and maintenance of heritage inventories

require knowledgeable and skilled staff who are invested in the inventory process. In developing areas where other foreign experts are brought in to help create a survey and inventory system, the danger is that once foreign involvement ends, so does the maintenance of an inventory. For example, in the Sana'a, a system was developed and local people were trained to use the system; however, as the project manager, Daniele Pini, laments, "after five years, the GIS we set up is completely useless because it's never been updated." (Grayson et al. 2013, 22) Third, issues regarding the actual inventory data exist. These include: (1) a lack of access to data by both heritage professionals and the public; (2) the interoperability of the data; and (3) the ability of the data to be maintained and migrated as technology develops.

1.1.2 French Colonial Era Architecture in Hanoi

The French Colonial period in Southeast Asia began in 1887, with the establishment of French Indochina, which initially consisted of the areas now known as Vietnam and Cambodia and expanded in 1893 to include Laos. In 1898, a small outlying area on the southern coast of Guangzhou, China was added. The colony lasted until 1954, when the French were defeated by the North Vietnamese in the First Indochina War, and North Vietnam and South Vietnam were created. Previously, Cambodia and Laos gained independence in 1953.

Hanoi was initially occupied by the French in 1873, and became the capital of French Indochina in 1902 until 1954, with some temporary relocations of the capital due to World War II and the First Indochina War. However, previous to this, Hanoi was always considered an important city in Vietnam, as it was the capital from 1010, the year of its founding, to 1802, when the emperor moved the government seat to Hue.

As a result of this long and illustrious history, much of the architectural heritage of Hanoi can be divided by what existed during the imperial period and what existed during the colonial

period. Before French colonization, the center of Hanoi was the Imperial Citadel, which is now a UNESCO World Heritage Site. To the east of the Citadel area and north of Hoan Kiem Lake, the Old Quarter is perhaps the best known historic neighborhood in Hanoi. It consists of a tight network of 36 main streets that each represent a particular type of commerce. This urban cultural landscape consists of both tangible and intangible heritage that dates back to the founding of the city more than 1,000 years ago. The remaining historic parts of central Hanoi are French colonial in nature, as the French proceeded to apply some Haussmann-esque city planning principles (e.g. wide Parisian-style boulevards with monumental buildings at key intersections) and in the process, removed some traditional areas in order to redevelop them in this way. This French concession, or the French Colonial Quarter is located to the immediate south of the Old Quarter along the Red River.

1.1.2.1 Survey Area in Hanoi

For this project, the Hanoi survey area is primarily composed of the area west of Hoan Kiem Lake, which comprises a portion of the French Colonial Quarter, which also includes a larger area south of Hoan Kiem Lake. The survey area, which is approximately 0.35 square miles, also overlaps to a small extent with the Old Quarter, which lies to the north of it. The Hanoi survey included 140 photographs representing different architectural styles within the study area (see Figure 1). The methodology behind the survey will be detailed in the data section of Chapter 3. Examples of how the architectural styles were expressed in the Hanoi survey are seen in Figure 2.

In general, the architectural styles in Hanoi are typically a mixture of different styles (Nguyen and Kammeir 1997, 5). This is both the result of organic and planned processes that occurred during the French colonial period. On the one hand, French master planners and

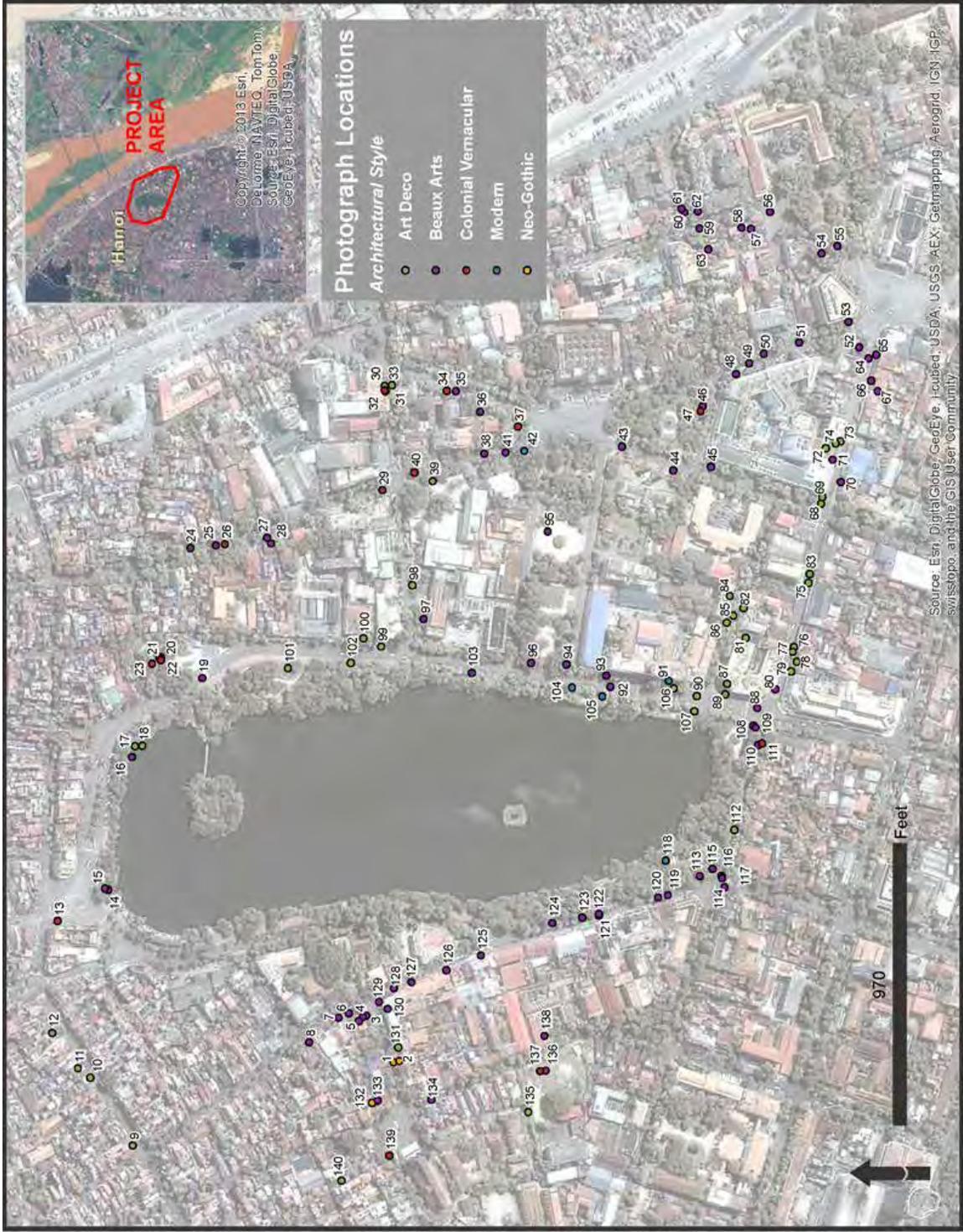


Figure 1 Hanoi survey photograph locations, organized by architectural style

architects developed blended styles on purpose, and on the other, the adaptation of European styles to a non-European climate and setting required the blending in of more pragmatic local styles (Wright 1991). For the purposes of this project, only the Art Deco cultural heritage resources will be used for the dataset, primarily because Art Deco, also known as Moderne, is a style that is not necessarily well recognized as historically significant as earlier French colonial era styles such as the Beaux Arts and Colonial French/Vernacular styles.



Figure 2 A sample of architecture styles in the Hanoi survey area

1.1.2.2 Cultural Heritage Resource Management and Inventory Activities in Hanoi

On paper, the management of cultural heritage resources by the Vietnamese government is deemed a priority. However, cultural heritage conservation as a function of the government is considered ineffectual due to a large body of "superficial", "ambiguous", impractical, inconsistent, and sometimes contradictory laws, directives, plans and regulations as well as "bureaucracy", corruption, mismanagement and weak enforcement (Nguyen and Kammeir 1997, 7). As a result, several non-governmental domestic and foreign organizations have provided assistance in cultural heritage conservation.

A recent example of this was the partnership between the city of Hanoi and the French city of Toulouse and the Brussels Capital Region. Funded by the European Asia Urbs programme, two projects were undertaken that included a strong focus on the architectural heritage conservation of Hanoi's Old Quarter: the ASIA REHAB European Project (2000-2003) and the Hanoi 2010 Project - Heritage and Cultural Identity (2004-2006). Generally, these two projects focused on individual architectural conservation projects, large street improvement projects, and implementing a GIS to record the Old Quarter's architectural heritage. Additionally, the Hanoi 2010 Project was meant to prepare for cultural events to celebrate the 1,000th anniversary of the official founding of Hanoi in 1010 (Hanoi 2010 Project 2014).

From 2006-2010, Toulouse continued the partnership with Hanoi, working on several objectives having to do with the promotion of Old Quarter heritage. These included: (1) an inventory of both tangible and intangible heritage resources; (2) developing a pilot street; (3) creating a detailed conservation plan; (4) establishing five locations that showcase architectural conservation and provide cultural gathering spaces; (5) architectural conservation projects on

individual structures; and (6) nomination of the Old Quarter for UNESCO World Heritage Site consideration.

The inventory portion consisted of the 2007 systematic review of the 1,080 Old Quarter houses that were initially identified as heritage properties in 1999 by Hanoi authorities. Conducted by a Toulouse-based architectural expert, the purpose of this review was to quickly verify and determine the state of the resources before a later more detailed study of each building could be performed by a Vietnamese team after the end of the partnership. The findings indicated that the 1999 inventory was incomplete and as a result, 880 houses were added, despite the fact that only 300 of those maintained their historic architectural integrity. Even more alarming is that between 1999 and 2007, only 30% of the originally-listed buildings have remained intact to varying degrees (Hanoi, Heritage and Identity 2010).

This fact underscores the importance of a heritage conservation plan developed on the basis of a cultural heritage inventory in Hanoi. While the above project focuses on the Old Quarter, which is a well-known and highly-regarded pre-colonial historic area, other areas of Hanoi that might contain cultural heritage resources may be overlooked, especially if those resources are relatively younger, such as the city's Art Deco resources. As the city's population increases and economic growth continues, its cultural heritage may suffer due to developmental pressure and other stressors if strong heritage conservation methods, that not only include statutory protections but also policies that promote a heritage-friendly environment, are not put into practice.

1.2 Objectives

The main objective of this thesis project is a web application that uses geo-referenced photographs as a starting point to gather useful information about cultural heritage resources

from both the general public and engaged cultural heritage enthusiasts and professionals. The information collected will conform to recognized heritage data standards in regards to content. The case study focuses on French Colonial Era Art Deco resources in the French Quarter of Hanoi, Vietnam. The web application will not be fully deployed, but its usefulness will be evaluated by cultural heritage professionals and others who have an understanding of heritage inventories.

The secondary objective is to use web development tools that are easily deployable and are relatively inexpensive to use in order to create a data collection model that can be applied by heritage professionals who may have very few resources and technical skills. Ideally, for example, if a geo-referenced photo catalog of a particular type of cultural heritage resource existed with very little information, this web application model could serve as a method of gathering information for a more complete inventory.

1.3 Organization of Thesis

The remainder of this thesis consists of four chapters covering: (1) Related Work, which is a review of related literature, processes and applications; (2) the Methodology, which consists of the methods and components used to first develop and then evaluate the web application; (3) the Results, which showcase the functionality of the web application as well as the feedback from the evaluation of the web application; and (4) the Conclusions, which highlight the web application's strengths and weaknesses, identifies possible next steps and discusses future trends with respect to web-based crowd sourced heritage inventories.

As seen in Figure 3, each section represents a part of the overall development of the web application, based on the idea of requirements. The requirements here are the minimum goals and elements that the web application needs to accomplish. The Related Work chapter forms the

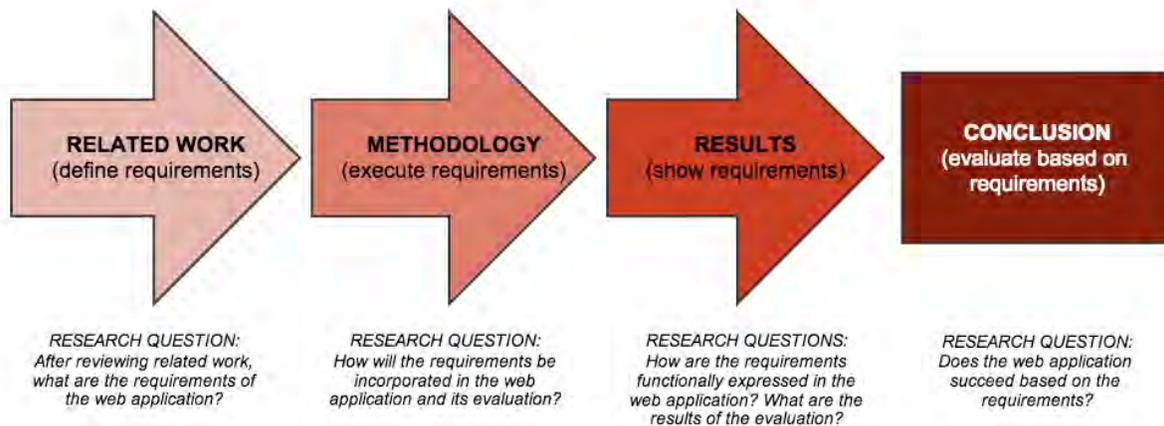


Figure 3 Thesis flow chart

basis for the web application requirements. The Methodology chapter documents how those requirements are actually used to develop the web application and its evaluation framework. The Results chapter shows how the web application meets the requirements. Finally, the Conclusions chapter determines to what degree the web application has fulfilled the requirements and if any adjustments and or new requirements need to be incorporated.

CHAPTER TWO: RELATED WORK

Before developing the web application, it is important to review both past, current, and planned web applications dealing with cultural heritage inventories and determine the best practices for creating a collaborative heritage inventory on the Internet that involves both heritage professionals and interested members of the public. This section will explore the following four topics: (1) current heritage site inventories on the Internet; (2) documentation standards for heritage sites; (3) volunteered geographic information and crowdsourcing as sources of heritage site documentation and inventory; and (4) a comparison of web application development technologies.

2.1 Current Web-based Heritage Site Inventories

In order to review the state of current heritage site inventories on the Internet, 25 websites were evaluated based on the basic tenets of website user experience (UX), with an added layer of further definition for the immovable cultural heritage domain. This evaluation method will also form the basis for the evaluation framework employed after the development of the current web application.

2.1.1 Evaluating Web-based Heritage Site Inventories

The goal of most websites is to provide value and meaning to their visitors or users. The following “User Experience Honeycomb” diagram by Peter Morville illustrates the basic components of what this entails.

For a website to be valuable, then, it should be useful, desirable, accessible, credible, findable, and usable. The following table (Table 1) shows the distillation of each of these elements by Usability.gov (the U.S. government’s web project to promote user experience



Figure 4 User Experience Honeycomb by Peter Morville
(Morville 2004)

best practices) paired with a more defined question for evaluating immovable cultural heritage inventory websites. Sections 2.1.1.1 through 2.1.1.6 explore the above concepts in more detail, citing examples from several web-based heritage site inventories. Section 2.1.1.2 shows the results of testing those concepts against 25 diverse web-based heritage site inventories. The purpose of this evaluation is to provide a quantitative summary of what current inventories do well and what they can improve on, based on the user experience concepts.

2.1.1.1 Usefulness

Does the website present heritage site information that is not found elsewhere and is adequate for user needs?

The range of information presented within an online heritage site inventory is dependent on the audience targeted by the publishing organization, and often, the target is the general public or

those involved in the conservation of heritage sites or a combination of those two groups. Also, while they are not the focus here, it is important to note that many heritage inventories are not accessible online, and that these offline inventories generally serve the needs of government officials and conservation professionals for particular projects or initiatives.

Table 1 User Experience Evaluation Questions for Web-based Heritage Site Inventories

| Element | General | Evaluation Question |
|--------------------------------|--|--|
| Useful | “Your content should be original and fulfill a need” | Does the website present heritage site information that is not found elsewhere and is adequate for user needs? |
| Usable | “Site must be easy to use” | Does the website present heritage site information in an easy to use format? |
| Desirable | “Image, identity, brand, and other design elements are used to evoke emotion and appreciation” | Does the website’s design evoke positive emotions and appreciation of heritage sites and promote their conservation? |
| Findable (Discoverable) | “Content needs to be navigable and locatable onsite and offsite” | Does the website’s navigation make it easy for users to find heritage site information? |
| Accessible | “Content needs to be accessible to people with disabilities” | Does the website hinder access in any way to the heritage site information? |
| Credible | “Users must trust and believe what you tell them” | Does the website provide credible information on heritage sites? |

Source: Data adapted from Usability.gov.

Online heritage inventories geared towards public access usually present: (1) a subset of a more detailed inventory database, which is generally either made available to conservation professionals or other credentialed users via a different interface on the same website or some other means; or (2) information that has been created primarily for public consumption.

For example, the Los Angeles Conservancy is a non-profit organization that is geared towards public outreach and historic preservation advocacy within Los Angeles County. Their website features original narrative descriptions with photographs and locations on more than 600

historic sites that are searchable by location, keywords, architectural style, architect, community, decade, and property type. However, the historic places that are featured are a subset of what has been designated as historic by local cities, the state of California, and the National Register. Also, the information presented is primarily an overview of each site. As a result, the website is very useful to the general public for outreach purposes, because while the same information is available through research on other websites, the Conservancy assembles it in a clear and easily digestible manner that highlights the overall theme of the importance of historic places in Los Angeles County. The website is less useful to conservation professionals and others who need more complete and detailed data on all of the designated and potential historic sites as determined by other experts through an established and documented methodology.

A website that is a good example of providing useful information for heritage professionals is the Australian Heritage Places Inventory. Each record contains: (1) photographs of the historic place; (2) inclusions on heritage lists; (3) legal status; (4) place identification number and file references; (5) a statement of significance; (6) how the historic place fulfils the criteria of the state's official values; (7) a detailed description; (8) a historical overview; (9) condition and integrity; (10) a description of location; and (11) a bibliography. Collectively, this information would help a heritage professional determine the status of the place and how best to conserve it.

Two types of information that would increase the usefulness of the data contained in an online inventory such as Australian Heritage Places Inventory would be some sort of spatial reference, such as a polygon that defined the borders of the site, and references to related records. In Section 2.1.2, an inventory must contain a geospatial reference for each record to score a 5 or "Strong Yes" to the question posed.

2.1.1.2 Usability

Does the website present heritage site information in an easy to use format?

An online inventory might contain as much useful information as possible for its desired audience. However, if the website's users cannot easily view the information through the interface, then the overall utility of such a site is lessened. This is a separate issue from that of discoverability or the ability to find information on a site, which will be covered in Section 2.1.1.4.

As mentioned in the previous section, the Los Angeles Conservancy's website is very easy to use, because its primary demographic is the general public. An example of an online inventory that is geared towards both the general public and heritage professionals is the Victorian Heritage Database, which is administered by the Heritage Council in the Australian state of Victoria. The Victorian Heritage Database (Figure 5) contains all of the information that a heritage professional would need to conduct conservation work, but it presents the information in a format that is easily digestible by a lay person. It contains much of the same information as the Australian Heritage Places Inventory, but it also includes a timeline photo viewer, ways for the public to provide input, and the ability to create tours of selected heritage places. The website was relaunched in April 2015 with these new features as well as a responsive template that can be viewed on both desktop and mobile browsers. Not surprisingly, the Victorian Heritage Database is the highest rated online inventory in this evaluation, as seen in the Findings section (Section 2.1.2).

2.1.1.3 Desirability

Does the website's design evoke positive emotions and appreciation of heritage sites and promote their conservation?

The idea of desirability is relatively subjective, but in this context, it is defined as how much of a heritage inventory website is dedicated towards design features or narratives that evoke a positive appreciation of the historic places that they represent. This can include the narrative descriptions or images that exist as part of place records or extra features that exist outside of the individual records. For example, the Victorian Heritage Database has recommended tours and a timeline browser for photos on its homepage (Figure 6).

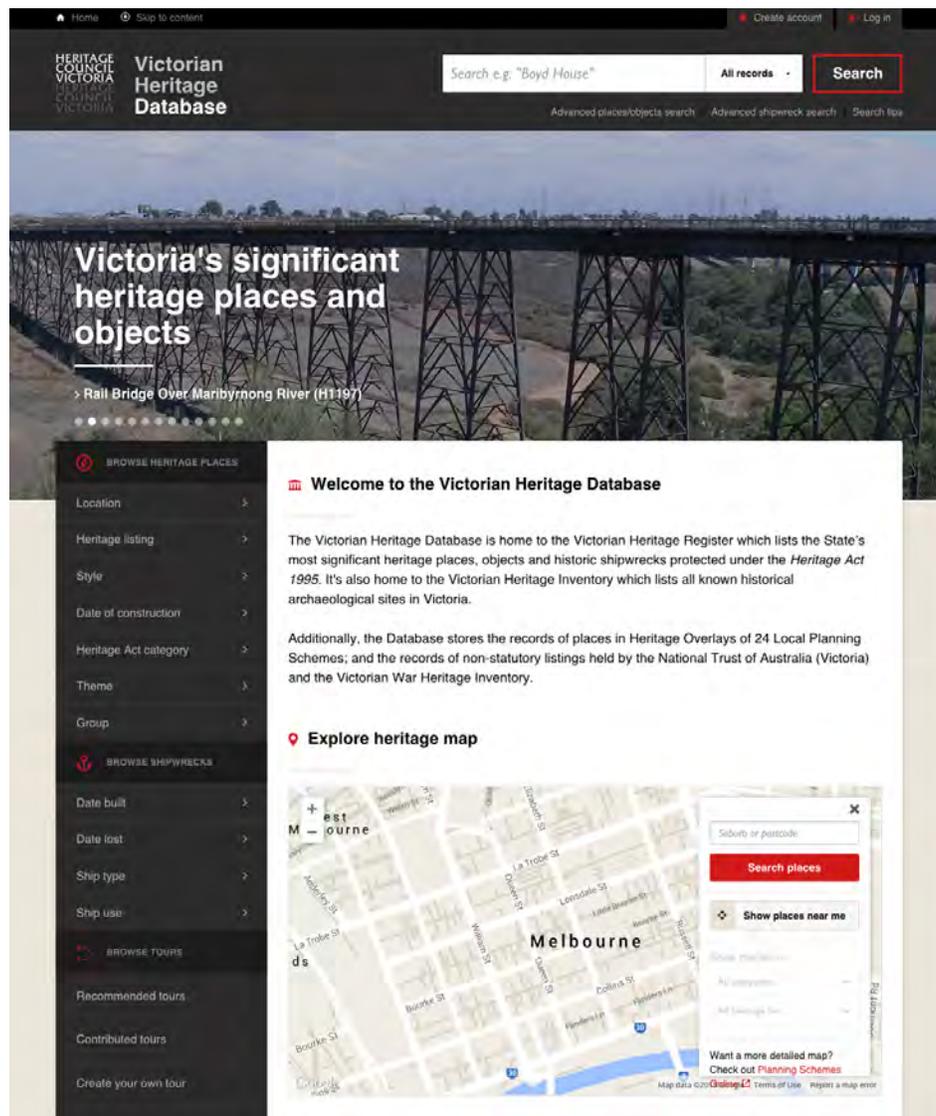


Figure 5 Victorian Heritage Database

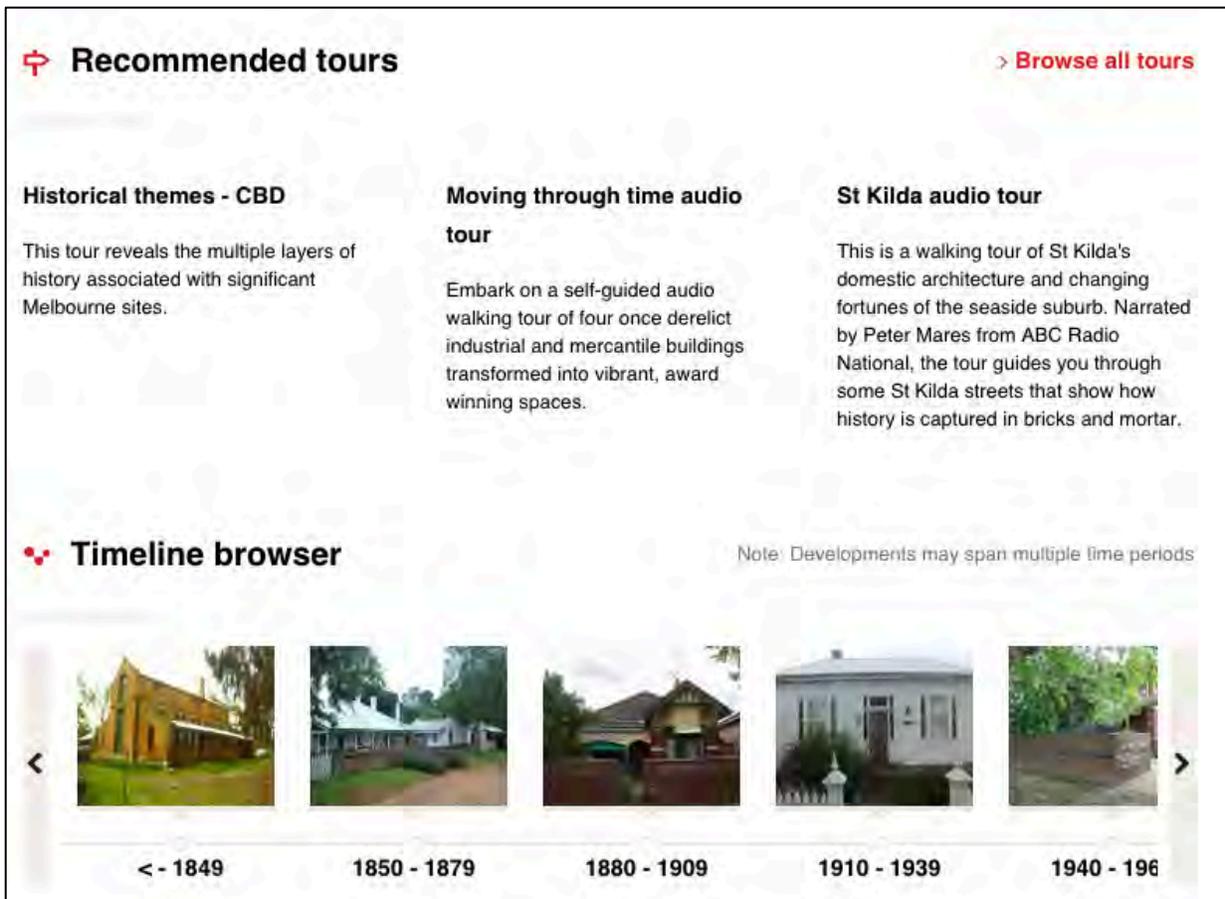


Figure 6 Recommended tours and Timeline browser sections from the Victorian Heritage Database

The CyArk website is not exactly an inventory but more a collection of heritage places that the nonprofit has documented via laserscanning, high dynamic range (HDR) photography, and other surveying methods. The site scores a 5 or “Strong Yes” for Desirability because it seeks to tell the story of each of the heritage places it has documented and features large imagery that is attractive and eye catching (Figure 7). It is included in this survey because some of its website practices might also be used for a more a comprehensive inventory of sites, particularly those that host large amounts of imagery for a historic place.

2.1.1.4 Discoverability

Does the website's navigation make it easy for users to find heritage site information?

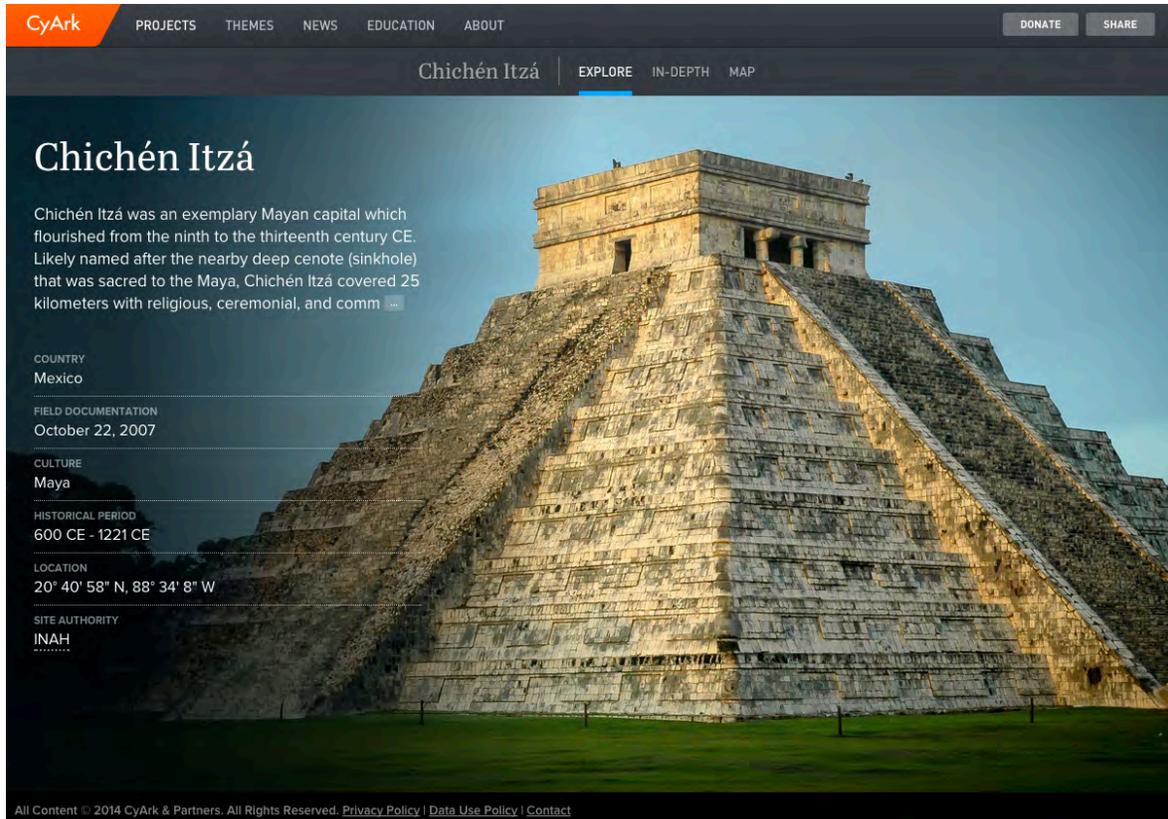


Figure 7 CyArk Record for Chichen Itza

The ability of users to find what they are looking for, at various levels of specificity, is a key aspect of an online heritage inventory. If information cannot be found, whether on purpose or through casual browsing, then it undermines the idea of publishing cultural heritage data online for public and professional consumption. In this survey, many of the websites had traditional advanced search screens, where users could filter results based on key data fields. What distinguishes a “Strong Yes” from a “Yes” is the number of fields available to filter with and the presence of a spatial search.

An interesting approach was that taken by the National Registry of Historic Sites and Structures in the Philippines. The site was built using the Blogger platform, with each page

representing a historic place record. Each record was tagged with the appropriate label and all of the tags are listed on each page as hyperlinks. The main categories are located in a right-hand-side column box, and the name tags are listed at the bottom of each page. While the site is neatly organized, the multitude of tags can make filtering daunting.

2.1.1.5 Accessibility

Does the website hinder access in any way to the heritage site information?

As mentioned in Section 2.1.1.1, some online heritage inventories choose to publish only a subset of the data available. This is to be expected, especially in cases where there are issues with confidentiality, access, or historic site security. For example, an online inventory might not want to call attention to certain archaeological sites for fear of looting. However, what accessibility refers to here is the ease with which a user is able to access the minimum amount of data that is considered useful.

In order to control who sees the data, some sites require users to sign up for access, while providing a stripped-down experience for those who do not want to go through the process of signing up. For the purposes of evaluation, all of the online heritage inventories examined were looked at as non-registered users, and websites that required credentials were seen as limiting access. Any data that was accessed after logging in was not counted in the full evaluation process.

2.1.1.6 Credibility

Does the website provide credible information on heritage sites?

It is important for a heritage inventory website to provide credible information because often decisions regarding the conservation of each heritage place depend on it. For example, property owners might refer to an online inventory to check the heritage status of their home or business

and what they find might affect whether they are able to make any improvements or demolish all or part of the property. If there are incentive programs, such as the U.S. Federal Historic Preservation Tax Incentives program, then a property owner might take advantage of his or her property's historic status. For local officials, especially in the U.S., an inventory might be used to determine whether a demolition or development permit can be issued.

An example of this is the City of Los Angeles Zone Information and Map Access System (ZIMAS), which is used by the city's planners to determine if there are any historic preservation designations, on either the city, state, or federal levels, for a given property. While ZIMAS is not solely a heritage inventory, it functioned as one until the city launched its new historic resource inventory, Historic Places LA, in February 2015. ZIMAS alerts planners and others to whether a city parcel has a designated property on it, and provides some information on the designations (Figure 8).

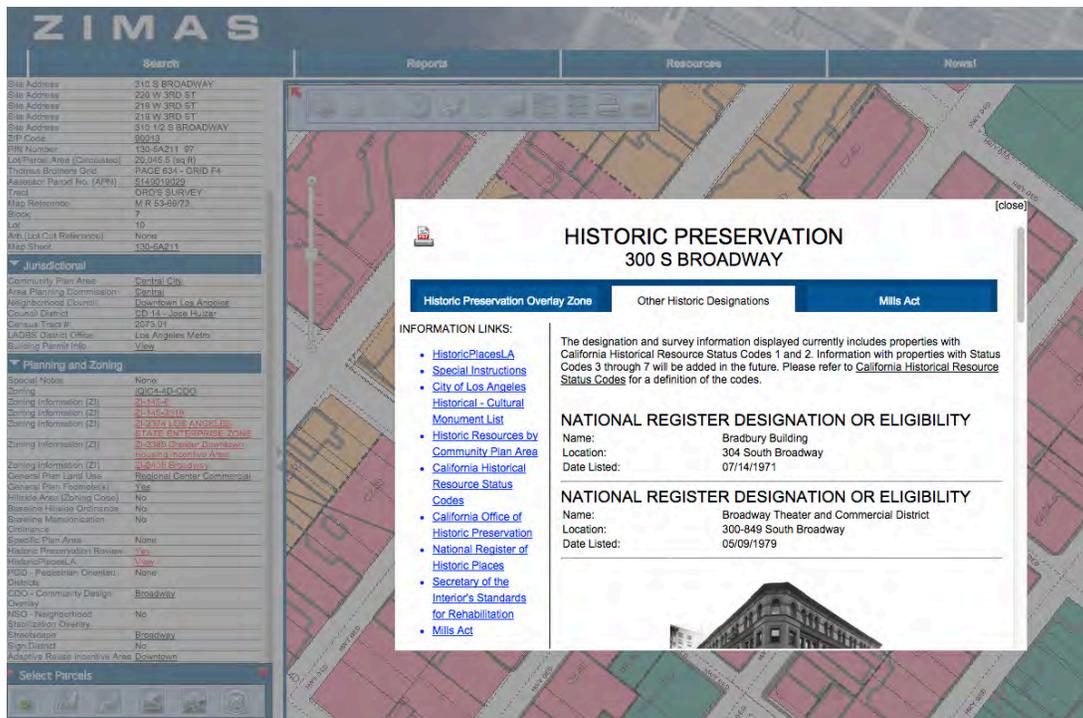


Figure 8 Historic Preservation Screen from LA ZIMAS

The majority of the inventories examined are the official inventories from government entities. Because of that, the information contained within each of those websites is expected to be authoritative and highly credible. For online heritage inventories that are not published by the statutory authority, credibility can be achieved through a listing of sources and an explanation of the methodology behind the information.

2.1.2 Findings

The results of the evaluation of the 25 heritage inventory websites are seen in Table 2. As mentioned previously, the newly revamped Victorian Heritage Database scored the highest based on the criteria with a 29 out of a possible 30. The median score was 24 and the mean was 23.68. Because this evaluation was based on the input of one person (the author), the rankings are not meant to be definitive. However, it was meant to be an exercise in how these online heritage inventories performed under each of the components of what makes a website valuable.

In general, most of the websites met the minimum requirements as defined. Perhaps, the area that was the least developed for most of the websites had to do with Desirability. This shows how most online heritage inventories do not tend to be particularly engaging to casual users, who may represent a large stakeholder group and who might need to be convinced of the value of conserving heritage places. Making an online heritage inventory appealing to the general public presents another opportunity for heritage organizations to advocate for their cause.

2.2 Documentation Standards for Built Cultural Heritage

In the last section, the idea of an online heritage inventory's usefulness was discussed. A major part of that has to do with whether the information presented is of value to the target audience, which in this case primarily consists of those involved in the conservation of built cultural heritage. Recognizing the importance of defining what data is of value to this domain, two data

Table 2 Heritage Inventory Website Evaluation

| Name | Useful (1-Strong No; 2-No; 3-Neutral/Unclear; 4-Yes; 5-Strong Yes) | Usable (1-Strong No; 2-No; 3-Neutral/Unclear; 4-Yes; 5-Strong Yes) | Desirable (1-Strong No; 2-No; 3-Neutral/Unclear; 4-Yes; 5-Strong Yes) | Discoverable (1-Strong No; 2-No; 3-Neutral/Unclear; 4-Yes; 5-Strong Yes) | Accessible (5-Strong No; 4-No; 3- Neutral/Unclear; 2-Yes; 1-Strong Yes) | Credible (1-Strong No; 2-No; 3-Neutral/Unclear; 4-Yes; 5-Strong Yes) | Rank |
|--|---|---|--|---|--|---|------|
| Victorian Heritage Database | 5 | 5 | 5 | 5 | 4 | 5 | 29 |
| National Heritage List for England | 5 | 4 | 4 | 5 | 4 | 5 | 27 |
| UNESCO World Heritage List | 5 | 4 | 4 | 4 | 4 | 5 | 26 |
| Canada's Historic Places | 5 | 4 | 4 | 4 | 4 | 5 | 26 |
| Andorra Inventari d'Patrimoni | 4 | 4 | 4 | 4 | 4 | 5 | 25 |
| Guia Digital del Patrimonio Cultural, Instituto Andaluz del Patrimonio Historico | 5 | 4 | 3 | 4 | 4 | 5 | 25 |
| Inventaire du Patrimoine Architectural, Region de Bruxelles-Capitale | 4 | 4 | 4 | 4 | 4 | 5 | 25 |
| Los Angeles Conservancy - Historic Places | 4 | 4 | 5 | 4 | 4 | 4 | 25 |
| New South Wales Heritage Inventory | 5 | 4 | 3 | 4 | 4 | 5 | 25 |
| US National Register of Historic Places NPS FOCUS | 5 | 4 | 3 | 4 | 4 | 5 | 25 |
| WISAARD, Washington Information System for Architectural and Archaeological Records Data | 5 | 4 | 3 | 4 | 4 | 5 | 25 |
| Flemish Heritage Inventory | 5 | 4 | 3 | 4 | 4 | 5 | 25 |
| Australian Heritage Database | 4 | 4 | 3 | 4 | 4 | 5 | 24 |
| Australian Heritage Places Inventory | 4 | 4 | 3 | 4 | 4 | 5 | 24 |
| CyArk | 4 | 4 | 5 | 3 | 4 | 4 | 24 |
| Saint Helena Historic Environment Record | 5 | 4 | 3 | 4 | 4 | 4 | 24 |
| SAHRIS - South African Heritage Resource Information System | 3 | 3 | 3 | 5 | 4 | 5 | 23 |
| Texas Historic Sites Atlas | 4 | 4 | 3 | 4 | 3 | 5 | 23 |
| GIS-ZH - Canton of Zurich GIS | 4 | 3 | 3 | 3 | 4 | 5 | 22 |
| National Registry of Historic Sites & Structures in the Philippines | 4 | 3 | 4 | 2 | 4 | 5 | 22 |
| Asian Historical Architecture | 4 | 4 | 3 | 3 | 4 | 3 | 21 |
| National Inventory of Architectural Heritage, Ireland | 3 | 4 | 3 | 2 | 4 | 5 | 21 |
| CRGIS - Pennsylvania Historical and Museum Commission | 4 | 2 | 3 | 3 | 3 | 5 | 20 |
| ZIMAS - Zoning Information and Map Access System | 4 | 3 | 2 | 2 | 4 | 5 | 20 |
| AZSITE - Arizona's Cultural Resource Inventory | 2 | 2 | 3 | 2 | 2 | 5 | 16 |

models have been developed, one for architectural sites and the other for archaeological sites, which outline mandatory and optional data fields for documentation. These data standards not only define what information is most useful, but also help to facilitate data sharing and transfer between diverse heritage organizations:

“...compatibility is most readily achieved at the level of minimum or "core" information, i.e., those categories of essential, basic information common to a number of documentation projects. The adoption of such "core data" categories makes it easier to record, retrieve, and exchange information electronically” (Thornes and Bold 1998).

In 1992, the Council of Europe adopted the *Core Data Index to Historic Buildings and Monuments of the Architectural Heritage*. This was the culmination of a process that started in 1985, when the *Granada Convention for the Protection of the Architectural Heritage of Europe* was ratified by the Council. The Granada Convention, in Article 17, required the ratifying countries to work towards information exchange in ways to take advantage of “the possibilities afforded by new technologies for identifying and recording the architectural heritage” (Council of Europe 1985). The data index outlines the minimum set of data necessary for each record, but also provides a loose framework for incorporating a richer set of data for each heritage record and also the ability to make cross references to other types of information.

In 1995, the Council of Europe adopted the *Core Data Standard for Archaeological Sites and Monuments*, which was a collaboration with the International Committee for Documentation (CIDOC) of the International Council of Museums (ICOM). The Core Data Standard was meant to serve as the archaeological complement to the Core Data Index, and are closely related in content, as the Council and CIDOC both realized that often both architectural and archaeological heritage are housed in the same inventory system. A comparison of the mandatory fields of each is seen in Table 3.

Table 3 Comparison of mandatory fields specified by the Core Data Index to Historic Buildings and Monuments of the Architectural Heritage and the Core Data Standard for Archaeological Sites and Monuments

| <i>Core Data Index to Historic Buildings and Monuments of the Architectural Heritage</i> | <i>Core Data Standard for Archaeological Sites and Monuments</i> |
|--|---|
| <p>1.2 Unique Reference Number</p> <p>The number or combination of characters which uniquely identifies each building recorded by the organization.</p> | <p>2.1.1 Reference Number</p> <p>The number or combination of characters which uniquely identifies each monument or site recorded by the organization within its database.</p> |
| <p>1.3 Date of Compilation</p> <p>Date of compilation of the core data index record. This date may be modified whenever the index record is updated.</p> | <p>2.1.3.1 Date of Compilation</p> <p>The date on which the core record was created.</p> |
| | <p>2.1.3.2 Date of Last Update</p> <p>The date on which the monument or site record was last added to, altered, or amended.</p> |
| <p>1.4 Recording Organization</p> <p>Name of the organization responsible for curating the record. This information is useful in establishing the provenance of the record when data is exchanged between recording organizations.</p> | <p>2.1.4 Originator of Reference</p> <p>The name of the individual or organization responsible for curating the monument or site record. This information is useful in establishing the provenance of the record when data is exchanged between recording organizations.</p> |
| <p>2.1.1 Location – State (Country)</p> | <p>2.2 Location</p> <p>This is a mandatory section which defines the spatial location of the monument or site in terms of political, postal, geographic, and cartographic criteria. Any combination of sub-sections defined below may be employed to identify the location of the monument or site:</p> <p>2.2.1 Administrative Location (includes country)</p> <p>2.2.2 Site Location (narrative descriptions)</p> <p>2.2.3 Address</p> <p>2.2.4 Cadastral Reference/Land Unit</p> <p>2.2.5 Cartographic Reference (coordinates)</p> |
| <p>3.1 Building Type</p> <p>Precise building type defined by function. This field may be repeated to accommodate changes in type over a period of time. Controlled vocabulary is desirable.</p> | <p>2.3.1 Monument or Site Type</p> <p>The term by which a monument has been indexed. This will normally be the interpretation of the monument by functional or descriptive criteria, e.g., Villa; linear earthwork. Controlled vocabulary is desirable.</p> |
| <p>3.2 Building Category</p> <p>Broad functional category to which the building type belongs, e.g., Agricultural (Category); Barn (Type). Controlled vocabulary is desirable.</p> | |

| | |
|--|--|
| <p>4.0 Dating</p> <p>This section allows for precise dating when it is known, or date ranges or periods when it is imprecise. Must consist of at least one of the following:</p> <p>4.1 Period</p> <p>4.2 Century</p> <p>4.3 Date Range</p> <p>4.4 Absolute Date</p> | <p>2.4.1.1 Dating - Cultural Period</p> <p>The cultural period to which the monument or site, or a part or phase of the monument or site, belongs: e.g., Neolithic. A controlled vocabulary is desirable and must include "unknown". Must be linked to 2.3.1 Monument or Site Type</p> |
|--|--|

Source: Data adapted from Thornes and Bold (1998)

Currently, a data standard that combines and extends the Core Data Index and Core Data Standard is in development by CIDOC with input from the International Documentation Committee (CIPA) of the International Council on Monuments and Sites (ICOMOS).

The *International Core Data Standard for Archaeological and Architectural Heritage* will incorporate much of the above in its mandatory fields. However, the standard has not yet been accepted or published. For an inventory focusing on urban architecture, then, the Core Index should be used.

2.3 Crowdsourcing as a Source of Cultural Heritage Site Documentation and Inventory

One of the main goals of this project is to include the ability to contribute information about the each of the Art Deco buildings in the dataset within the web application. However, before that can be incorporated, two questions must be explored: (1) what is crowdsourcing? and (2) how can crowdsourcing be applied to a cultural heritage inventory of places?

2.3.1 Crowdsourcing Definition

Crowdsourcing is “the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call” (Oomen and Aroyo 2011). The “crowd”, i.e. the people who answer that call, can be compensated or not, but are still not considered employees of the sponsoring

organization. For example, the Amazon Mechanical Turk marketplace matches small tasks that are difficult to automate (human intelligence tasks or HITs) with actual human operators who complete each task for a small amount of money (Ipeirotis 2010). Typically, crowdsourced projects, especially in the cultural heritage domain, try to leverage non-monetary motivators in order to have people participate. These motivational factors are social in nature, and can be divided into two groups: (1) connectedness and membership; and (2) sharing and generosity (Shirky 2010).

Crowdsourced projects can also be categorized based on the interaction between the sponsoring organization and the crowd. Table 4 highlights three models of crowdsourcing which are defined by the level of participation by the members of the public. Amongst these, contributory crowdsourcing projects involve the least amount of responsibility from the public and require only some sort of data contribution. With collaborative crowdsourcing projects, the public has an invitation to become more involved by possibly analyzing contributed data and helping to define the project. Co-created crowdsourcing projects are still designed primarily by the professionals at the sponsoring organization; however, the public participants interact with each other and may also be involved in all aspects of the project.

Table 4 Categorization of Crowdsourcing Projects in the Cultural Heritage Domain

| Crowdsourcing Model | Definition |
|-------------------------------|--|
| Contributory projects | Designed by professionals, where members of the public contribute data. |
| Collaborative projects | Designed by professionals, where members of the public contribute and analyze data, help in refining project design, or disseminate findings. |
| Co-Created projects | Designed by professionals, where members of the public are working together, and some of those public participants are actively involve in (all) steps of a process. |

Source: Oomen and Aroyo 2011

Regardless of the crowdsourcing model, crowdsourcing projects can involve many different types of tasks. In the cultural heritage field, particularly as it relates to the digital

information workflow for Galleries, Libraries, Archives, and Museums (GLAM), there are six types of tasks that can be incorporated into a project (Oomen and Aroyo 2011). Table 5 shows those tasks with the corresponding ones for historic places. All of the tasks except crowdfunding will be considered for this project.

Table 5 Classification of Crowdsourcing Initiatives in Cultural Heritage

| Crowdsourcing type | For Cultural Heritage Objects | For Cultural Heritage Places |
|---|--|--|
| Correction and Transcription Tasks | Inviting users to correct and/or transcribe outputs of digitization processes. | Inviting users to correct and/or transcribe outputs of digitization processes, such as spatial information for historic places. |
| Contextualization | Adding contextual knowledge to objects, e.g. by telling stories or writing articles/wiki pages with contextual data. | Adding contextual knowledge about historic places e.g. by telling stories or writing articles/wiki pages with contextual data. |
| Complementing Collection | Active pursuit of additional objects to be included in a (Web) exhibit or collection. | Active pursuit of additional places to be included in an online cultural heritage inventory. |
| Classification | Gathering descriptive metadata related to objects in collection. Social tagging is a well-known example. | Gathering descriptive metadata related to historic places . Social tagging is a well-known example. |
| Co-curation | Using inspiration/expertise of non-professional curators to create (Web) exhibits. | Using inspiration/expertise of non-professional curators to create collections of historic places to form a historic narrative. |
| Crowdfunding | Collective cooperation of people who pool their money and other resources together to support efforts initiated by others. | Collective cooperation of people who pool their money and other resources together to support efforts initiated by others. |

Source: Adapted from Oomen and Aroyo 2011

2.3.2 Applying Crowdsourcing to a Cultural Heritage Inventory

One of the main applications of crowdsourcing occurs in scientific research. Because of this, much of crowdsourcing methodology and best practices originates from citizen science projects, also known as Public Participation in Scientific Research (PPSR) (Shirk et al. 2012). Figure 9 illustrates a framework for PPSR projects. First, the question or issue is identified through the examination and input of both scientific and public interests. Second, a project to address the question or issue identified is developed. Third, the project generates observational and

experiential outputs relating to the original inputs. Fourth, the outputs are analyzed to come up with outcomes in the areas of science and social-ecological systems, and for the individuals taking part. Finally, the impacts of the project, which are less specific and broader in scope, are realized.

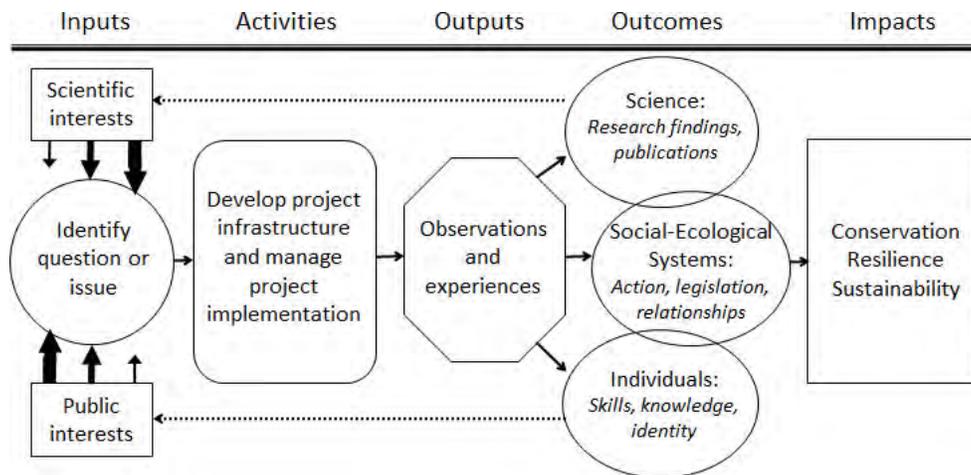


Figure 9 Framework for public participation in scientific research projects
(Source: Shirk et al 2012)

In order to apply the same principles towards an online cultural heritage inventory for historic places, the framework was modified, as seen in Figure 10.

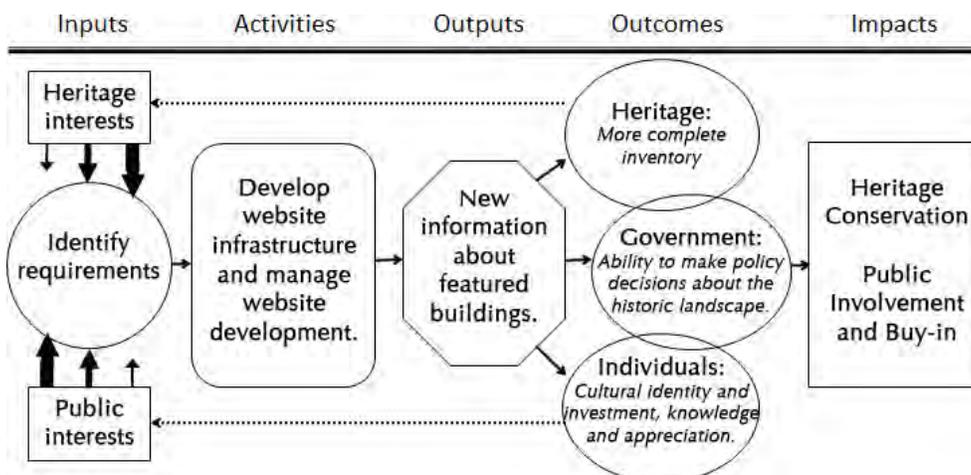


Figure 10 Framework for crowdsourced cultural heritage inventory based on Figure 9

In this adapted framework, the inputs from heritage and public interests are considered in order to identify the crowdsourcing requirements for the online inventory site. Then, based on those requirements, a web application is built that tries to facilitate the crowdsourcing goals. The output of that web application is crowdsourced information about the buildings. The outcomes are three-fold: (1) a more complete, accurate, and/or precise inventory; (2) a tool that gives government agencies the ability to make informed policy decisions about historic places; and (3) individuals who are more engaged with their cultural identity through the knowledge and appreciate of their historic environment. The impact is that eventually the project will contribute to heritage conservation both locally and globally, and that the public will recognize the importance of conserving their heritage places.

In determining the crowdsourcing requirements, then, the process should involve looking at both crowdsourcing models and crowdsourcing types through the lens of the heritage interests and the public interests. Chapter 3 will go through this process to determine the best way to employ crowdsourcing for this project.

2.4 Web Application Development Technology

In Section 2.3, standards for archaeological and architectural heritage were outlined that specify data models for heritage inventory best practices. It is important to note that the standards discussed are not dependent on particular hardware or software choices because of the rapidly changing nature of technology and the variability in user needs and requirements. However, technology choices for heritage inventories have been discussed in broad strokes and typically consist of a relational database, preferably spatially-enabled, that is normalized and utilizes controlled vocabularies. For online heritage inventories, the back end relational database and map server would be accessed via a front end user interface.

In determining how to create a simple collaborative online inventory model, it is important to think of the requirements of both those who would contribute and those who might try to replicate the model for their own purposes, namely cultural heritage professionals and organizations. Cultural heritage professionals are not typically experienced in web application development and do not necessarily have the technical skills to successfully implement any of the individual components outlined above. And many cultural heritage organizations are limited by a lack of resources when implementing and maintaining a heritage inventory system and staffing qualified people to do so. This is especially true when in developing areas, such as in the project region of Southeast Asia and project area of Hanoi. For these reasons, it is imperative to keep the limitations in funding, staffing, and technical knowledge and infrastructure in mind when making choices in the technology used to power a cultural heritage inventory.

Of the components mentioned, the most critical is the choice of where and how to house the data. As mentioned, typically a relational database is used, but often, proprietary database programs, such as Oracle or SQL Server can be both costly and too unwieldy to manage without the appropriate skills, especially those involved in spatially-enabling the database. In that case, implementing a geodatabase solution within the Esri workflow might help streamline the spatial visualization of the data, but again, the Esri software environment is expensive and proprietary. In trying to eliminate the negatives of using proprietary software, an open source solution such as a PostGIS/PostgreSQL database, which is spatially-enabled, could be used, but the difficult set up and on-going maintenance might still be too much of a hurdle for a cultural heritage professional. The above does not even take into account structuring the database in a normalized fashion with as much standardization as possible through controlled values.

Because of these potential barriers to implementation, this project will look for low-cost or free solutions that do not require extensive technical knowledge and provide a relatively easy workflow. Given that, the requirements for the database component of this project are as follows: (1) it should be cloud-based to limit exposure to complicated server and traditional database setup; (2) it should be spatially-enabled with mapping capabilities; (3) it should be low-cost or free; and (4) it should have an established application programming interface (API) that allows access to the database to develop a web application. Two systems, which meet those criteria, will be explored: Google Fusion Tables and CartoDB.

Google Fusion Tables (<http://tables.googlelabs.com>) is an experimental application from the data management team at Research at Google. Launched in 2009 as part of Google's free ecosystem of applications available to the public, it leverages structured data that can be entered directly into a fusion table or uploaded via different formats, such as CSV (Comma Separated Values), KML (Keyhole Markup Language), and spreadsheet formats (Excel, Open Office, Google Spreadsheets). The application allows collaboration and contribution in similar ways to that of Google Docs, with synchronous editing, commenting, and a discussion feature, but also allows the fusion tables to interact with each other in similar ways to that of a relational database. This creates a way for contributors to share information while keeping datasets distinct. The application also provides an easy path for the visualization of data, whether through graphs and charts, temporally via a timeline, or as a layer or layer set on a Google map. Fusion Tables also has an API that allows external applications to query and draw upon the database. (Gonzalez et al. 2010)

CartoDB (<http://www.cartodb.com>) is similar to Google Fusion Tables in that it is delivered as Software as a Service (SaaS), which means that the software is hosted from a central

server and accessed by users via a thin client, in this case, a web browser. Unlike Google Fusion Tables, CartoDB is a freemium service, so while there is a free tier for light usage, other pricing tiers exist for heavier and enterprise usage. A free account with CartoDB allows for unlimited datasets and unlimited map views with a cap at 50 MB of data hosted via the server. Other plans charge on a monthly basis for more hosted data as well as complete privacy of datasets and maps and the ability to remove the CartoDB branding. While Google does not expose their source code, CartoDB relies on open source software, such as PostGIS and PostgreSQL, and uses JavaScript in its CartoDB Editor application, which uses the CartoCSS language to provide fine-tuned control of map styling and visualization. Figure 11 diagrams how the CartoDB Platform with its set of APIs integrates with the development of a web application.

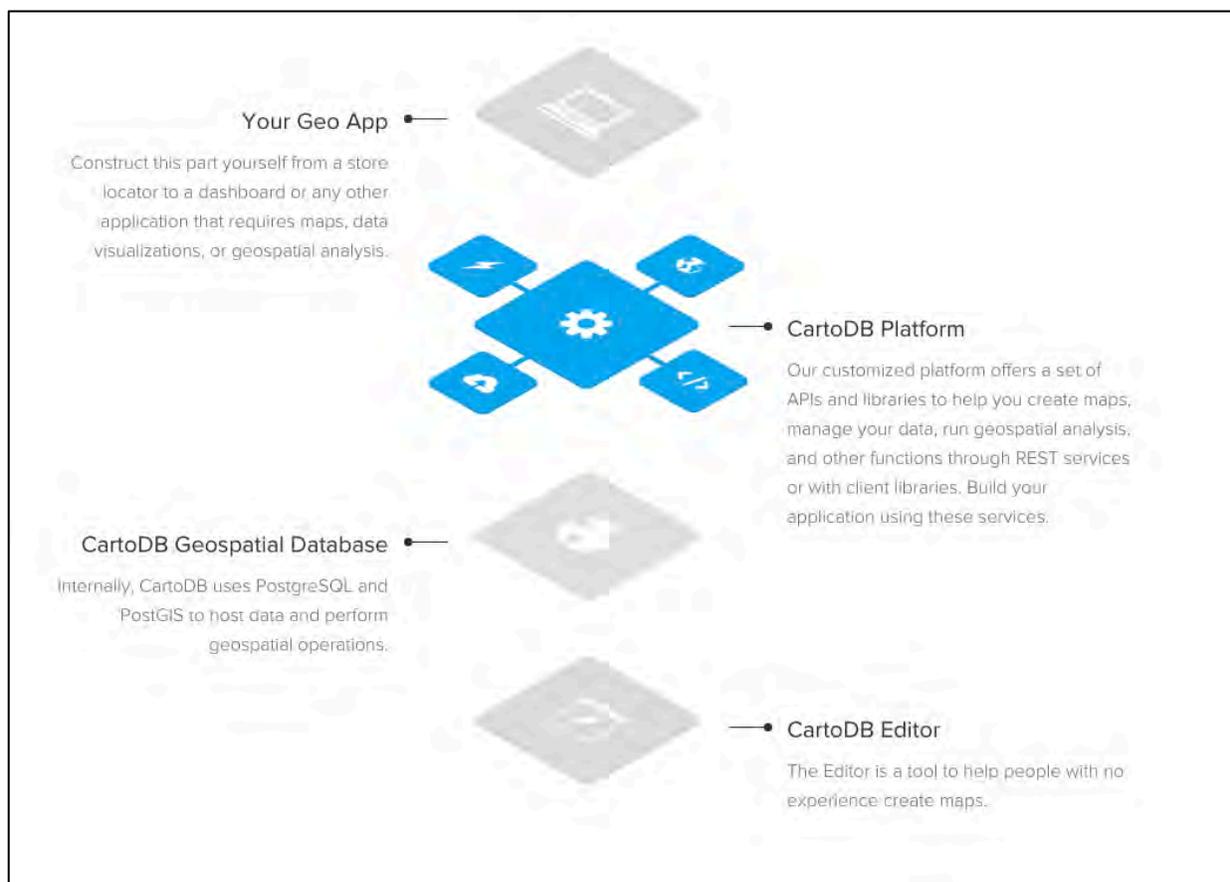


Figure 11 CartoDB Integration with Web Applications
(Source: cartodb.com)

The CartoDB Platform consists of three APIs and one JavaScript library to aid in developing web applications with CartoDB. They include: (1) the Maps API, which allows for the creation and display of maps from the data; (2) the Data API, which allows data query and retrieval, as well write, update, delete, and import data programming functions; (3) the Import API, which allows for asynchronous upload of files and data; and (4) the JavaScript library, CartoDB.js, which allows for the extension and creation of visualizations within websites and web applications.

A comparison of the two platforms is seen in Table 6. Both Google Fusion Tables and CartoDB eliminate the need for a traditional spatial database and map server and function as web services which can be accessed by the web application via each service’s API. However, based on the flexibility of CartoDB in styling and lack of limits on usage, even within the free pricing tier, this project will be using CartoDB as the backend database and mapping platform.

Table 6 Comparison of Google Fusion Tables and CartoDB

| Google Fusion Tables | CartoDB |
|---|---|
| Up to five Fusion Table layers to a map via Google Maps API. | No limitation on amount of layers displayed. |
| Up to five styling rules for one layer. | No limitation on number of styles, using Carto CSS. |
| Only first 100,000 rows of data are mapped or included in query results. | No limit on amount of rows to query on the CartoDB SQL API or to display on maps. |
| 500 vertices per map tile with a maximum of 5 million vertices per table. | No limit on vertices. |
| 250 MB size limit. | Free version: 50 MB of data, unlimited datasets. |
| Proprietary Google database | Open source PostgreSQL/PostGIS database, which can be queried using full SQL. |

Source: <http://blog.cartodb.com/comparing-fusion-tables-to-open-source-cartodb/> and <https://developers.google.com/maps/documentation/javascript/fusiontableslayer>

After choosing the database and mapping platform, the next component is the user interface. Because of the need to adapt to the specific requirements determined in this chapter, it is important that the method used to develop the user interface is flexible and extensible.

Common web development tools and languages, such as HTML, CSS, JavaScript, and Python

will be used to create the user interface. The application development process, along with programming challenges in building an application from the ground up based on specific requirements, will be addressed in Chapter 3.

CHAPTER THREE: METHODOLOGY

In this chapter, the methodology behind the development and evaluation of the cultural heritage inventory web application will be discussed. This includes: (1) determining what the requirements are for the web application by applying the principles introduced in Chapter 2; (2) selecting the most appropriate and achievable ways to incorporate as many of the requirements in the web application as possible; and (3) establishing a framework on which to evaluate the successes and failures of the resulting web application in Chapter 4.

3.1 Application Development

3.1.1 Target Workflow

The target workflow for the development of the web application involves the following steps: (1) Refine the web application's main purpose (Section 3.1.1.1); (2) Determine the requirements necessary to achieve that purpose (Section 3.1.1.2); (3) Determine the application components best suited to achieve the requirements (Section 3.1.2); (4) Develop the web application (Section 3.1.3); (5) Evaluate the web application based on a defined framework (Section 3.2 and Chapter 4); and (6) Outline a possible roadmap to address the deficiencies found in the application (Chapter 5).

3.1.1.1 Purpose

The main purpose of the web application is to publish data collected regarding Art Deco buildings in Hanoi, Vietnam, and to collect additional information about the buildings from application users. The target users are architectural historians and other heritage professionals, as well as members of the general public, any of whom may be able to provide some information

about each of the buildings. A secondary purpose is to develop the web application in such a way that it becomes a reusable application model for others to implement in other areas.

3.1.1.2 Requirements

In Chapter 2, a review of Related Work was conducted in order to help determine the requirements of the web application. The four areas examined were: (1) existing websites used to publish information on heritage sites; (2) heritage inventory and documentation standards; (3) crowdsourcing in cultural heritage; and (4) web development technologies for inventory databases.

Regarding heritage site inventories made available to the public online, most of the evaluated websites were generally found to be fit for their purpose. However, the evaluation in Section 2.1 exposed some issues that could be improved in each of the categories explored. Most of the websites scored either a “Yes” or a “Strong Yes” in the area of Usefulness, which measured how useful the information provided in the online inventory was. The key to how useful the data was often hinged on two things: (1) the breadth of information; and (2) whether the heritage places were spatially referenced and shown on a map. Because one of the purposes of this project is to gather additional information about each building, the resulting web application will not have the breadth of information necessary. However, because the information collected includes the location where each photo was taken, a map should be central to the web application.

In the area of Usability, it is important that the information that is featured is easy to understand and clear, and that the web application has intuitive navigation and workflows. The requirement in this area, then, is that the web application have a simple layout with explanatory text and links that clarify how to use the web application.

In regards to Desirability, the online inventories were evaluated by looking at how the content and features worked together to evoke positive emotions toward the conservation of the heritage places featured. It should be made clear in the branding and design of the web application, then, that its ultimate goal is indeed heritage conservation. The resulting requirement is that there be some content that speaks to the ultimate goal.

With Discoverability, it was found that the ability to find information was just as important as the information itself. Users of the web application must then be able to find a particular place to either learn or contribute more information about it. Because each record does not yet have a richer set of data associated with it, searching at the initial stage will primarily be map-based.

Accessibility, as defined for this project, measures whether there are any barriers to access the information contained with the web application. It is assumed that users will have access to the internet via a high speed connection. The web application will be fully functional on either Google Chrome or Mozilla Firefox, as both of these web browsers are free to download and widely used, regardless of operating system. In the evaluation process, most of the online inventories did not restrict access to the information by requiring users to establish login credentials, and the resulting requirement for this web application is that the information be accessible without a login. However, in order to contribute information to the application, some type of login was found to be necessary in order to be able to keep track of the information being submitted and to establish the credibility of the information.

Because the web application is not sponsored by an official government body, users will need other evidence of the credibility of the information as well as the credibility of the publisher. This Credibility will be established by exposing as much of the methodology as

possible in regards to the existing data and to include information as to the purpose of the web application.

The above requirements that resulted from Section 2.1 are summarized in Table 7.

Table 7 User Experience Elements and Web Application Requirements

| Element | Requirement |
|------------------------|--|
| Usefulness | Map, showing each record's location. |
| Usability | Simple layout with explanatory text and links that clarify how to use the web application. |
| Desirability | Content that promotes the application's purpose of heritage conservation. |
| Discoverability | Map-based search. |
| Accessibility | No requirement to login or sign up to view information. |
| Credibility | An About section dedicated to exposing the purpose and methodology of the application. |

Regarding the required information that needs to be collected to meet the minimum data model standards for architectural heritage, the *Core Data Index to Historic Buildings and Monuments of Architectural Heritage's* minimum mandatory requirements will be incorporated into the web application as either specific fields or as part of a general description text field that can be contributed to. See Table 8 for a listing of fields.

As shown in Section 2.3, crowdsourcing projects can take on any combination of characteristics. Based on the scope of this project, a contributory model of crowdsourcing, in which the users' involvement consists only of contributing information will be used. Table 9 shows the type of tasks that can be associated with the project and how they will actually be deployed, if at all.

The last requirement as determined from Chapter 2 involves the use of CartoDB as the both the mapping platform and the backend database. The web application development will mostly involve leveraging CartoDB's capabilities in order to provide a simpler way to store, manage,

Table 8 Core Data Index to Historic Buildings and Monuments of the Architectural Heritage and Web Application Fields

| <i>Core Data Index to Historic Buildings and Monuments of the Architectural Heritage</i> | Corresponding Application Field |
|--|--|
| <p>1.2 Unique Reference Number</p> <p>The number or combination of characters which uniquely identifies each building recorded by the organization.</p> | Each record will have a unique identification number. |
| <p>1.3 Date of Compilation</p> <p>Date of compilation of the core data index record. This date may be modified whenever the index record is updated.</p> | Each record will show the original date of compilation, as well as the dates of contributions and modifications. |
| <p>1.4 Recording Organization</p> <p>Name of the organization responsible for curating the record. This information is useful in establishing the provenance of the record when data is exchanged between recording organizations.</p> | Because the original records were all recorded by the author, this information will be noted in the methodology. However, all contributions will be logged with information on who contributed the information. |
| <p>2.1.1 Location – State (Country)</p> | All of the records are located in Hanoi, Vietnam. However, because this project includes spatial information, the map location of each record will be both viewable and editable. |
| <p>3.1 Building Type</p> <p>Precise building type defined by function. This field may be repeated to accommodate changes in type over some period of time. Controlled vocabulary is desirable.</p> | Building type and category will be combined in one dropdown list. |
| <p>3.2 Building Category</p> <p>Broad functional category to which the building type belongs, e.g., Agricultural (Category); Barn (Type). Controlled vocabulary is desirable.</p> | |
| <p>4.0 Dating</p> <p>This section allows for precise dating when it is known, or date ranges or periods when it is imprecise. Must consist of at least one of the following:</p> <p>4.1 Period</p> <p>4.2 Century</p> <p>4.3 Date Range</p> <p>4.4 Absolute Date</p> | This project will provide a free text field for recording all types of information. Because there are many methods of dating that consists of different data formats, any information on dating will be directed here. |
| | Although not required, this project will incorporate a dropdown field where users can contribute information on the condition of a building, i.e. whether the building is still there or if it has been altered. |

Source: Data adapted from Thornes and Bold (1998)

Table 9 Crowdsourcing Tasks and Suitability for Contributory Inventory Web Application

| Crowdsourcing type | For Cultural Heritage Places | For Web Application |
|---|--|--|
| Correction and Transcription Tasks | Inviting users to correct and/or transcribe outputs of digitization processes, such as spatial information for historic places. | Users will be able to submit an edit regarding the location of each record. |
| Contextualization | Adding contextual knowledge about historic places e.g. by telling stories or writing articles/wiki pages with contextual data. | Users will be able to submit a free text description that may enhance understanding of a record's significance. |
| Complementing Collection | Active pursuit of additional places to be included in an online cultural heritage inventory. | Adding records is not within the scope of this project, but may be included in some future phase of the project. |
| Classification | Gathering descriptive metadata related to historic places. Social tagging is a well-known example. | Users will be able to classify each record in regards to building type. |
| Co-curation | Using inspiration/expertise of non-professional curators to create collections of historic places to form a historic narrative. | This is not within the scope of this project or within the scope of most online inventories. |
| Crowdfunding | Collective cooperation of people who pool their money and other resources together to support efforts initiated by others. | This is not within the scope of this project. |

Source: Adapted from Oomen and Aroyo 2011

and visualize data. This will be discussed further in the following sections which focus on the web development components and programming.

3.1.2 Components

For its major components, the web application uses several web services (Figure 12), which for this small implementation are provided at a free pricing tier. The survey data was processed using software that adheres to traditional models, such as those provided by Microsoft, Adobe, and Esri. However, the remainder of the application components follow the Software as a Service (SaaS) or Platform as a Service (PaaS) model. Essentially, the web application's code accesses CartoDB (where the survey data and new contributor data is stored), MapBox, Google

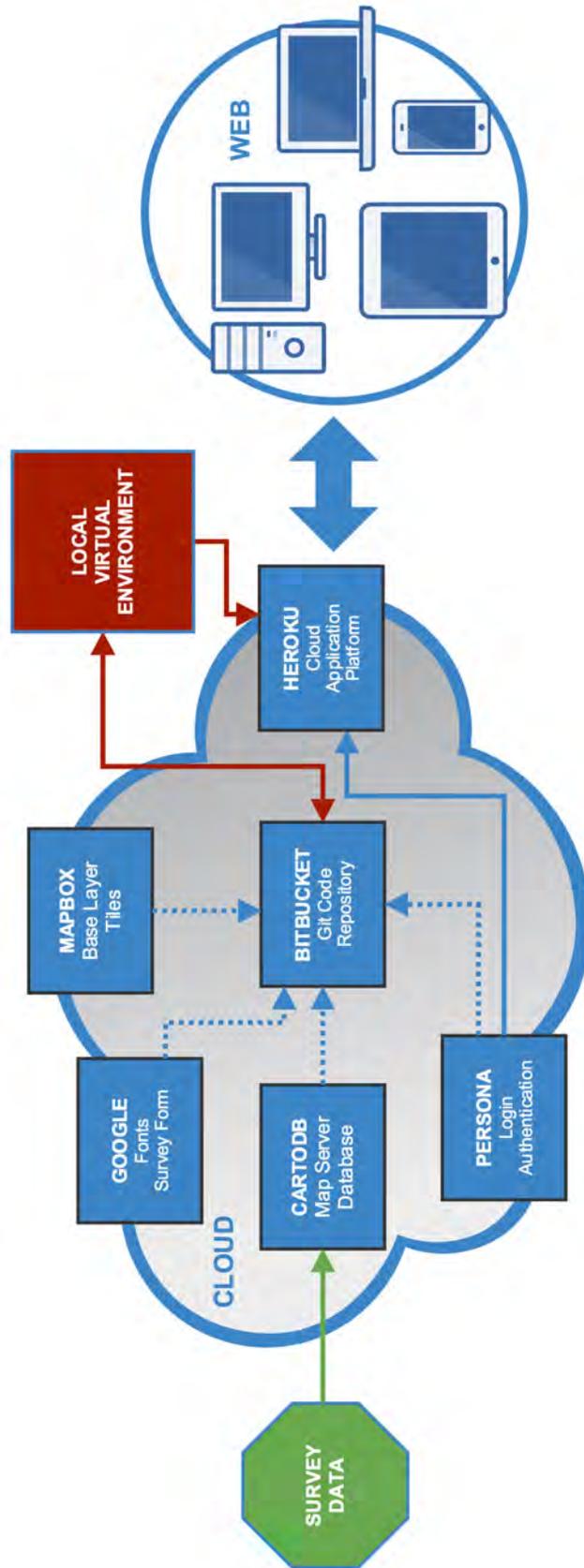


Figure 12 Web Application Components

Fonts, and Persona through their respective APIs (Application Program Interfaces). The application's code is stored in a free code repository, Bitbucket, with free and open source version control between it and the local virtual environment handled by Git. The application is then deployed using Git to push to Heroku, a platform that enables web applications, with the necessary dependencies, to run in the cloud. Finally, a feedback survey powered by Google Forms is enabled by a URL link embedded in the application's user interface. These components will be discussed in more detail in the following sections.

3.1.2.1 Input Data

In this section, the design and methodology behind the collection of data for the web application will be described. As mentioned in the Introduction, the input dataset consists of geo-tagged photographs taken within a defined survey area around Hoan Kiem Lake in Hanoi. More than 140 photographs were taken (see Appendix A) while also recording a separate GPS track. The two types of recording that were necessary to arrive at the final input dataset—image recording and location recording—as well as the post-processing efforts will be described in this section.

The image recording instrument, the photographic camera, had to be able to capture buildings accurately and also had to be available to the general public, per the goals of the study. At minimum, a wide angle lens was required to capture as much of the full extent of a building as possible. To that end, a Canon L Series F4.0 17-40mm lens was used in conjunction with a full-frame Canon EOS 5D DSLR camera. As a backup, a Canon G9 point and shoot camera with a maximum focal length of 28 mm (equivalent) and full manual capabilities was also available.

The location recording instrument had to be able to receive either a GPS or GLONASS signal. Because they are ubiquitous, an iPhone 4s enabled with the trail tracking app, Easy Trails, was used to record the location track.

Ideally, the two types of recording could be combined into one device. At one point, using an iPhone as the only recording device was considered, but was ultimately discounted as an option due to the focal length of the lens and resulting inability to capture an entire building at the necessary angles.

The main software used for the survey included: (1) EasyTrails for iOS; (2) Adobe Lightroom and Photoshop; (3) HoudahGeo; (4) Microsoft Excel; and (5) Esri ArcMap 10.1. EasyTrails for iOS is an iPhone app that records the user's trail path via GPS. It indicates the strength of the GPS signal, location in longitude and latitude, altitude, timestamp, and speed. The tracking information can then be exported in GPX, KMZ or CSV formats. GPX is the most common format for GPS tracking information. KMZ is the Google Earth/Map format. CSV or Comma Separated Values is a text file with information separated by commas to be imported by spreadsheet programs, such as Microsoft Excel. For the purpose of this study, tracks were exported in GPX format for later integration with the images.

Adobe Lightroom is a photo management software application with batch editing capabilities, while Adobe Photoshop is a photo manipulation software application. Adobe Lightroom was used to manage the large groups of photographs and their metadata as well as to perform light color correction operations of image batches. Adobe Photoshop was used primarily to create photo panoramas via the automatic setting of the Photomerge function.

HoudahGeo is a software application for Mac that merges GPS tracking information with photographs based on timestamp information of each. In other words, this application creates geotagged images (Figure 13).

The software gives users the option of exporting the merge information as metadata for each photograph in EXIF format or providing a CSV file with the image filename, timestamp,

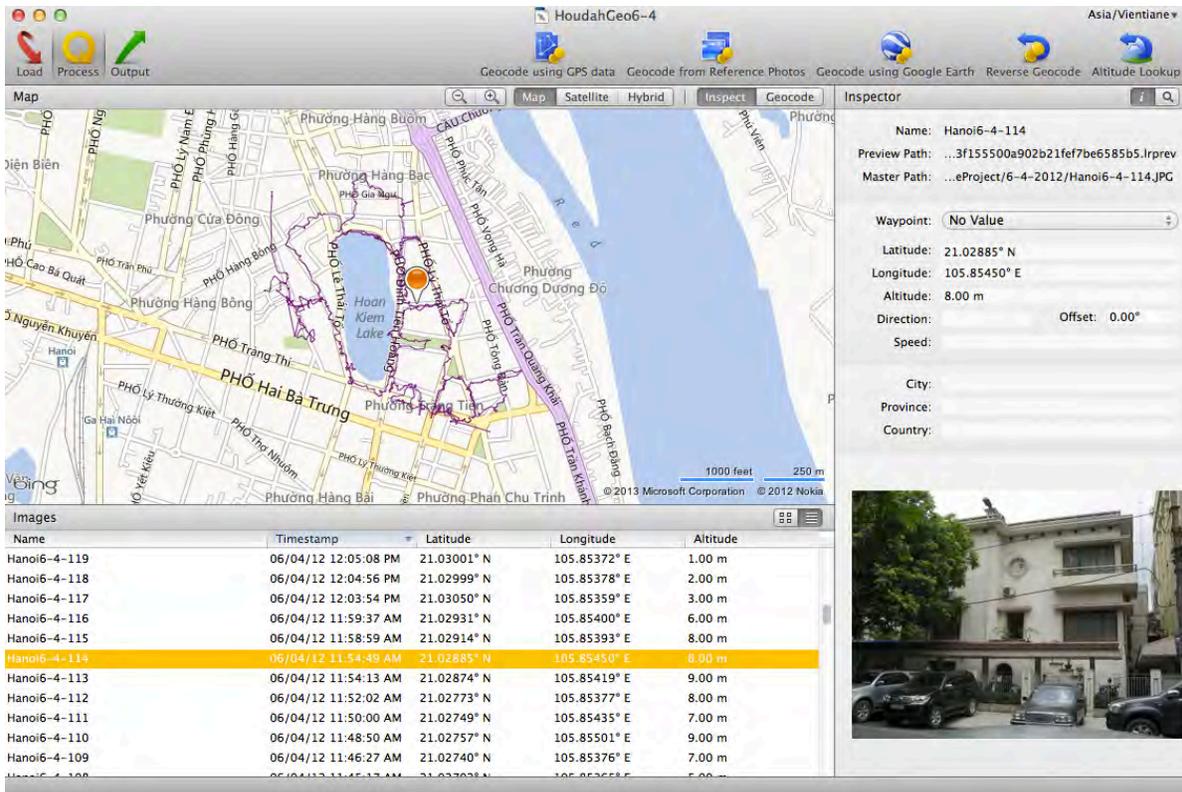


Figure 13 An example of HoudahGeo locating a Hanoi photograph along the GPS track latitude, longitude and altitude. This CSV file can be used to create a point feature class in ArcMap to plot out the locations of where the photographs were taken.

Microsoft Excel was used to edit the CSV file, so that other categories of information could be added to each image file. For this project, two category fields, Style and Comments, were added. Style refers to the predominant architectural style of the main subject building in each photograph, while Comments specifically refers to any obstructions or impediments to capturing a clean image of the building or area. In addition, each photograph was given an ID number, which would serve as its identifier in any maps or catalogs.

Esri ArcMap 10.1 is the mapmaking software application that is included in the Esri ArcGIS bundle. As a geographic information system (GIS) application, it was used to create thematic maps using the geotagged photographs and the software-provided satellite imagery basemaps. Using the CSV file and the Display XY Data function, point feature classes were

created that showed the locations of the geotagged photographs. For the Hanoi maps, a region-specific geographic projection, the 1927 Hanoi geographic projection, was used so that the points would appear in the correct location. Once the point feature class was created, simple thematic maps based on architectural style and obstructions were created. These maps also used the ID field to label each location.

For the web application, the data was imported into CartoDB using the CSV file. Upon import, using CartoDB's import interface, a table, hanoifrenchcolonial, was created with the existing information.

3.1.2.2 Base Layer

The web application uses a street and satellite hybrid base layer generated via MapBox (<http://www.mapbox.com>). It was determined that the base layer needed to show satellite imagery so that users might be able to correct the location of each record with more accuracy. In order to be able to use the MapBox hybrid street and base map, the steps were as follows: (1) create a free MapBox account; (2) start a new Project; (3) select the Street/Satellite Hybrid base map; (4) publish the Project (Figure 14); (5) insert the Map ID of the project and User API Key into the map layer URL specified by the MapBox API; and (6) use the map layer URL in the JavaScript code that initiates the maps in the application.

The satellite imagery of this base layer does not display at zoom levels higher than 17 (or 1:4,000 scale), but because the streets still display, the map is still functional. The Mapbox Satellite imagery includes commercial imagery from DigitalGlobe, Geodatastyrelsen, FOT Orthophoto, LGV Hamburg, National Survey of Finland, NLS Orthophotos, Geoportal Berlin, DOP orthophotos, and other public sources. The Streets information is provided by OpenStreetMap.

3.1.2.3 Database and Mapping Platform

Much of Section 2.4 was dedicated to describing CartoDB and the reasons why it is being used for this project. This section will discuss the implementation of CartoDB for this web application.

As mentioned in Section 3.1.2.1, the project's survey data was imported into CartoDB, after establishing a free account. The table, hanoifrenchcolonial, was created from this data. For the purposes of the web application, the additional field, functional_type, was added to this table. Table 10 describes all of the fields for the hanoifrenchcolonial table.

Table 10 Data fields for hanoifrenchcolonial table on CartoDB.

| Field Name | Type | Description |
|----------------------|----------|--|
| cartodb_id | number | Identification number; generated by CartoDB. |
| the_geom | geometry | Spatial reference in decimal degrees; generated by CartoDB. |
| altitude | string | Altitude information; part of imported data. |
| city | string | City name; part of imported data. |
| comments | string | Survey comments; part of imported data. |
| country | string | Country name; part of imported data. |
| functional_type | string | Building type, by function; added to table for application. |
| id | string | Identification number; part of imported data. |
| latitude | string | Latitude in decimal degrees; part of imported data. |
| longitude | string | Longitude in decimal degrees; part of imported data. |
| name | string | Name; part of imported data. |
| photo_url | string | URL of photograph; part of imported data. |
| style | string | Architectural style; part of imported data. |
| the_geom_webmercator | geometry | Spatial reference for Web Mercator projection; generated by CartoDB. |
| timestamp | string | Photograph date/timestamp; part of imported data. |
| created_at | date | Record date/timestamp; generated by CartoDB. |
| updated_at | date | Record update date/timestamp; generated by CartoDB. |

Using the hanoifrenchcolonial table, a map visualization, hanoi_2, was created on CartoDB (Figure 15). This visualization is a standalone map that includes all of the survey records and is categorized by style. This visualization is important because some of the layer properties for hanoifrenchcolonial are specified via the options selected here. For example, as seen in Figure 15, the hover properties for each map marker are specified here. The

implementation for the web application involves specifying the hanoifrenchcolonial layer and querying it via SQL to SELECT for Art Deco records only.

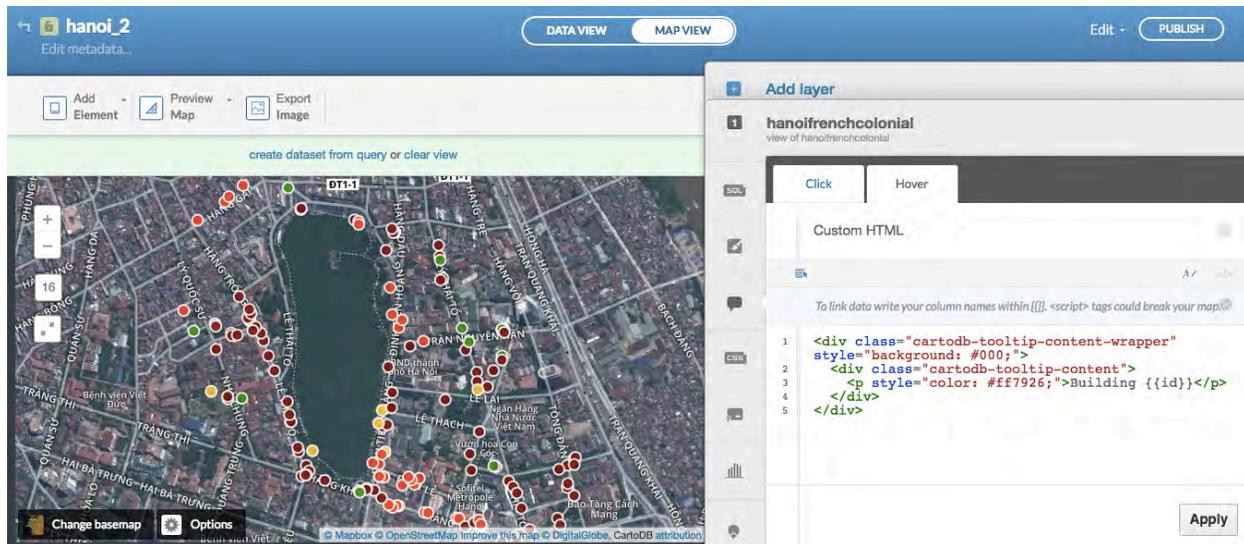


Figure 15 CartoDB visualization of hanoifrenchcolonial data layer

A second table was created in CartoDB to house the data on the contributions collected by the web application. Essentially, a copy of the hanoifrenchcolonial table and data was made with the addition of fields specific to contributions: contribution_id, contributor, and state. The original id field was renamed heritage_id. For the existing original records, the contribution_id was populated with the number “1” to indicate its primary status. Also, for these original records, the contributor field was populated with the author’s email address, since contributors will be identified by email address, as described in the next section (Section 3.1.2.4). Any new records will result from contributions from the web application and will be assigned a contribution_id based on order for each heritage_id.

3.1.2.4 User Login and Authentication

Because the crowdsourcing aspect of this project involves the automatic publishing of contributions submitted by contributors alongside the main record, it is important that the contributors are real people who can be held accountable for what they submit. Because of

this need, this project uses the Mozilla service Persona to authenticate users via email. Persona (<http://www.persona.org>) is hosted by Mozilla as a service to developers to enable easy implementation of a password-free sign-in process to websites, without having to deal with password management. Basically, users choose which email address to sign in with and the service has them sign in through that email program's authentication screen. Similar to signing in with social media, such as Facebook or Twitter, the service only requires the inclusion of the Persona JavaScript file (`include.js`) script reference and the associated JavaScript embedded in the application's code for the sign in/out buttons as well as for establishing the user's session on the site.

3.1.2.5 Google Services

While Google Fusion Tables were not chosen and used for this project, three other Google services are being used—Google Fonts, Google Forms, and Google Analytics.

Google Fonts (<http://www.google.com/fonts>) provides the ability to use 700 font families on any website. Google hosts the fonts on their server, and developers can use the font by simply referencing the font's stylesheet URL and specifying the font style in the application's CSS document(s). For this application, the Google font, Josefin Sans, in both bold and semi-bold weights were used for the headings, because of its Art Deco-like characteristics.

Google Forms (<http://www.google.com/forms>) is part of the Google Drive constellation of services and offers an easy way for anyone to create an online survey. The survey forms are hosted on Google's servers, and can also be embedded, with the provided embed code, within another website or web application. Responses can be captured via a Google Sheets spreadsheet document, and then exported to another format, if required. For this application, a Feedback

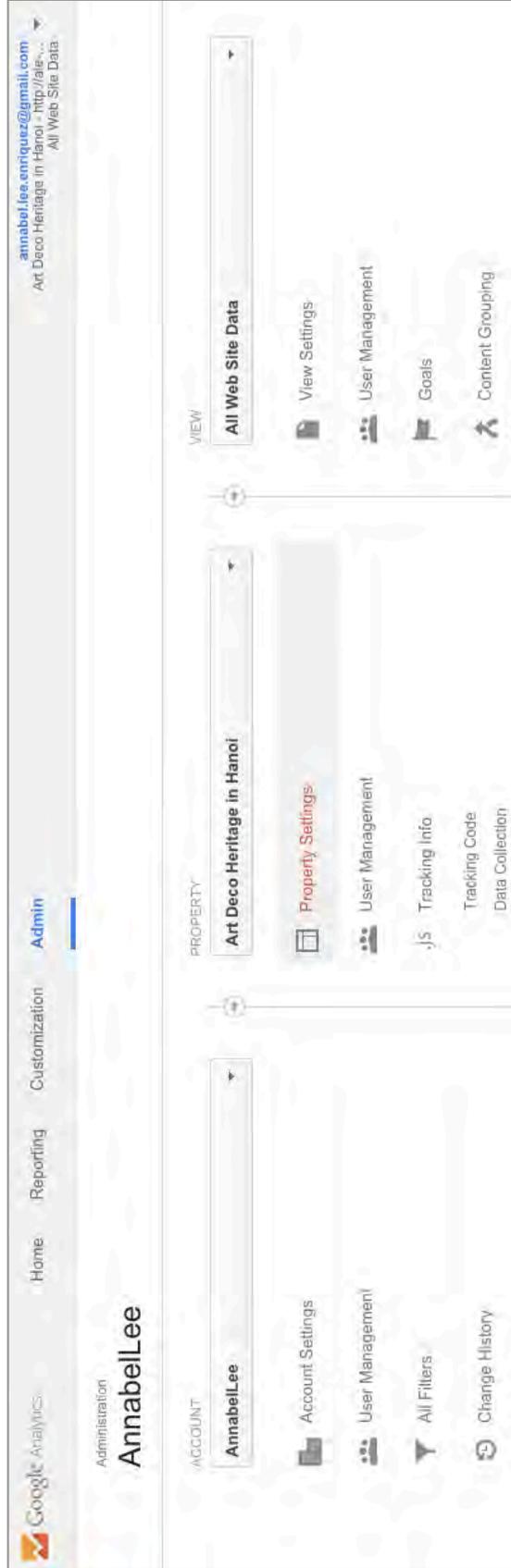


Figure 16 Google Analytics page for Art Deco Heritage in Hanoi

Survey was created via Google Forms, and a link to the survey was included in the footer of every page of the application. For more information about the contents of the Feedback Survey, see Section 3.2.2.3.

Google Analytics (<http://www.google.com/analytics>) is being used to track the web application's traffic (Figure 16). Generally, the implementation for Google Analytics involves the insertion of a script into a webpage that references the Google Analytics JavaScript file, `analytics.js`, as well as the Google Analytics tracking key, which is established by signing up on the Google Analytics website. However, for this implementation, Google Analytics is deployed using a macro that is part of the Jinja2 templating engine for Python, which is being used for this project (see Section 3.1.3.3).

3.1.3 Programming

Once it was established that a secondary purpose for this project was to develop the web application in such a way that it could become a model for deploying similar types of applications, the need for some robust programming became apparent. While the project employs as many relatively easy to use services as possible, as seen in Section 3.1.2, solid programming is required to ensure that all of the services work together harmoniously and in a way that promotes best practices. Figure 17 provides an overall view of what will be discussed in this section as the outside circles represent the development environment (Section 3.1.3.5), and everything within the triangle represents the actual programming and implementation. However, before delving into those topics, it is important to understand the basics of how a web application works.

3.1.3.1 Client-Server Model for Web Applications

Most web applications adhere to a traditional 2-tiered client-server model. A client (a web browser on a desktop or laptop computer, smartphone, tablet, or other device) connects to a

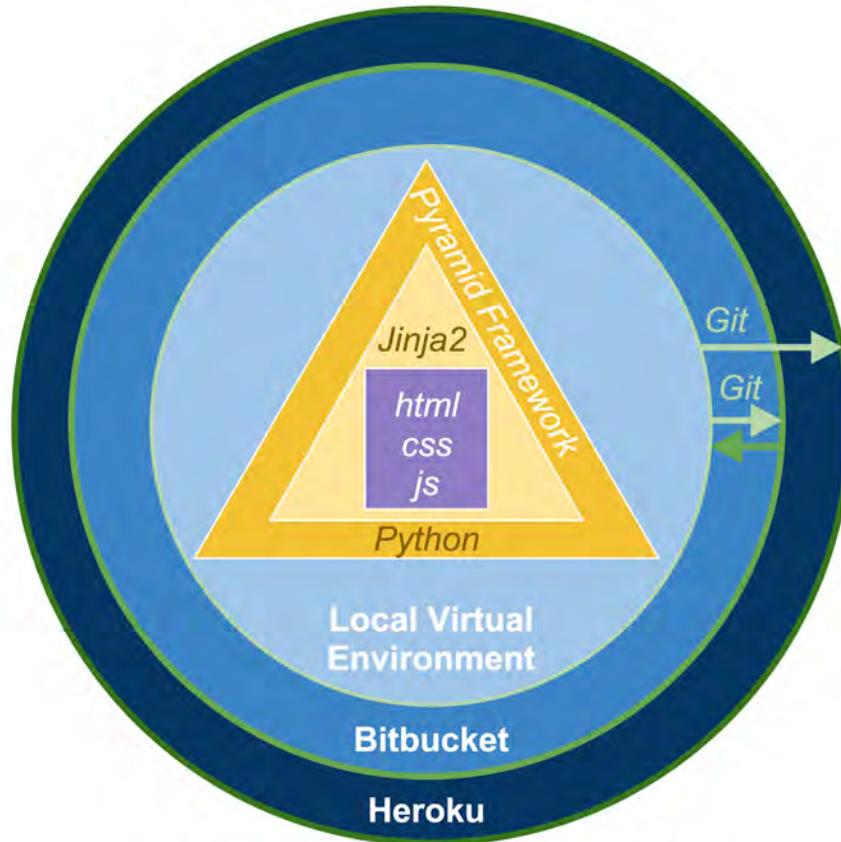


Figure 17 Programming Diagram

server (the web application), and exchanges data with it. To facilitate this data exchange, the client and the server use HTTP (Hypertext Transfer Protocol) to communicate with each other (Figure 18).

For example, the client will request a website in the form of a URL (i.e. <http://ale-hanoi.herokuapp.com>, the current URL for this project's web application). The server receives this request and tries to generate an appropriate response. It will indicate how appropriate the response was by using a status code. If the server understood the request and could find an appropriate response, it will be reply by sending the response and adding a 200 OK status. But, if it understood the request but could not find the resource in question, then it will reply indicating

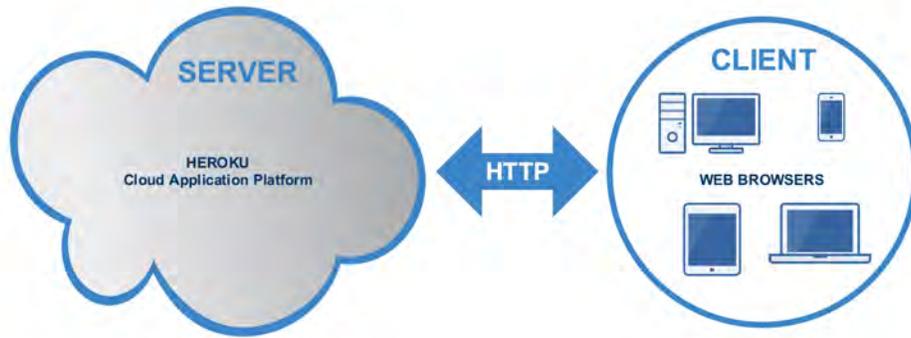


Figure 18 Client-Server Model

a 404 Not Found error. While the HTTP protocol is the backbone of the operations behind the web, it is largely invisible to most end users.

Another important part of the web to understand is the actual format of the response being sent back to the client from the server. In a traditional website, this is almost always in the form of HTML (Hypertext Markup Language). In combination with HTML, CSS (Cascading Stylesheets) is used to provide style to the markups designated by HTML. While HTML and CSS present web pages to clients that are meant for people, there are other protocols used to send data for machines. Traditionally, the XML (Extensible Markup Language) format was used for this purpose, but now, the lighter JSON (Javascript Object Notation) format is more common. Both XML and JSON allow a client to ask a server for data without the presentation that HTML and CSS provide. The client can then use these data for any purpose without having to deal with the presentation layer. For this web application, both types of responses will be used. HTML is sent to the client to present a certain page. And when requesting data from the CartoDB database, the responses are returned in JSON.

Lastly, it is important to note that unlike earlier static versions of web pages, most web pages are now generated dynamically. This means that if a website has 1,000 web pages, its server does not need to store all of those web pages and then look for them once a request is made by the client. Instead, the server will pass a request onto a program, which will

dynamically create a response to the request and pass it back to the server, which will, in turn, pass it on to the origin of the request, the client. In this way, each web page can potentially be tailored to each request.

3.1.3.2 Programming Languages

Most web applications today use more than one programming language, usually specific to certain purposes. First, a programming language needs to be used on the server to generate HTML output. For this purpose, several languages can be used, such as PHP, Ruby, Python, and Java. For this web application, Python has been selected to generate the dynamic content. The reasons behind this selection are as follows: (1) it can be used for a wide variety of purposes, from generating content to GIS analysis and general scripting; (2) it is easy to read, understand, and hence, learn; and (3) it is a mature language and as a result, has an equally mature set of frameworks and libraries for generating content, communicating with web services and dealing with spatial operations. Second, because the web application will also require programming on the client side, JavaScript will be used, as it the standard for this purpose.

Apart from these two main programming languages, a couple of other languages were used as well. In addition to HTML and CSS, which have already been discussed in the previous section, the other language used is SQL (Structured Query Language). SQL is primarily used for retrieving and inserting data into databases. In a traditional web application, a database server would be hosted in addition to the web server, but for this application, the web service, CartoDB will take the place of a traditional geodatabase. Regardless, SQL will be used to communicate with CartoDB, which is built on top of a PostGIS/Postgres database, through the CartoDB API.

3.1.3.3 Server-Side Implementation

As discussed, Python will be used to generate a response on the server. Python's maturity also means that there are several well documented and well used Python frameworks for web development. A framework gives a developer a way of structuring the code, with some scaffolding tools, and a set of best practices that help prevent the developer from needlessly starting with a blank page. The three most popular Python frameworks are: Django, Flask, and Pyramid. Because Flask is more of a microframework suited for smaller applications, Django and Pyramid were compared for the purpose of determining which was a better fit for this web application.

Django is a very opinionated full-stack framework, meaning it comes with a clear set of tools and libraries for typical tasks that a developer might need to execute. In contrast, Pyramid has a well-defined core, but gives the developer lots of flexibility to choose which tools are best for which tasks. With Django, these choices have been largely determined by the framework, and require a lot more effort to be changed.

Because of Pyramid's flexibility in this way, it was chosen as the framework for the web application. As opposed to Django and Flask, it does not assume a local database will be used. It is also very flexible in the authentication mechanisms it supports. As such, it has been configured to run with Mozilla Persona, but due to the framework's flexibility, another identity provider could be substituted, if the need arose. In addition, a library was found within the framework that made it easy to incorporate a SKOS thesaurus for the controlled list of building types in our application without much additional programming.

The main purpose of the Pyramid application is generating the response to a certain request. In broad strokes, it does this in the following way:

1. It analyzes the incoming request. The requested resource is matched against a set of routes. If the request matches one of these, a corresponding view is selected. If not, the application generates a HTTP 404 Not Found response.
2. The selected view is compared to the user's credentials. If the view requires certain credentials, and the user is not yet logged in, they are redirected to a login form. If the user is logged in and has the required credentials, they are passed to the next step. If the user does not have the necessary credentials, they are told they have insufficient privileges.
3. The view is executed. This is a piece of code that can do whatever the developer needs it to do. It is where the main activity takes place. For this web application, a view generally connects to CartoDB using the Python requests library either to request data from the CartoDB database, or to add new data to it. In the end, the view returns some data.
4. Pyramid then takes the response of this view and determines what renderer to use. A renderer is responsible for turning the data returned by a view into the actual output to be sent to the client. In this web application, either the Jinja2 renderer (cfr.infra) is used to generate HTML or the JSON renderer is used to generate JSON data.
5. The renderer response is then returned as the body of an HTTP response, with the necessary HTTP status code added to it.

Since most of the responses generated by the web application are HTML, the Jinja2 renderer is used extensively. Jinja2 (<http://jinja.pocoo.org/>) is a templating language that was developed outside of the Pyramid framework. It can be used with both the Flask and Pyramid frameworks, and recently support for it was added to the Django framework as well. A templating language serves several purposes. First, it is a simplified programming language

aimed at generating output. So, it has a very narrow focus. A good templating language is also a security measure. It creates a sandbox within which only a limited set of operations are possible, making it more difficult for attackers to hack a system. And because it is focused on presentation, it is easy for a web designer or non-programmer to learn because all of the details of a complete programming languages are not necessary to understand.

For the web application, Jinja2 was set up with a simple inheritance model. Every template created extends a base.jinja2 template. This base templates defines the general HTML structure of each page on the site and allows the templates that extend it to inject content into well-defined blocks. Also, there is a macro.jinja2 file that is used by the other templates in order to take advantage of frequently used HTML macros. This file contains micro templates that can be used as functions would be in other programming languages.

3.1.3.4 Client-Side Implementation

Although the server is essential, some programming had to be accomplished on the client-side, as well. As mentioned, for this, Javascript was used. To make it easier to style the web application, the Foundation CSS framework was used. Just as with the Python framework, this provides a set of tools and best practices to help in creating useful and rich interfaces. One of its main strengths is that it creates fully responsive web pages as a default. This means that with little effort by the developer, a website using this CSS framework will run on very diverse screen sizes, from a small smartphone to a larger desktop. Foundation CSS relies on the jQuery library, which is one of the most popular JavaScript libraries, and makes certain tasks such as animating parts of the screen or doing AJAX requests easier.

One of the focal points of the web application is the interactive map on the Home page (see Figure 22). This is typically the kind of functionality that would require a lot of custom

JavaScript. However, because the web application model is using CartoDB, the map rendering and functionality is largely taken care of by CartoDB's simple library (which itself is powered by the Leaflet mapping library).

3.1.3.5 Development Environment

After describing the different components of the web application, the next step is to define the process by which the application will actually be developed and deployed. Because the application is eventually meant to be put forth as a model that can possibly be used for other deployments, the process has been geared towards working in a development environment that facilitates this.

As such, the most essential component in developing the application is Git. Git (<http://www.git-scm.com/>) is a version control system that allows tracking of all the files used for an application and all modifications made during development. It keeps a full history of who changed what, where, and when. This kind of tracking comes in handy when a bug is detected and needs to be resolved. In contrast to a version control system such as Subversion, Git is decentralized, meaning that there is no single master copy that controls all of the other copies. Multiple copies (clones) of a repository exist that contain all of the code needed to deploy a web application. Usually, one is designated as a master copy, but the clones can easily take the place of that copy if something goes wrong. In a sense, it serves as a sort of backup.

In order to host the "master" copy of the web application's code, Bitbucket (<http://www.bitbucket.org>) is being used. This web service hosts git repositories, with features such as a ticketing system for bugs and a wiki, that helps to facilitate usage by others and collaboration. The development workflow with Git and Bitbucket for the web application is illustrated in Figure 19. In addition to the code being hosted on Bitbucket, a local git repository

was maintained where most of the programming and development took place. Once changes were made locally, git was used to push those changes to the Bitbucket repository in order to keep both versions in sync. In a more collaborative development environment, the Bitbucket repository would be the master source for the code and individual developers would both pull changes from it and push changes to it.

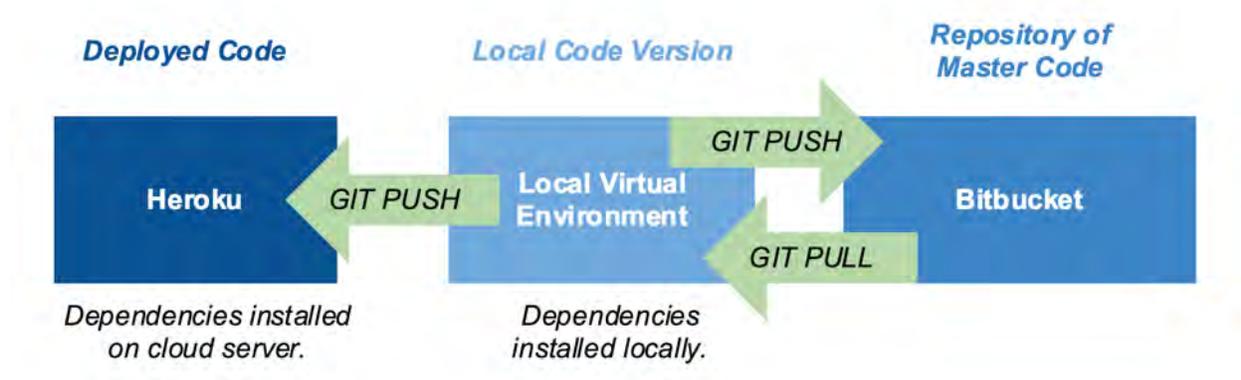


Figure 19 Development Environment Diagram

During the development process, a local server was run on the development machine. In this case, the development machine was a MacOS laptop. Because our web application required certain dependencies, primarily Python, a virtual environment was set up with those dependencies and the application code installed. This is a generally accepted best practice in web development as it creates a separation between the normal operations of one's development machine and those required for the development of a specific web application. For example, virtual environments enable developers to run local servers for two different applications with different dependencies without creating problems due to issues having to do with different versions. In other words, an application running on Pyramid 1.0 can exist on the same machine as one written for Pyramid 1.5.

Once the application development is complete, the final step is to publish it onto the web. While running a server locally is expected for development, this is not an option for a production web application. After doing research on cloud-based hosting platforms, Heroku was chosen due to its ease of use. Setting up a Heroku account created a git repository for the application on the Heroku servers. At this point, the local repository could be pushed using git to the Heroku repository, triggering a build. At that point, Heroku looks for the requirements.txt file in the repository and installs all of the dependencies listed in that file and restarts the application.

3.1.3.6 Programming Challenges

Admittedly, the majority of the Python programming was challenging because it was a relatively new language for the developer/author. However, as discussed in the sections above, much of the harder work was handled by the Pyramid framework, which is very well documented and has a very active community for support, despite not being as popular as Django. Because the developer/author is well-versed in HTML, CSS, SQL, and to a lesser extent, JavaScript, much of the client-side implementation was easy, especially working with the Jinja2 language. Given all of that, most of the programming challenges had to do with interacting with CartoDB, which does not offer the same level of documentation or support for its service, especially at the free pricing tier, and can be somewhat buggy given this type of implementation.

For example, initially building names contained a “#”, such as “Building #123.” Unfortunately, the inclusion of that character within the HTML of the jinja2 template somehow rendered the call to CartoDB useless, and contributions were not being logged. After trying to find a way to fix this, looking through existing documentation and also doing internet searches on the same problem, it was determined that the best fix was just to change the names and remove the “#” so that they would appear as “Building 123.”

In addition, functionality that is currently specified in the application roadmap (Section 5.3) such as giving contributors the ability to create new records was beyond the ability of the developer in the midst of development. However, that functionality is within better reach given the experience of developing the current web application.

3.2 Application Evaluation

The evaluation of the web application is divided into two categories: primary and secondary. Primary evaluation refers to the immediate assessment that will take place after the initial development as described in Section 3.1. It is the only type of evaluation that will be completed for this thesis project. The secondary evaluation is not part of this thesis project, but will be described because the tools to initiate it long after the scope of this thesis were built into the application.

3.2.1 Primary Evaluation

Upon completion of initial development, the web application will be evaluated by determining whether it has met the requirements put forth in Section 3.1.1.2. These requirements are phrased as yes or no questions, and are grouped by user experience, standard inventory data fields, and crowdsourcing tasks. An evaluation using these questions will be detailed in Chapter 4.

3.2.1.1 User Experience Requirements

These questions correspond to the requirements outlined in Table 7:

- Does the application feature a map showing each record's location?
- Does the application feature a simple layout with explanatory text and links that clarify how to use the web application?

- Does the application feature content that promotes the application's purpose of heritage conservation?
- Does the application feature a map-based search?
- Does the application feature no requirements to login or sign up to view information?
- Does the application feature an About section dedicated to exposing the purpose and methodology of the application?

3.2.1.2 Heritage Inventory Data Field Requirements

These questions correspond to the requirements outlined in Table 8:

- Does each record have a unique identification number?
- Does each record show the original date of compilation, as well as the dates of contributions and modifications?
- Are all contributions logged with information on who contributed the information?
- Is the map location of each record both viewable and editable?
- Does each record have a field for building type and category with controlled values in a combined dropdown list?
- Is there an area to contribute dating information on the building?
- Are users able to contribute information on the basic condition status of a building?

3.2.1.3 Crowdsourcing Task Requirements

These questions correspond to the requirements outlined in Table 9:

- Are users able to submit an edit regarding the location of each record?
- Are users able to submit a free text description that may enhance understanding of a record's significance?

- Are users able to classify each record in regards to building type?

3.2.2 Secondary Evaluation

The secondary evaluation is not a part of this thesis project. However, once the web application has been deployed and efforts at dissemination have been made, it is intended that a secondary evaluation will occur and as a result, the tools needed to conduct a secondary evaluation were incorporated into the web application. The three measures that will be used after the thesis project to evaluate the application are: (1) web application traffic; (2) contributions; and (3) responses to the feedback survey.

3.2.2.1 Web Application Traffic

The web application currently logs traffic via Google Analytics (see Figure 22). When the secondary evaluation is undertaken in the future, the appropriate web application traffic statistics will be analyzed.

3.2.2.2 Contributions

The number and quality of contributions will be taken into account during the secondary evaluation, as well as a look at the unique contributors. A request for information will likely be sent to the email addresses used to log in via Persona to the application.

3.2.2.3 Feedback Survey

A link to a feedback survey is included on every page of the web application. This links to a Google Forms-hosted survey that focuses on the user experience of visitors to the application. As such, the questions asked are closely aligned to the user experience questions used for evaluating other heritage inventory websites as well as those used for the primary evaluation. Table 11 details the feedback survey questions.

Table 11 Feedback Survey Questions

| Category | Question | Type |
|-------------------|---|--|
| Usefulness | Does the website present information on the buildings that is new and/or unique? | Scale (1-5; 1=Strong No/5=Strong Yes) |
| Usefulness | Does the website present information on the buildings that is useful? | Scale (1-5; 1=Strong No/5=Strong Yes) |
| Usefulness | How would you improve the usefulness of the information on the website? | Paragraph Text |
| Usability | Does the website present information on the buildings in an easy to use format? | Scale (1-5; 1=Strong No/5=Strong Yes) |
| Usability | How would you make the website easier to use? | Paragraph Text |
| Desirability | Does the website's design evoke positive emotions and appreciate for the buildings? | Scale (1-5; 1=Strong No/5=Strong Yes) |
| Desirability | Does the website promote the conservation of the buildings? | Scale (1-5; 1=Strong No/5=Strong Yes) |
| Desirability | How would you improve the website's design to enhance its ability to contribute to the conservation of these buildings? | Paragraph Text |
| Discoverability | Does the website's map make it easy for you to find the buildings and the information on them? | Scale (1-5; 1=Strong No/5=Strong Yes) |
| Discoverability | How would you improve the website and/or map to make it easier to find the buildings and the information on them? | Paragraph Text |
| Accessibility | Does the website hinder access in any way to the information on the buildings? | Scale (1-5; 1=Strong No/5=Strong Yes) |
| Accessibility | How would you improve access to the information on the website? | Paragraph Text |
| Credibility | Do you think the website provides credible information on the buildings? | Scale (1-5; 1=Strong No/5=Strong Yes) |
| Credibility | How would you improve the credibility of the information on the website? | Paragraph Text |
| Contributions | Did you log in to the website and contribute information? | Yes or No |
| Contributions | If yes, was it easy to contribute information to the website? | Scale (1-5; 1=Strong No/5=Strong Yes) |
| Contributions | Is the website collecting information on the buildings that is not found elsewhere? | Scale (1-5; 1=Strong No/5=Strong Yes) |
| Contributions | Is the website collecting information on the buildings that is adequate for your needs? | Scale (1-5; 1=Strong No/5=Strong Yes) |
| Contributions | How can we improve the contribution process on the website? | Paragraph Text |
| General Questions | Are you... <ul style="list-style-type: none"> • a student? • a heritage and/or conservation professional? | Check Boxes <i>(Instruction: Check as many boxes for which your answer is "Yes".)</i> |

| | | |
|-------------------|--|---|
| | <ul style="list-style-type: none"> • an architectural historian, architect, or historian? • a current or prior resident of Hanoi? • a current or prior visitor of Hanoi? • a current or prior tourist of Hanoi? • interested in the conservation of Hanoi's architectural heritage? • involved in government or public policy in Hanoi? | |
| General Questions | <p>Did you...</p> <ul style="list-style-type: none"> • access the website from a desktop computer? • access the website from laptop computer? • have access to a high speed internet connection? • use Chrome as your browser? • use Internet Explorer as your browser? • access the website from a mobile device (i.e. tablet or phone)? • use Safari as your browser? • use Firefox as your browser? | <p>Check Boxes</p> <p><i>(Instruction: Check as many boxes for which your answer is "Yes".)</i></p> |
| General Questions | General Comments | Paragraph Text |

CHAPTER FOUR: RESULTS

In this chapter, the results of both the application programming and the application evaluation will be discussed. In the first section, titled Application Description and Functionality, all aspects of the resulting web application will be shown. In the second section, titled Application Evaluation, the application will be measured using the evaluation framework that was outlined in Chapter 3. That framework was itself the result of the process shown in Figure 3, in which an emphasis on requirements was shown to be central to the organization of this thesis project.

4.1 Application Description and Functionality

Figure 20 illustrates the information architecture of the web application, which can be found at <http://ale-hanoi.herokuapp.com>. Starting at the Home page, users immediately encounter a map of the project area, which they can interact with and explore the various records through. After clicking on a map marker, an InfoWindow pops up with an image of the subject building as well as a button with the option to view the full record, and a link to log in to contribute to the record. If the user has already logged into the application, then a button to contribute to the record will appear. If the logged-in user clicks the button to contribute, then he or she will be taken to a contribution form for the record.

Based on the login status of the user, the top bar navigation changes from having links to the Home page and map, the About page, and the Login page, to having links to the Home page and map, the About page, the My Contributions page, and the Logout page. The About page (Figure 21) has relevant information about the project background and will have a link to this thesis document so that users can see the methodology behind the project.

The diagram highlights one external link, the Feedback Survey Form, which opens a new window with a Google Form where users can evaluate the application based on the established

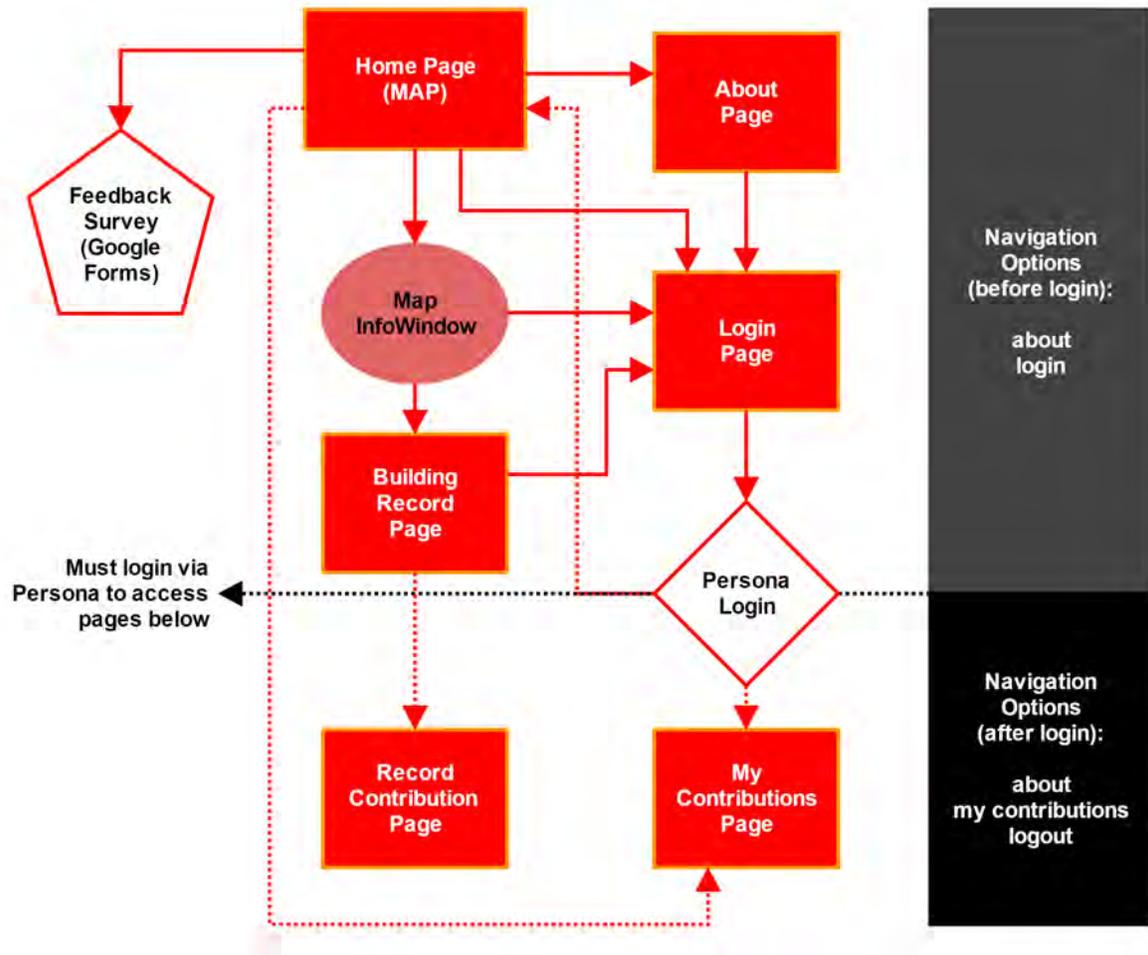


Figure 20 Application Flow Diagram

framework and also offer other comments on how best to improve the application.

As mentioned previously the web application has been built on a responsive template, so that it can be viewed on both traditional and mobile screens with the same utility. As a result, the site is relatively simple, using similar colors to that of the Vietnamese flag paired black and grey for impact. Two sans serif fonts are used in order to provide design continuity throughout the site. For the titles and headings, the Art Deco-inspired Google Font Josefin Sans is used. Arial is used for the body and other smaller sized text. Each page is based on a similar

Art Deco Heritage of Hanoi (return to map) [about](#) [my contributions](#) [logout](#)



About Art Deco Heritage of Hanoi

This web application is part of the masters thesis project of [Annabel Lee Enriquez](#) in pursuit of a MSc degree in Geographic Information Science and Technology from the University of Southern California.

Project Background

The economic growth of Southeast Asia, fueled by capital investment originating from outside of the region, particularly from China, Japan, South Korea, and Australia, is rapidly modernizing its urban landscapes, irreparably changing the character of its cities. For example, in 2010, the construction of the South Korean-owned \$1.05 billion Keangnam Hanoi Landmark Tower was underway in Hanoi's new central business district, and plans for "the second tallest building in Asia after the Burj Kalifa" were being circulated, prompting concern over the effects on Hanoi's fragile architectural heritage.

Indeed, the push to become part of the developed world has the potential to create an atmosphere in which the cultural heritage resources of the area are at risk of demolition or significant alteration. In Asia, this pattern of sacrificing cultural heritage in the wake of modernization is seen most prominently in Shanghai, where many of the city's Art Deco vernacular buildings were razed in order to build larger contemporary buildings. In the 1990s, approximately 600 of Beijing's historic hutongs were destroyed in order build new developments.

As a result of the perceived threat to these resources, in 2012, I traveled to Southeast Asia to try to document what French colonial era buildings were left. Because the region is fairly large, the informal field survey was limited to small areas in several key cities, including Vientiane, Hanoi, and Phnom Penh. It consisted of taking photos and recording geographic coordinates in order to create an eventual set of geo-referenced photos of potentially significant buildings from the French colonial period.

Away from the field, each building was assigned a building style based on visual inspection of the photograph and the initial assessment in the field. However, no other information exists for each building documented. The purpose of this project, then, is to establish an initial web application and and web application model that facilitates the gathering of additional essential information for historic buildings based on geotagged photographs. For the initial implementation, the web application will focus on the small group of Art Deco buildings in the Hanoi photoset.

Methodology

The project's full methodology will be available soon via a link to the full thesis document.

© Copyright 2015 [Annabel Lee Enriquez](#) | [Feedback Survey](#)

Figure 21 About page

template which has at its minimum top navigation bar, and a simple footer. The content between those two elements changes depending on the page.

4.1.1 Home Page and Map

It was important that users encounter the main map immediately so that they could explore the main content of the application the building records. As a result, the map takes up most of the area of the page (Figure 22). Each of the markers on the map can be rolled over to reveal a tooltip that shows the building's name as given for this project. Upon clicking the marker, a InfoWindow pops up.

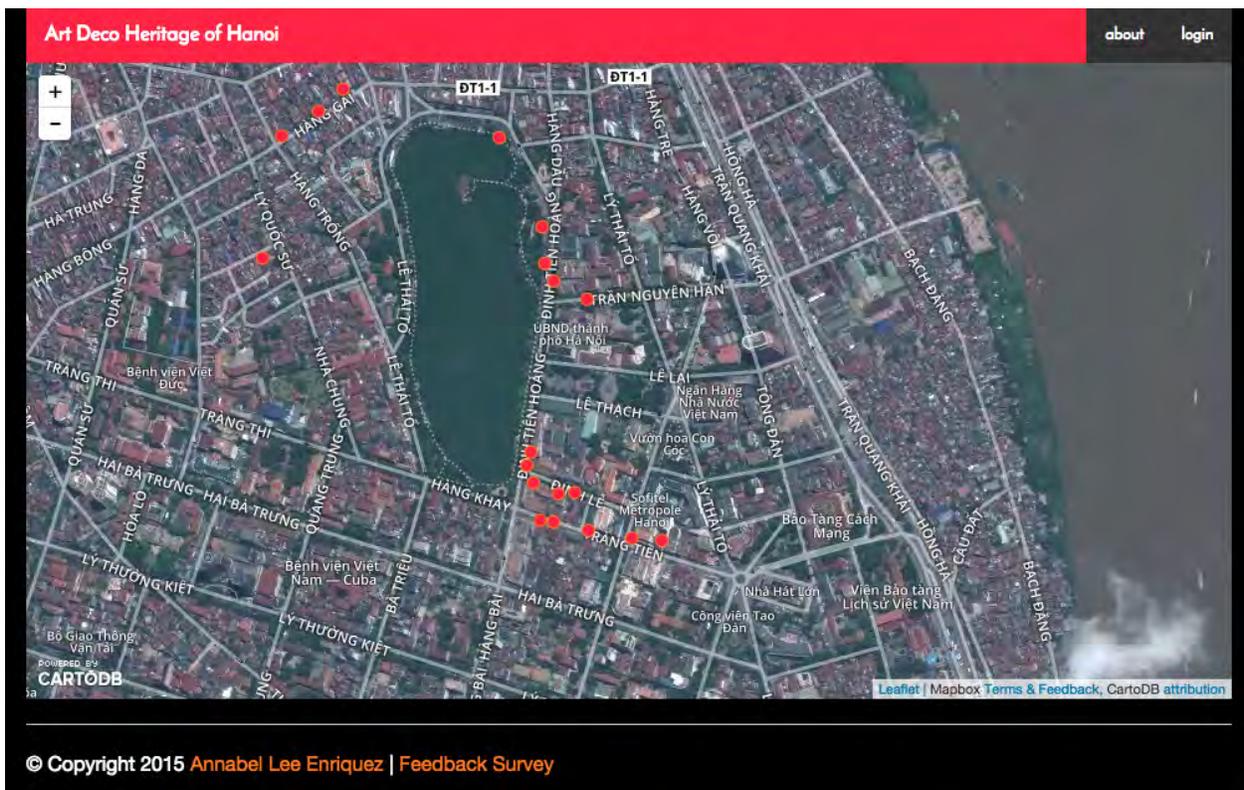


Figure 22 Home page

4.1.1.1 Home Page Map InfoWindow

The map InfoWindow (Figure 23) contains the building name, the associated photograph, a button for the full record ("See the record!"), and depending on the login status of the user, either

another button to contribute to the record ("Make a contribution!") or a link to login to the application. When viewed on a mobile phone, the InfoWindow fills the entire screen.

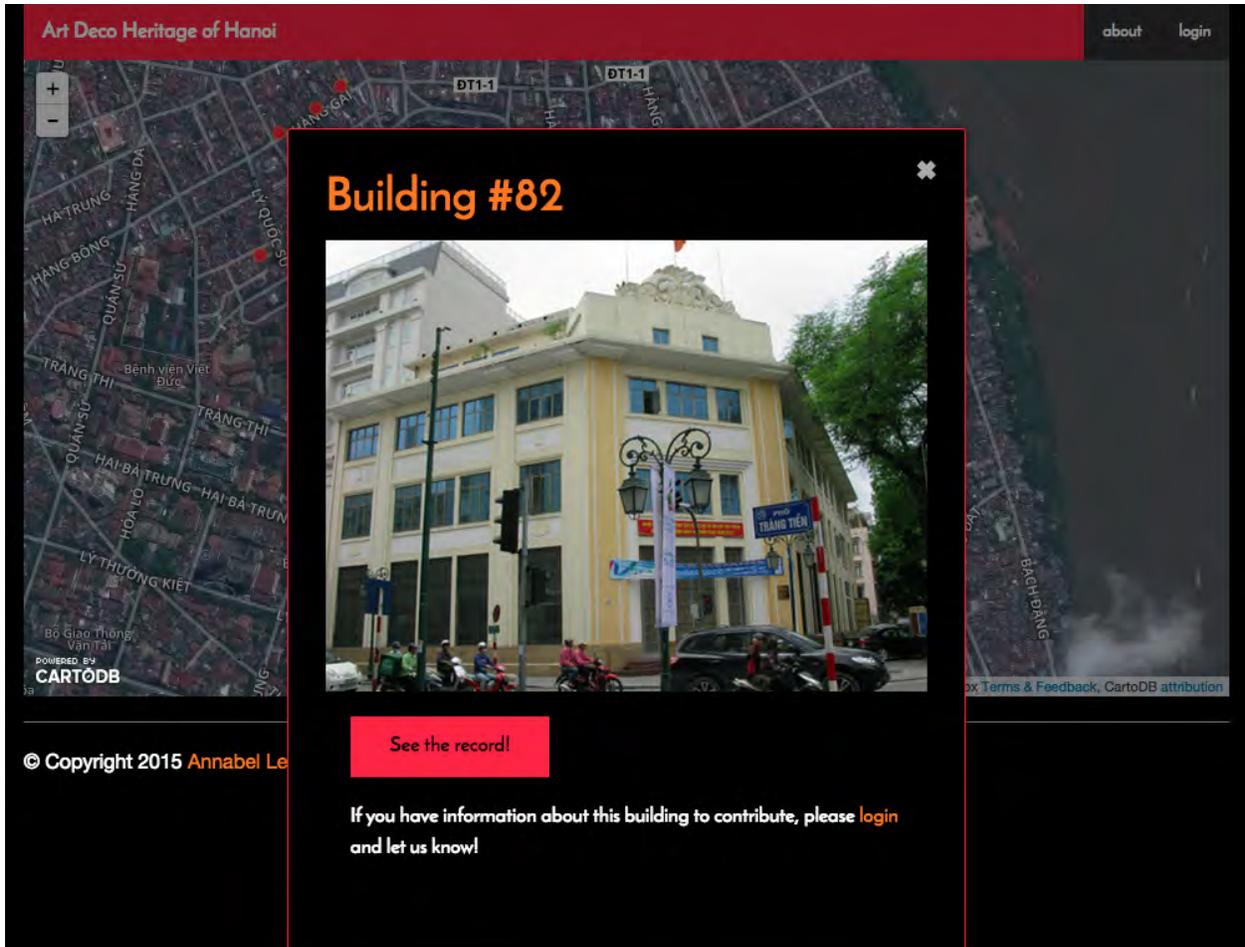


Figure 23 InfoWindow screenshot

4.1.2 Building Record Page

The full record of the building (Figure 24) contains two tiers of information. The first, the Main Record, is the original record that resulted from the June 2012 survey. The second, Contributions, includes that initial record and any subsequent contributions that were submitted afterward.

The Main Record contains the original photo, and a table of information that was assigned in the post-processing stage of the input data preparation: (1) the project ID number; (2)

Building #82

Main Record



| | |
|-----------------|------------------|
| ID | 82 |
| Country | Vietnam |
| City | Hanoi |
| Style | Art Deco |
| Functional type | |
| Survey date | 2012-06-04 |
| Last update at | 2014-01-13 09:03 |

Contributions



| | |
|----------------------|--|
| Contribution ID | 82-2 |
| Style | Art Deco |
| Functional type | |
| State | Unaltered |
| Notes | Building looks to be painted a different color |
| Contributed by | eetroy@outlook.com |
| Date of contribution | 2015-06-17 |



| | |
|----------------------|--------------------------------|
| Contribution ID | 82-1 |
| Style | Art Deco |
| Functional type | |
| State | Unaltered |
| Notes | None |
| Contributed by | annabel.lee.enriquez@gmail.com |
| Date of contribution | 2014-01-13 |

Figure 24 Building record page

the Country, which is "Vietnam" for this dataset; (3) the City, which is "Hanoi" for this dataset; (4) the Style, which at this stage should all be "Art Deco"; (5) the Functional type, which is blank

because this information is awaiting contribution; (6) the Survey date; and (7) the date of the Last Update.

The Contributions section has entries that contain: (1) either a new photo or the default photo for the record; (2) a Contribution ID number, (3) the Style, which can be left unchanged from the original; (4) the Functional type, which can be left blank, if unknown; (5) the State of the building compared with the original 2012 record; (6) any Notes made by the Contributor about the record; (7) the Contributor's email address, which serves as their login ID; and (8) the Date of contribution.

4.1.3 Login Page

The Login page can be accessed via two links. The first and most prominent link is through the top bar navigation. The second link is located inline within the text of the map InfoWindow. This page (Figure 25) has some text briefly describing what can be viewed with and without signing into the site. The Sign In button is a standard Persona-branded Sign In button. Once pushed, the Persona pop-up window is activated.



Figure 25 Login page

4.1.3.1 Persona

As described in Chapter 3, Persona is a Mozilla service that provides user sign in and authentication via a valid email address. The Persona pop-up window (Figure 26) contains the necessary fields for users to enter their email address and associated password. The password information is not stored by the application at all. Once the email address is verified, the site shows the user as logged in.

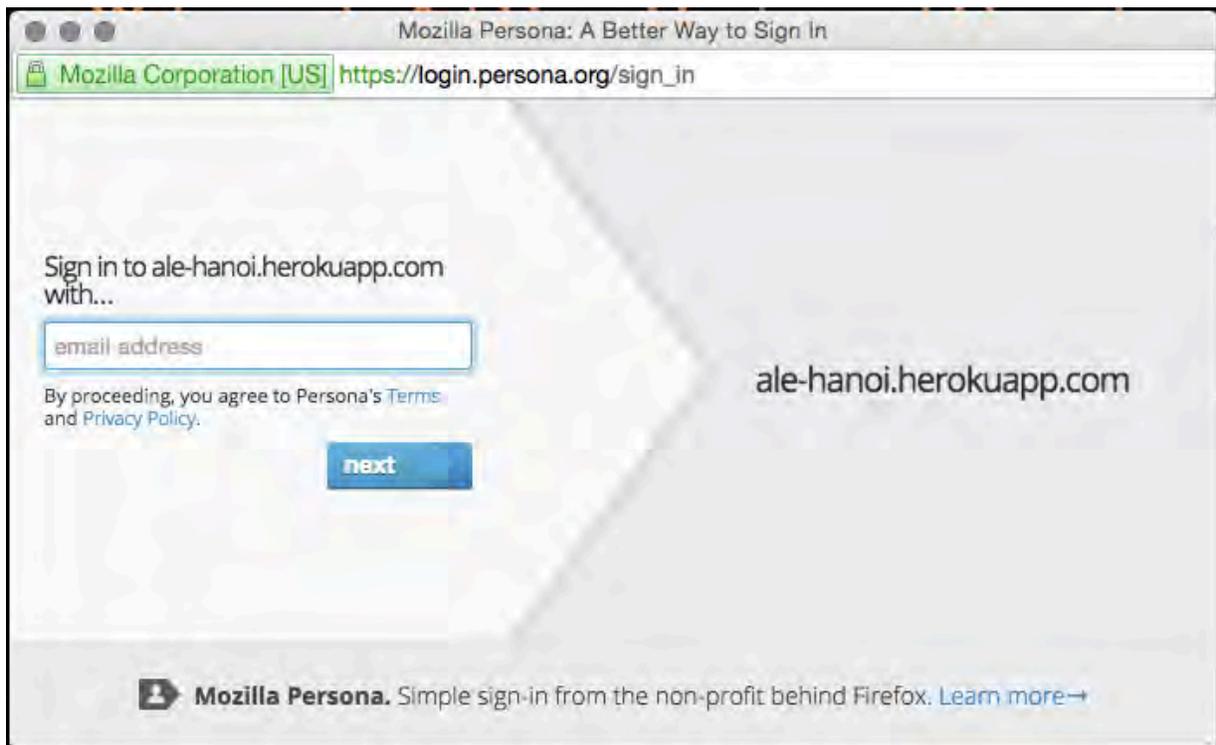


Figure 26 Persona Pop Up Window

4.1.3.2 Logout Page

Clicking on the logout link in the top bar navigation will lead to the logged in version of the login page which has a logout button instead of the Persona sign in button (Figure 27).

4.1.4 Contribute Page

After logging into the application, users can return to the map and contribute to each record by



Figure 27 Logout Screen

selecting the "Make a contribution!" button. The Contribute page (Figure 28) has fields for: (1) the Building ID, which cannot be changed; (2) the Name of the building, which is a text field; (3) Map Marker edits, where the user can reposition the record's marker on the map; (4) the Current Condition State, which consists of a selectable dropdown list; (5) the Architectural Style, which is prepopulated with Art Deco, but also gives contributors the opportunity to disagree with the style assessment and select another style from the dropdown list; (6) the Building Type, also known as the Functional Type, which also consists of a dropdown list; (7) a Photo URL, where a new contributor-supplied URL for a photo can replace the existing URL for the contribution; and (8) a free text field which contributors can use to provide notes or other relevant information.

For the dropdown fields, the controlled values help to enforce consistency. The values for each of these fields and source for the values are detailed in Table 12. The editable map marker is powered by Leaflet Draw, and the map source is the same as the main map on the home page.

Once the contributor submits the entry via the "Submit" button at the bottom of the page, the information is automatically sent to the CartoDB table, hanoifrenchcolonial_contributions, where

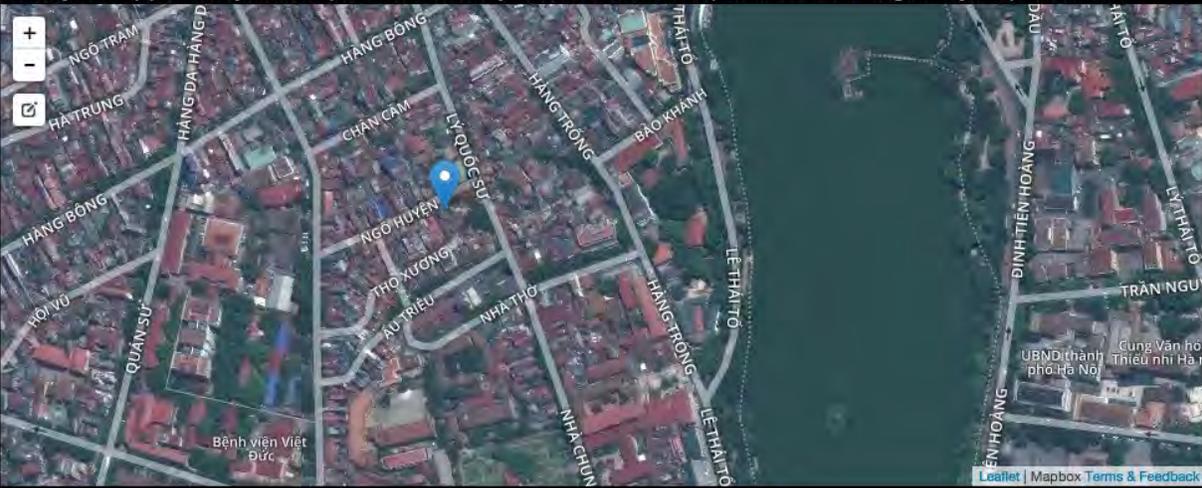
Art Deco Heritage of Hanoi (return to map) [about](#) [my contributions](#) [logout](#)

Thank you for taking part in this project. Please add your contribution for the record below and press Submit.

Building ID
158

Name - If there is another name for the building, please enter it here.
Building #158

Currently, the map pins identify where the photos were taken. If you would like to move the pin to where the building actually sits, please do so.



Current Condition State - Has the building been altered or demolished since the June 2012 survey?
Unaltered

Architectural Style - If you disagree that this is an Art Deco building, feel free to select another option from the dropdown list.
Art Deco

Building Type - Please let us know what the building's function is.
[Empty dropdown menu]

You may provide a photo of the building, if you have a URL for it.
photo url

Use this field to provide additional information about the building, such as when the building was built or who the architect was.
[Empty text area]

© Copyright 2015 [Annabel Lee Enriquez](#) | [Feedback Survey](#)

Figure 28 Contribute page

Table 12 Dropdown field values on Contribute page

| Field Name | Values |
|----------------------------|--|
| Current Condition State | Unaltered; Altered; Demolished |
| Architectural Style | Art Deco; Beaux Arts; Colonial Vernacular; Modern; Other |
| Building (Functional) Type | schools (buildings); pre-primary schools (buildings); elementary schools (buildings); middle schools (buildings); junior high schools (buildings); high school (buildings); university and college buildings; academies (buildings); secondary schools (buildings); office buildings; government office buildings; corporate plazas; corporate headquarters; administration buildings; health facilities; multipurpose buildings; religious structures; public accommodations; hotels (public accommodations); hostels; commercial buildings; markets (structures); market halls; supermarkets; stores; restaurants; bars; financial institutions (buildings); institutes (buildings); residential structures; institutions (buildings); museums |

the application administrator can view them. The contributor can either visit the Building Record or the My Contributions page.

4.1.5 My (User) Contributions

Each contributor can see what they have contributed by clicking on the "my contributions" link in the top navigation bar or via the inline link on the login page. The My Contributions page (Figure 29) has every contribution made while logged in with the contributor's email address.

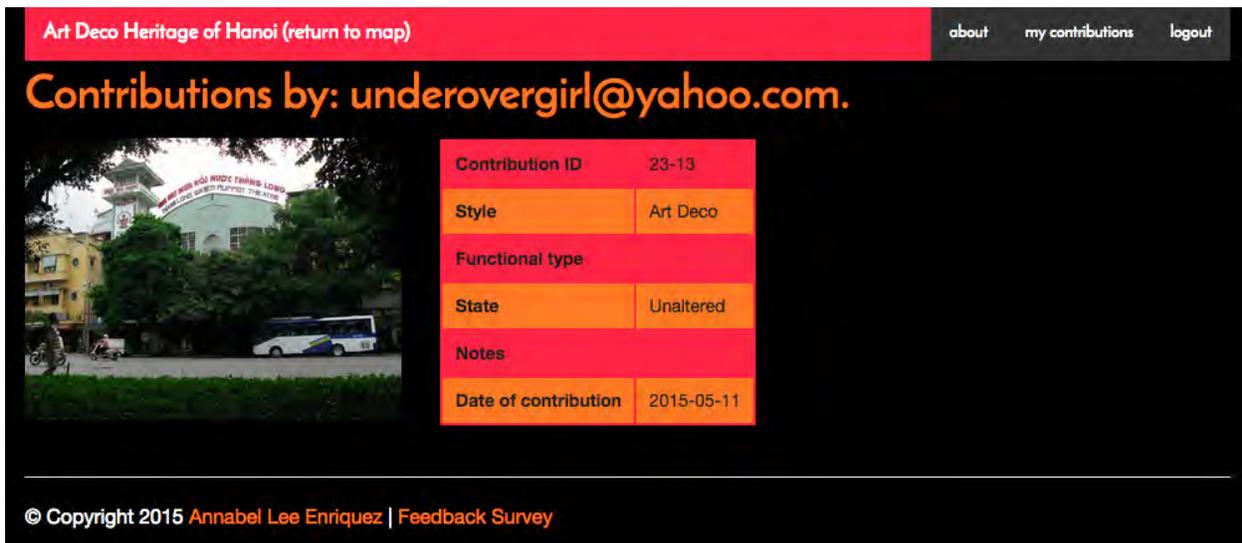


Figure 29 My Contributions page

4.1.6 CartoDB Table View

While not necessarily part of the web application, it is important to note that at this stage in development, there is no administrator tool built into the web application with which to evaluate user contributions. The information in the CartoDB contribution table will have to be evaluated by the administrator via some other external method or process.

4.1.7 Feedback Survey Form

In addition to a link for the personal website of the author, the footer includes a link to a survey (Figure 30) for users to provide feedback on the site. Hosted by Google Forms, the survey is based on the evaluation framework developed in Section 3.2. The results are captured in a Google Sheets spreadsheet.

4.2 Evaluation Results

Overall, the web application fulfilled all of the requirements established in Chapter 3 for the primary evaluation. The primary evaluation set minimum requirements based on a survey of related work. The extent to which these minimum requirements lead to a successful web application in the long term will eventually be measured in a secondary evaluation, which will not occur until the web application has been used by both the general public and those involved in cultural heritage conservation.

4.2.1 User Experience Requirements

As mentioned in Chapter 3, this set of requirements relates to the application's user experience.

4.2.1.1 Usefulness Requirement

Does the application feature a map showing each record's location?

The web application features a map that occupies most of the Home page (see Figure 24).

Art Deco Heritage in Hanoi - Feedback Survey

Please fill out the following survey to provide your feedback regarding the Art Deco Heritage in Hanoi site.

Usefulness

Does the website present information on the buildings that is new and/or unique?

1 2 3 4 5

Strong No Strong Yes

Does the website present information on the buildings that is useful?

1 2 3 4 5

Strong No Strong Yes

How would you improve the usefulness of the information on the website?

Usability

Does the website present information on the buildings in an easy to use format?

1 2 3 4 5

Strong No Strong Yes

Figure 30 Feedback Survey on Google Forms

4.2.1.2. Usability Requirement

Does the application feature a simple layout with explanatory text and links that clarify how to use the web application?

Because the web application is built on a responsive template, much of the layout is simple because of the potential need to collapse content containers to accommodate smaller mobile

screens. The navigation is clearly labeled, and most pages contain explanatory text and links that instruct the users on how to use the application.

4.2.1.3 Desirability Requirement

Does the application feature content that promotes the application's purpose of heritage conservation?

The About page (see Figure 21) provides some background on heritage conservation in the area as well as some information about the project's purpose.

4.2.1.4 Discoverability Requirement

Does the application feature a map-based search?

Because each original record consists mainly of a photograph and a spatial reference, searching on anything but the map is unnecessary at this point. The map on the Home page (see Figure 24) is interactive, so users can zoom in and out, and pan around the map in order to find records.

4.2.1.5 Accessibility Requirement

Does the application feature no requirements to login or sign up to view information?

As stated on the Login page (see Figure 25), "You may browse the site and view all of the information (including contributions) on the buildings in the system without signing in."

However, if the user wants to contribute information to the site on any building record, then he or she must log in using Persona button.

4.2.1.6 Credibility Requirement

Does the application feature an About section dedicated to exposing the purpose and methodology of the application?

The web application features an About page (see Figure 21) with content as to the project's purpose, as well as link under Methodology to this thesis document. In addition, information on the author is provided via a link to her personal website.

4.2.2 Heritage Inventory Data Field Requirements

As described in Chapter 3, this set of requirements relates to the most essential data fields needed for a heritage inventory of historic architecture. The illustrative figures for this section come from the Building Record (see Figure 24) and Contribute pages (see Figure 28), which accommodate the capture of all necessary data fields.

4.2.2.1 Unique Identification Number Field Requirement

Does each record have a unique identification number?

This unique identification number was automatically generated when the photographs were initially processed and also forms part of the record name. The unique identification number can be found in the Main Record section of the Building Record page in the ID field (Figure 31). In addition, each Contribution is automatically assigned a Contribution ID, which is a combination of the original record's ID and the order number of the contribution (Figure 32).

4.2.2.2 Recordation Date Field Requirement

Does each record show the original date of compilation, as well as the dates of contributions and modifications?

Each record shows the original compilation or survey date, which in this case, refers to when the photograph was originally taken. The web application automatically shows the date of any update to the main record (see Figure 31), as the CartoDB table automatically logs the date of any changes to the record. In addition, the date of each contribution is recorded (Figure 32).



Figure 31 Main Record section of Building Record page

4.2.2.3 Contributor Information Field Requirement

Are all contributions logged with information on who contributed the information?

With each contribution, the web application also logs and displays the email address of the contributor (Figure 32).



Figure 32 Contributions section of Building Record page

4.2.2.4 Location Information Field Requirement

Is the map location of each record both viewable and editable?

In addition to being able to view the location of each record on the Home page map (see Figure 21), the Contribute page features the ability to edit the location of the map marker for each building record (Figure 33).

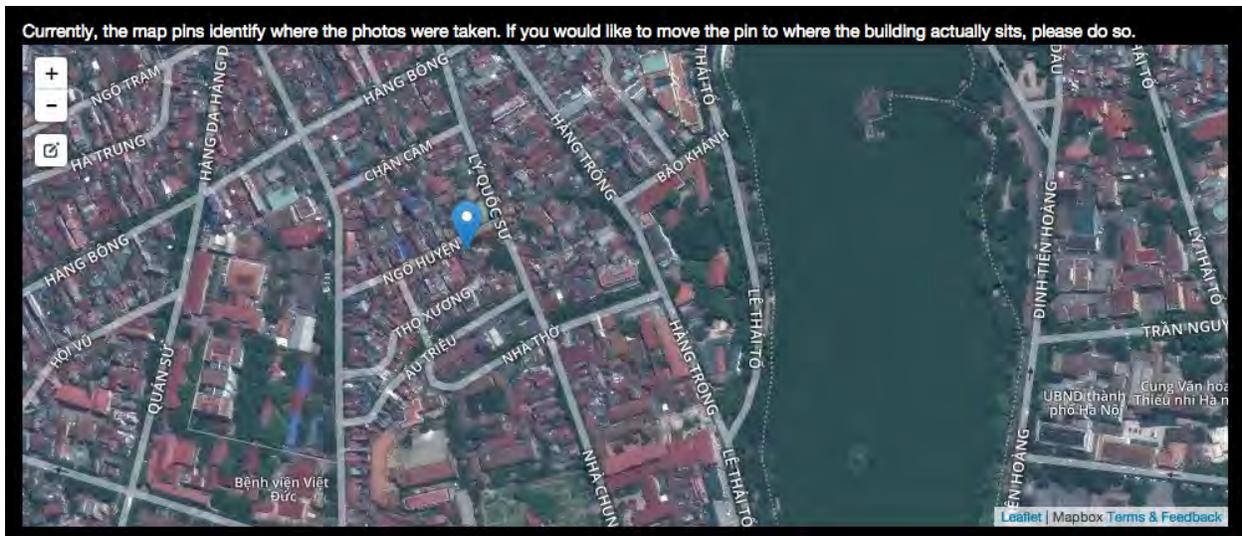


Figure 33 Location editing section of the Contribute page

4.2.2.5 Building Type and Category Field Requirement

Does each record have a field for building type and category with controlled values in a combined dropdown list?

Users are able to classify each building by function using the controlled values in the Building Type field dropdown list (Figure 34). These values combine both building types and categories. On the Building Record page, each type is hyperlinked with information (Figure 35), corresponding to the Getty Art and Architecture Thesaurus, from which the values were selected.

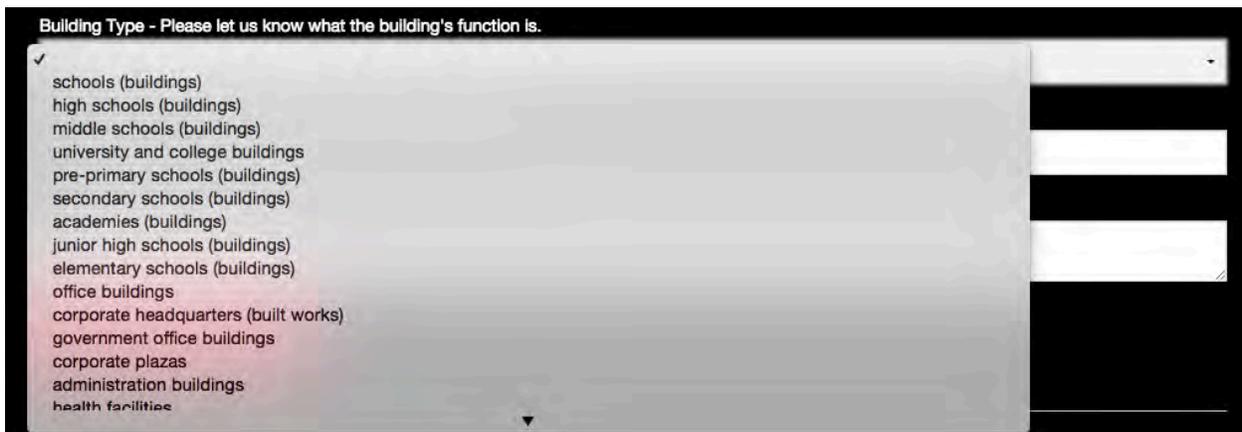


Figure 34 Building Type dropdown list detail on Contribute page

Schools (buildings)

- id: 6
- type: concept
- uri: [um:x-hanoi:heritagetypes:6](#)
- conceptscheme: Functional types

labels

prefLabel:

- schools (buildings) (*en*)

altLabel:

- buildings, school (*en*)
- educational building (*en*)
- educational buildings (*en*)
- school (building) (*en*)
- school building (*en*)
- school buildings (*en*)

notes

- scopeNote (*en*): Individual buildings or groups of buildings designed or used as places of instruction, typically having one or more classrooms where students may sit at desks and listen to an instructor, often including a library and other areas having books, computers, or other items necessary for the lessons.

relations

narrower:

- high schools (buildings)
- middle schools (buildings)
- university and college buildings
- pre-primary schools (buildings)
- secondary schools (buildings)
- academies (buildings)
- junior high schools (buildings)
- elementary schools (buildings)

matches

exact:

- <http://vocab.getty.edu/aat/300006495>

Figure 35 Building (Functional) Type detail, accessed via hyperlink on Building Record page

4.2.2.6 Dating Field Requirement

Is there an area to contribute dating information on the building?

Because dating and time period information regarding when a building was built can come in different formats, and can be hard to verify without additional research, this information was grouped in the set of information that could potentially be provided in the free text field (Figure 36).

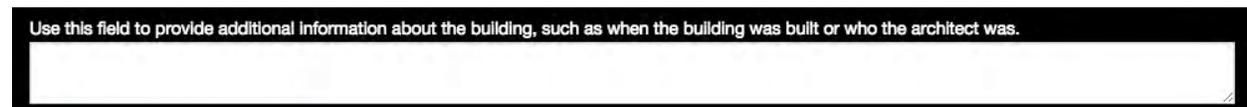


Figure 36 Free text field on Contribute page

4.2.2.7 Condition Status Field Requirement

Are users able to contribute information on the basic condition status of a building?

This information was not required, but because it provides basic information on whether the building still exists, it was included (Figure 37). By making the dropdown choices simple, most users who have had a recent experience with or a photograph of the building can compare that with the original photograph to determine whether the building is unaltered, altered, or demolished.



Figure 37 Current Condition State dropdown list detail on Contribute page

4.2.3 Crowdsourcing Task Requirements

The crowdsourcing requirements for the web application relate directly to the submittal of contributions by users who have logged into the site. Three types of contributory tasks -- correction, contextualization, and classification -- have been included in the web application.

4.2.3.1 Correction Task Requirement

Are users able to submit an edit regarding the location of each record?

This was answered in Section 4.2.2.4.

4.2.3.2 Contextualization Task Requirement

Are users able to submit a free text description that may enhance understanding of a record's significance?

While contributors are given suggested topics for the free text description, they can provide any type of information or narrative in the free text field (see Figure 35).

4.2.3.3 Classification Requirement

Are users able to classify each record in regards to building type?

This question was answered by Section 4.2.2.5.

CHAPTER FIVE: DISCUSSION AND CONCLUSIONS

In this final chapter, the web application's observed strengths and weaknesses will be discussed. This discussion will then lead into a summary of the next steps for the project and the web application. Building upon this, an example of an emerging trend in online heritage inventories, the Arches platform, will be explored with possible implications for this project in the future.

5.1 Application Strengths

The evaluation in Section 4.2 demonstrated that the application fulfilled the minimum requirements that were determined in Section 3.1.1.2. This section will further outline the strengths of the web application, and also, discuss the strengths of the resulting web application model.

Generally, the web application's strengths are as follows: (1) it publicizes Art Deco buildings that might not necessarily be well known in the area; (2) it invites anyone to get involved and contribute information to each record that might be able to be used by others in the process of conservation; (3) it is easy to use and can be accessed on any computer or device that has an internet connection; and (4) it incorporates heritage inventory data standards so that the eventual collected information can be useful for inclusion in a statutory or other type of heritage inventory that follows best practices.

As mention in Section 3.1.1.1, part of the purpose of this project is to develop the web application in such a way that it can serve as a web application model for others. Taking this into account, the web application model's strengths are: (1) it does not require advanced database management setup and maintenance skills; (2) once the code repository is opened on Bitbucket, the code can be customized and extended to better suit a project's requirements; (3) the

application's components are either free or relatively inexpensive compared to setting up similar services hosted on one's own servers; and (4) it enables technically skilled individuals to become involved in cultural heritage conservation.

5.2 Application Weaknesses

The web application's weaknesses stem from the execution of some of its strengths. For example, while in theory, anyone can contribute to the project, one major hurdle to overcome is the local language. The official language in Vietnam is Vietnamese, and while English is becoming more popular as a second language for the younger generation (Nguyen 2012), the majority of the population speaks Vietnamese. As a result, the web application is effectively inaccessible to most of the local community, many of whom might have relevant information to contribute. For this reason, translation of the web application into Vietnamese is included in the application's roadmap for future development.

In terms of publicizing Art Deco buildings that are not well known, because the project started with a smaller survey area, much smaller than the entire Hanoi metropolitan area, there are likely many more Art Deco buildings that can be included. However, the application currently lacks the ability to add new records, which would facilitate the real discovery of possibly underappreciated buildings of the style and era. Again, this functionality has been placed on the roadmap as a high priority item. Also related to this as a medium priority is the ability to load photographs without the need for contributors to host the image somewhere else and generate a URL. Photographs are the main source of information for these buildings so far, and not being able to load new photograph without this barrier limits the amount of information about the existing records that can be collected.

Also, in regards to recording additional information, the application does not have a way to record a user's location on the map using mobile geotracking or geolocation. The application is already responsive and as such, is optimized to be viewable on a tablet or mobile device. Adding the ability to see and record actual spatial coordinates will add a new level of usefulness for those who might want to use the application as a survey tool. There are several ways that this can be accomplished without creating a non-browser-based mobile application. The application uses the Leaflet javascript library to serve the map, and a Leaflet plug-in, Leaflet.Locate, provides the ability to geotrack the user on the map. In addition, Esri has some developer tools that prompt additional research, such as its Geotrigger Service, which can alert users when they are near a recorded building site and can prompt them to record or confirm information.

On the administrative side, no application interface exists to manage, vet, and push contributions to the main record. Currently, the administrator will have to perform that analysis through a comparison of the hanoifrenchcolonial and hanoifrenchcolonial_contributions tables. This does not even take into account the veracity or accuracy of the contributions, and perhaps a public vetting process is also in order.

In regards to using the web application as a development model for similar projects, apart from the already-mentioned weaknesses of the application itself, implementation will require some technical expertise and programming experience, despite all efforts to make the application as easy to implement as possible, with the use of several different user-friendly web services. In order to counteract this, the Bitbucket repository will not be made accessible until good documentation for installation and usage is included.

5.3 Application Roadmap

During the development process, it became clear that there were some features that would improve the web application despite not being within the scope of the initial requirements or perhaps being too difficult at this stage to program or implement. These, along with other initiatives, have been included in the web application’s roadmap for future development, which has been categorized by level of importance (Table 13).

Table 13 Web Application Roadmap

| Future Web Application Feature or Activity | Importance | Notes |
|---|-------------------|---|
| Translation into Vietnamese | High | This would expand the possible contributor pool for the project area. |
| Ability to add new records via application | High | This would allow contributors the ability to add records from outside the pilot survey area. |
| Refine navigation | Low | Once the site has more records and information, this would help users to find what they are looking for. |
| Integrated interface to manage contributions | Medium | This would give the application administrator and/or users the ability to vet contributions and push changes to the main record. |
| Ability to upload images without user-supplied URL | Medium | This would give users the ability to include an image with a contribution without having to host the image online. |
| Add geotracking/geolocation ability to map | Medium | This would give users the ability to see and record their actual location in relation to the building records while viewing and/or contribution to the application. |
| Open Git repository on Bitbucket and provide documentation for web application model implementation | High | This would allow others the ability to implement and improve the web application model. |
| Secondary evaluation activities described in Section 3.2.2. | Medium | This would provide an actual user perspective to the evaluation of the web application. |

The importance of each item on the roadmap is determined by looking at the item's ability to improve the project as well as the ease of execution and amount of effort. For example, the ability to add new records is a feature that does not currently exist for contributors and would expand the amount of data collected on Art Deco buildings in Hanoi and possibly beyond. Whereas, refining the navigation only marginally improves the user's experience and might require a substantial amount of programming to execute.

5.4 Future Trends

For online heritage inventories, future trends involve leveraging new semantic technologies and incorporating geospatial features more heavily. An illustration of this will be described below.

In 2013, the Arches Project, a joint effort between the Getty Conservation Institute and the World Monuments Fund, released the first version of a purpose-built geospatial immovable heritage inventory and management system as free open source software. It is an enterprise-level, server-hosted platform that is accessed via a web browser and can be used as is or customized for each individual deployment. In 2015, the project released a third version of the inventory platform, Arches Version 3.0. This version restructured the platform to include a core system, Arches Server, that serves as the backbone for various Arches web applications, such as the Arches Heritage Inventory Package (HIP) web application, which provides a heritage inventory data model and user interface. The system consists of four basic components: (1) a server tier built in Django using Python; (2) a responsively designed user interface built using Bootstrap, Javascript, and CSS; (3) a PostGIS/PostgreSQL database; and (4) a semantically-driven search engine powered by Elasticsearch.

One of the goals of the project is to provide an inventory platform to cultural heritage organizations that incorporates the latest semantic technologies to facilitate data interoperability,

longevity, and discoverability. To that end, the Arches platform models its data through a graph structure that incorporates an ontology based on the CIDOC Conceptual Reference Model (CRM). The CIDOC CRM ontology is an event-based model that creates defined relationships (Properties) between entity types (Classes). For example, a historic place would be given a class number of E18, which represents a Physical Thing, and its name would be given a class number of E41, which represents an Appellation. The relationship between them is defined through a property number of P1, which says that the historic place (E18) “is identified by” an appellation (E41). Working in conjunction with this was the unpublished data standard mentioned earlier, the *International Core Data Standard for Archaeological and Architectural Heritage*.

Another way in which Arches supports its semantic goals is through its Reference Data Manager (RDM) module, which manages controlled vocabularies for the dropdown fields in the Arches data entry forms. The RDM is compliant with the Simple Knowledge Organization System (SKOS), which is a set of specifications that take advantage of the Resource Description Framework (RDF) to represent knowledge systems such as controlled vocabularies, taxonomies, and classification schemes. Currently, SKOS specifications are published as World Wide Web Consortium (W3C) Recommendations.

Despite the complexity of the Arches system, much of that complexity is hidden via a highly usable user interface for both those interacting with the public face of the system to view and search through the data and those editing and managing the data by logging into the system. The geospatial capabilities allow for the assignment of multiple types of geometries to a single record, as well as the in-system geometry digitization for defining a site location as well as a search area.

Arches was not used for this project because of several factors. At the time of the initial development of this project, Arches Version 2.0 was the stable version of the software, and the system setup required technical knowledge that is beyond what most heritage professionals would reasonably have. Version 3.0 streamlines the setup process significantly, but even in this case, customization from the generic Arches inventory application requires intermediate programming skills in Python and JavaScript. In addition, in order to deploy a functional version of the Arches platform, investment in and management of a server, whether traditional or cloud-based, would be required. Arches is a robust system, and taking into account the setup of the PostGIS/PostgreSQL database and ElasticSearch engine that it depends on, as well as other requirements, it does not fit the goals of this project. In addition, at the time of development of this project, it did not have an internal contributor workflow in place to deal with the requirements of crowdsourcing information.

However, because the data fields for the web application are based on similar standards to Arches, it should be possible to import the information from the web application to Arches once enough information has been gathered through user contributions.

5.5 Final Thoughts

In April 2015, a colleague was able to visit Hanoi and take photos of many of the Art Deco buildings in the project area. As a result, it was confirmed that after almost three years since the June 2012 survey, 14 out of the 24 Art Deco buildings in the project are still extant, many in a similar condition or improved. While this can be attributed to the project area being in the French Quarter, a well preserved part of Hanoi that houses many government buildings and tourist sites, it is still a heartening indicator that at least some of the French Colonial architectural heritage in the city is of value to the area.

Hopefully, this project will grow to contribute to a sense in the community that these buildings are worthy of conservation, not just in the tourist areas, but also in areas that might not traditionally be considered part of the usual tourist routes. There are many instances of urban landscapes that were preserved because of benign neglect or some similar type of conservation by accident that later experienced a resurgence due to the numbers of extant historic buildings.

An example of this is the Downtown Los Angeles area. For much of the latter part of the 20th century, Downtown Los Angeles was considered an undesirable place to be within the city, for both work and personal pursuits. As a result, little development took place within the area and the existing early 20th century commercial buildings stood with retail establishments on the street level but with upper floors that were often used for storage or data centers. But the point is that the buildings stood. In the beginning of the 21st century, people began to move into the historic buildings as a city ordinance made it easier to redevelop the commercial buildings for residential purposes. And in 2014, the New York Times named Downtown Los Angeles as the fifth highest ranked place out of 52 to visit in the world for its emerging food scene and the historic environment in which it is flourishing.

This example shows that public opinion about the built environment can change over time and that a built environment rich in history can be of great value to a community. The French Quarter and Old Quarter areas of Hanoi are definitely prized for their unique character, but other historic areas of the city might just be waiting for their time to be rediscovered. And this is the important role that cultural heritage inventories have to play. They have the power to alert policy makers, community members, and visitors to the presence of other lesser-known places that can contribute to the economic livelihood, environmental quality, and overall experience of a city.

REFERENCES

Council of Europe. 1985. *Convention for the Protection of the Architectural Heritage of Europe*.

<http://conventions.coe.int/Treaty/en/Treaties/Html/121.htm>

Council of Europe. 2012. *Guidelines on Cultural Heritage: Technical Tools for Heritage*

Conservation and Management. Strasburg: Council of Europe. September.

Girard, Greg. 2007. *Phantom Shanghai*. Toronto: The Magenta Foundation.

Gonzales, Hector, Halevy, Alon Y., Jensen, Christian S., Langen, Anno, Madhavan, Jayant,

Shapley, Rebecca, Shen, Warren, Goldberg-Kidon, Jonathan. 2010. "Google Fusion Tables: Web-Centered Data Management and Collaboration." *Proceedings of the ACM SIGMOD conference*. <http://www.cs.washington.edu/homes/alon/files/sigmod10.pdf>

Grayson, Gillian, Janet Hansen, Daniele Pini, David Myers, and Jeffrey Levin. 2013. "Taking

Stock: A Discussion about Inventories and Heritage Decision Making." *Conservation Perspectives: The GCI Newsletter*. Volume 28. No. 2: 18-23.

Hanoi, Heritage and Identity. 2010. "Architectural heritage Inventory." Accessed February 17,

2014. <http://www.toulouse-hanoi.org/english/co-operation-initiatives/architectural-and-urban-heritage/architectural-heritage-inventory.html>

Hanoi 2010 Project. 2014. "The Old Quarter of Hanoi." Accessed February 17, 2014.

http://www.hanoi2010.org/uk/pagesEditos.asp?IDPAGE=57&sX_Menu_selectedID=m1_8D9EE853

Ipeirotis, Panagiotis G. 2010. "Analyzing the Amazon Mechanical Turk marketplace." *XRDS* 17, 2 (December 2010), 16-21. <http://doi.acm.org/10.1145/1869086.1869094>

Kaiman, Jonathan. 2012. "Razing History: The Tragic Story of a Beijing Neighborhood's Destruction." *The Atlantic*. February 9.

<http://www.theatlantic.com/international/archive/2012/02/razing-history-the-tragic-story-of-a-beijing-neighborhoods-destruction/252760/>.

Logan, David, and Richard Mackay. 2013. "Inventories and Heritage Management: The Australian Experience." *Conservation Perspectives: The GCI Newsletter*. Volume 28. No. 2: 10-12.

McCarthy, Deirdre. 2013. "Facing Disaster: The Importance of Heritage Inventories in Preparation and Response." *Conservation Perspectives: The GCI Newsletter*. Volume 28. No. 2: 16-17.

Merriam-Webster.com. "Inventory." Accessed August 6, 2015. <http://www.merriam-webster.com/dictionary/inventory>

Morville, Peter. 2004. "User Experience Design." Accessed June 3, 2015.

http://semanticstudios.com/user_experience_design/

Myers, David, Yiannis Avramides, and Alison Dalgity. 2013. "Changing the Heritage Inventory Paradigm." *Conservation Perspectives: The GCI Newsletter*. 28 (2): 4-9.

National Park Service. 2002. *National Register Bulletin 15*. Washington, DC: National Register Publications. Accessed February 8, 2014.

http://www.cr.nps.gov/nr/publications/bulletins/nrb15/nrb15_8.htm

Nguyen, Ngan. 2012. "How English Has Displaced Russian and Other Foreign Languages in Vietnam Since 'Doi Moi.'" *International Journal of Humanities and Social Science*. Volume 2. No. 23, 259-266.

http://www.ijhssnet.com/journals/Vol_2_No_23_December_2012/29.pdf

Nguyen Quang and Hans Detlef Kammeir. 1997. *Case study: Conservation program for the French colonial quarter in Hanoi*. The Economics of Heritage: UNESCO Conference on Adaptive Re-use of Historic Properties in Asia and the Pacific. Hanoi.

Oomen, Johan and Aroyo, Lora. 2011. "Crowdsourcing in the cultural heritage domain: opportunities and challenges." In *Proceedings of the 5th International Conference on Communities and Technologies (C&T '11)*. ACM, New York, NY, USA, 138-149.

<http://doi.acm.org/10.1145/2103354.2103373>

- Sharp, Rob. 2008. "Heritage site in peril: Angkor Wat is falling down." *The Independent.com*.
March 14. <http://www.independent.co.uk/news/world/asia/heritage-site-in-peril-angkor-wat-is-falling-down-795747.html>
- Shirk, Jennifer L., Heidi L. Ballard, Candie C. Wilderman, Tina Phillips, Andrea Wiggins, Rebecca Jordan, Ellen McCallie, Matthew Minarchek, Bruce V. Lewenstein, Marianne E. Krasny, and Rick Bonney. 2012. "Public participation in scientific research: a framework for deliberate design." *Ecology and Society* 17(2): 29. <http://dx.doi.org/10.5751/ES-04705-170229>
- Shirky, Clay. 2010. *Cognitive surplus: Creativity and generosity in a connected age*. New York: Penguin Press.
- Thornes, Robin and John Bold. 1998. *Documenting the Cultural Heritage*. Los Angeles: J. Paul Getty Trust.
- Stokes, Connla. 2010. "Is Hanoi losing its Asian-ness?" *CNN.com*. November 25. <http://travel.cnn.com/explorations/life/skys-limit-hanoi-077265>
- Stone, Peter. 2013. "War and Heritage: Using Inventories to Protect Cultural Property." *Conservation Perspectives: The GCI Newsletter*. Volume 28. No. 2: 13-15.

World Monuments Fund. 2015. "The Watch." Accessed August 6, 2015.

<http://www.wmf.org/watch/about-watch>

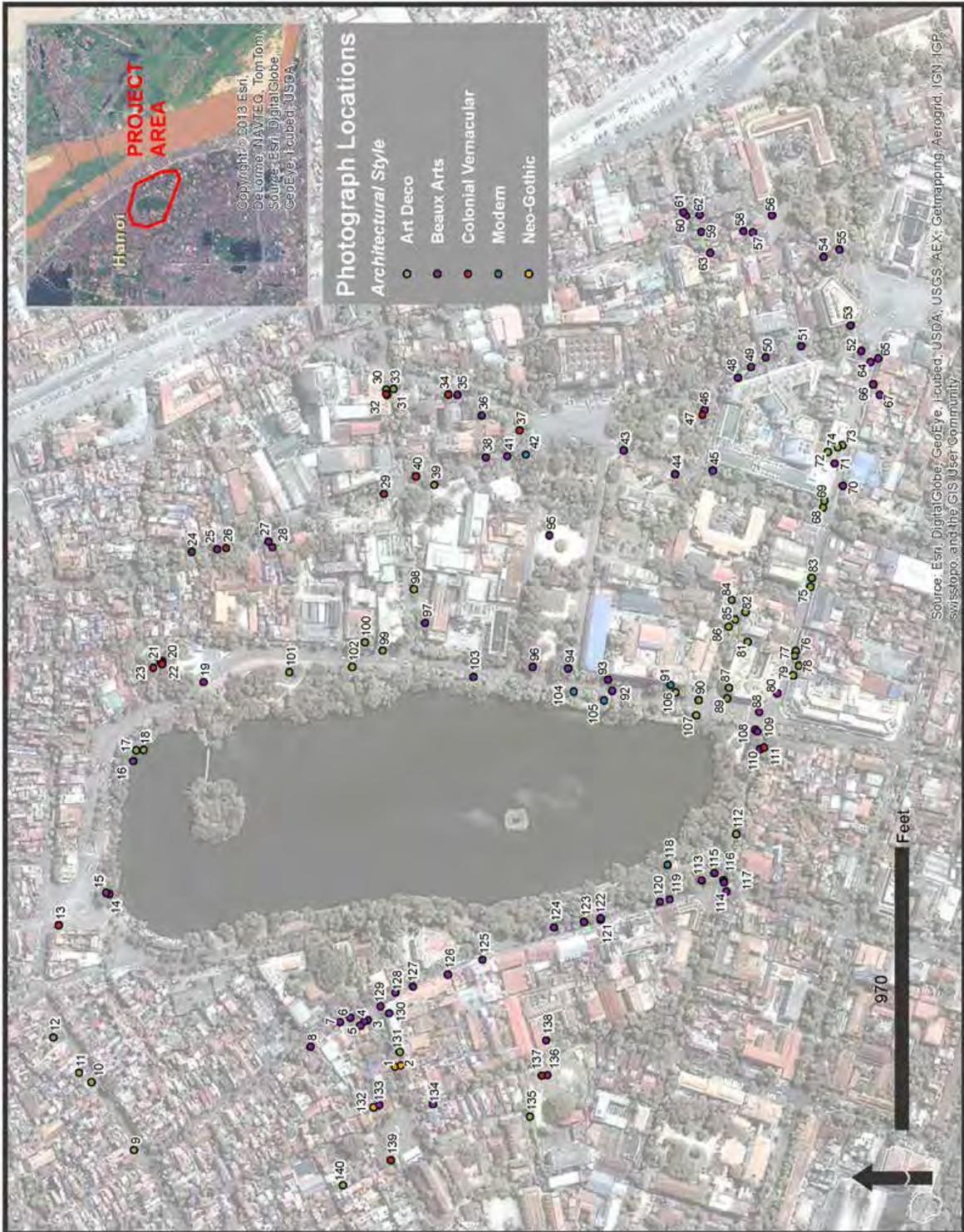
Wright, Gwendolyn. 1991. *The Politics of Design in French Colonial Urbanism*. Chicago: The University of Chicago Press.

APPENDIX A: HANOI INVENTORY



HANOI INVENTORY June 4, 2012







#4

STYLE: BEAUX ARTS

COMMENTS: None.



#5

STYLE: BEAUX ARTS

COMMENTS: Dense tree coverage.



#6

STYLE: BEAUX ARTS

COMMENTS: Trees, signage.



#7

STYLE: BEAUX ARTS

COMMENTS: Trees.



#8

STYLE: BEAUX ARTS

COMMENTS: Trees, Utility wires.



#9

STYLE: ART DECO

COMMENTS: None.



#10

STYLE: ART DECO

COMMENTS: None.



#11

STYLE: ART DECO

COMMENTS: None.



#12

STYLE: ART DECO

COMMENTS: Dense tree coverage.



#13

STYLE: COLONIAL VERNACULAR

COMMENTS: High traffic roundabout.



#14

STYLE: COLONIAL VERNACULAR

COMMENTS: High traffic roundabout.



#15

STYLE: BEAUX ARTS

COMMENTS: None.



#16

STYLE: BEAUX ARTS

COMMENTS: Lakefront location.



#17

STYLE: ART DECO

COMMENTS: Dense tree coverage.



#18

STYLE: ART DECO

COMMENTS: Trees, high traffic.



#19

STYLE: BEAUX ARTS

COMMENTS: High traffic.



#20

STYLE: BEAUX ARTS

COMMENTS: Trees.



#21

STYLE: COLONIAL VERNA CULAR

COMMENTS: Trees, high traffic.



#22

STYLE: COLONIAL VERNACULAR

COMMENTS: Trees, high traffic



#23

STYLE: COLONIAL VERNACULAR

COMMENTS: Trees.



#24

STYLE: BEAUX ARTS

COMMENTS: None.



#25

STYLE: BEAUX ARTS

COMMENTS: Trees.



#26

STYLE: COLONIAL VERNACULAR

COMMENTS: None.



#27

STYLE: BEAUX ARTS

COMMENTS: None.



#28

STYLE: BEAUX ARTS

COMMENTS: Utility wires.



#29

STYLE: COLONIAL VERNACULAR

COMMENTS: Trees.



#30

STYLE: ART DECO

COMMENTS: None.



#31

STYLE: BEAUX ARTS

COMMENTS: Trees, gate, utility wires.



#32

STYLE: COLONIAL VERNACULAR

COMMENTS: Trees.



#33

STYLE: ART DECO

COMMENTS: Trees.



#34

STYLE: COLONIAL VERNACULAR

COMMENTS: None.



#35

STYLE: BEAUX ARTS

COMMENTS: None.



#36

STYLE: BEAUX ARTS

COMMENTS: Trees, gate.



#37

STYLE: COLONIAL VERNACULAR

COMMENTS: Gate.



#38

STYLE: BEAUX ARTS

COMMENTS: Trees, gate.



#39

STYLE: ART DECO

COMMENTS: Dense tree coverage.



#40

STYLE: COLONIAL VERNACULAR

COMMENTS: Trees, utility poles/wires.



#41

STYLE: BEAUX ARTS

COMMENTS: Trees.



#42

STYLE: MODERN

COMMENTS: High traffic roundabout.



#43

STYLE: BEAUX ARTS

COMMENTS: Gate.



#44

STYLE: BEAUX ARTS

COMMENTS: Trees.



#45

STYLE: BEAUX ARTS

COMMENTS: Trees, gate.



#46

STYLE: BEAUX ARTS

COMMENTS: Trees, gate.



#47

STYLE: COLONIAL VERNACULAR

COMMENTS: Trees, gate.



#48

STYLE: BEAUX ARTS

COMMENTS: None.



#49

STYLE: BEAUX ARTS

COMMENTS: Gate.



#50

STYLE: BEAUX ARTS

COMMENTS: Trees, gate.



#51

STYLE: BEAUX ARTS

COMMENTS: Trees.



#52

STYLE: BEAUX ARTS

COMMENTS: High traffic roundabout.



#53

STYLE: BEAUX ARTS

COMMENTS: High traffic roundabout.



#54

STYLE: BEAUX ARTS

COMMENTS: Gate.



#55

STYLE: BEAUX ARTS

COMMENTS: Trees.



#56

STYLE: BEAUX ARTS

COMMENTS: Trees, gate.



#57

STYLE: BEAUX ARTS

COMMENTS: Trees, utility pole.



#58

STYLE: BEAUX ARTS

COMMENTS: Trees.



#59

STYLE: BEAUX ARTS

COMMENTS: Trees.



#60

STYLE: BEAUX ARTS

COMMENTS: None.



#61

STYLE: BEAUX ARTS

COMMENTS: Trees.



#62

STYLE: BEAUX ARTS

COMMENTS: Trees, utility pole/wires.



#63

STYLE: BEAUX ARTS

COMMENTS: Gate, utility wires.



#64

STYLE: BEAUX ARTS

COMMENTS: None.



#65

STYLE: BEAUX ARTS

COMMENTS: None.



#66

STYLE: BEAUX ARTS

COMMENTS: None.



#67

STYLE: BEAUX ARTS

COMMENTS: Trees, Tarp.



#68

STYLE: ART DECO

COMMENTS: None.



#69

STYLE: ART DECO

COMMENTS: None.



#70

STYLE: BEAUX ARTS

COMMENTS: None.



#71

STYLE: BEAUX ARTS

COMMENTS: None.



#72

STYLE: ART DECO

COMMENTS: None.



#73

STYLE: ART DECO

COMMENTS: None.



#74

STYLE: ART DECO

COMMENTS: Dense tree coverage.



#75

STYLE: ART DECO

COMMENTS: None.



#76

STYLE: ART DECO

COMMENTS: None.



#77

STYLE: ART DECO

COMMENTS: None.



#78

STYLE: ART DECO

COMMENTS: None.



#79

STYLE: ART DECO

COMMENTS: None.



#80

STYLE: BEAUX ARTS

COMMENTS: None.



#81

STYLE: ART DECO

COMMENTS: None.



#82

STYLE: ART DECO

COMMENTS: None.



#83

STYLE: ART DECO

COMMENTS: None.



#84

STYLE: ART DECO

COMMENTS: Utility wires.



#85

STYLE: ART DECO

COMMENTS: Trees, utility wires.



#86

STYLE: ART DECO

COMMENTS: Gate.



#87

STYLE: ART DECO

COMMENTS: None.



#88

STYLE: BEAUX ARTS

COMMENTS: Trees.



#89

STYLE: ART DECO

COMMENTS: None.



#90

STYLE: ART DECO

COMMENTS: None.



#91

STYLE: MODERN

COMMENTS: None.



#92

STYLE: BEAUX ARTS

COMMENTS: Trees.



#93

STYLE: BEAUX ARTS

COMMENTS: Trees.



#94

STYLE: BEAUX ARTS

COMMENTS: None.



#95

STYLE: BEAUX ARTS

COMMENTS: None.



#96

STYLE: BEAUX ARTS

COMMENTS: Trees, gate, shrubs.



#97

STYLE: ART DECO

COMMENTS: Trees.



#98

STYLE: ART DECO

COMMENTS: Trees, utility wires.



#99

STYLE: ART DECO

COMMENTS: None.



#100

STYLE: ART DECO

COMMENTS: None.



#101

STYLE: ART DECO

COMMENTS: Trees, high traffic.



#102

STYLE: ART DECO

COMMENTS: Tree, Gate.



#103

STYLE: BEAUX ARTS

COMMENTS: Trees.



#104

STYLE: MODERN

COMMENTS: Trees.



#105

STYLE: MODERN

COMMENTS: Trees.



#106

STYLE: ART DECO

COMMENTS: None.



#107

STYLE: ART DECO

COMMENTS: None.



#108

STYLE: BEAUX ARTS

COMMENTS: None.



#109

STYLE: BEAUX ARTS

COMMENTS: None.



#110

STYLE: BEAUX ARTS

COMMENTS: None.



#111

STYLE: COLONIAL VERNA CULAR

COMMENTS: Trees.



#112

STYLE: ART DECO

COMMENTS: None.



#113

STYLE: BEAUX ARTS

COMMENTS: Trees.



#114

STYLE: BEAUX ARTS

COMMENTS: Trees.



#115

STYLE: BEAUX ARTS

COMMENTS: Trees.



#116

STYLE: BEAUX ARTS

COMMENTS: Trees.



#117

STYLE: BEAUX ARTS

COMMENTS: High traffic.



#118

STYLE: MODERN

COMMENTS: Lakefront location, trees.



#119

STYLE: BEAUX ARTS

COMMENTS: Plants.



#120

STYLE: BEAUX ARTS

COMMENTS: Trees.



#121

STYLE: BEAUX ARTS

COMMENTS: None.



#122

STYLE: BEAUX ARTS

COMMENTS: None.



#123

STYLE: BEAUX ARTS

COMMENTS: None.



#124

STYLE: BEAUX ARTS

COMMENTS: None.



#125

STYLE: BEAUX ARTS

COMMENTS: Trees



#126

STYLE: BEAUX ARTS

COMMENTS: Signage, gate.



#127

STYLE: BEAUX ARTS

COMMENTS: None.



#128

STYLE: BEAUX ARTS

COMMENTS: None.



#129

STYLE: BEAUX ARTS

COMMENTS: None.



#130

STYLE: BEAUX ARTS

COMMENTS: None.



#131

STYLE: ART DECO

COMMENTS: Trees.



#132

STYLE: NEO-GOTHIC

COMMENTS: Trees.



#133

STYLE: BEAUX ARTS

COMMENTS: Trees, utility wires.



#134

STYLE: BEAUX ARTS

COMMENTS: Utility wires.



#135

STYLE: ART DECO

COMMENTS: Trees.



#136

STYLE: BEAUX ARTS

COMMENTS: None.



#137

STYLE: COLONIAL VERNACULAR

COMMENTS: Utility wires.



#138

STYLE: BEAUX ARTS

COMMENTS: None.



#139

STYLE: COLONIAL VERNACULAR

COMMENTS: None.



#140

STYLE: ART DECO

COMMENTS: Trees.

APPENDIX B: ONLINE HERITAGE INVENTORIES

| Name | URL | Description |
|---|---|---|
| Andorra Inventari d'Patrimoni | http://www.cultura.ad/inventari/cercador-inventari-patrimoni | A searchable inventory of cultural heritage in Andorra. Each record includes a photo, key information, and a narrative description. |
| Asian Historical Architecture | http://www.orientalarchitecture.com/index.php | A contributor-based site of photographs, maps, and descriptions for more than 855 Asian historic architectural resources distributed over 21 countries. Each record is represented differently depending on the information contributed. |
| Australian Heritage Database | http://www.environment.gov.au/cgi-bin/ahdb/search.pl | Searchable inventory of heritage resources within Australia that are on the National Heritage, World Heritage, Commonwealth Heritage lists and the Register of the National Estate. Each record contains photos, and narratives regarding history, significance, and description. |
| Australian Heritage Places Inventory | http://www.heritage.gov.au/ahpi/index.html | Searchable inventory of heritage resources within Australia that are contributed by the Commonwealth, State and Territory governments via various registers and statutory lists. Each record has a brief summary with significance, description, and some basic information, with a link to the source of the entry for more detailed information. |
| AZSITE - Arizona's Cultural Resource Inventory | https://azsite3.asurite.ad.asu.edu/azsitepublic/protected/Default.aspx | Public site for state cultural resource inventory GIS. No locations are provided in the public site, which only shows broad information layers, such as resource sensitivity, which displays the extent to which each 1 mile square grid area might have cultural heritage restrictions. An application to the State Historic Preservation Office is required for more information. |
| CRGIS - Pennsylvania Historical and Museum Commission | http://www.portal.state.pa.us/portal/server.pt/community/crgis/3802 | A cultural resources GIS that generates a map of cultural resources based on user inputs. First, the user must conduct a text-based search to obtain a key number for a property that the map will be centered on. Then, the user can select the map layers and areas of interest. After that, the map can be generated. This site requires a login for professional users who need access to sensitive archaeological data, but the public can view all non-sensitive historic resource information. |

| | | |
|--|---|---|
| CyArk | http://archive.cyark.org | A searchable archive of heritage sites that have been digitally documented via laser scanning, photography, and GIS. The archive is relatively small (under 100 sites), but searchable via interactive map or by photo grid. Each record contains access to 3D and 2D imagery, virtual tours, narrative descriptions, and a project specific GIS with interactive layers. |
| GIS-ZH - Canton of Zurich GIS | http://maps.zh.ch/ | The GIS for the Canton of Zurich, Switzerland. This includes numerous layers, including a heritage resource one, that enable spatially-based information searches. |
| Guia Digital del Patrimonio Cultural, Instituto Andaluz del Patrimonio Historico | http://www.iaph.es/web/canales/conoce-el-patrimonio/guia-digital/buscador/ | After selecting a province and city from a dropdown list, users are directed to a page for that area with a launcher for a GIS of the area. The GIS contains all of the heritage resources in the area, with narrative information and links to photographs, panoramas, 3D imagery, videos and other information (if available) housed in the infowindow for each resource. |
| Inventaire du Patrimoine Architectural, Region de Bruxelles-Capitale | http://www.irismonument.be/index.php?lg=fr | A searchable inventory of architectural cultural heritage in Brussels, Belgium. Each record contains images and narratives about each resource. |
| Los Angeles Conservancy - Historic Places | https://www.laconservancy.org/explore-la/historic-places | An inventory of more than 400 historic places in Los Angeles County that is searchable by a filterable map. A summary of each record with an image is available via map infowindow. The full record contains a narrative description, key information, photos, map location, related information, and related locations. |
| National Inventory of Architectural Heritage, Ireland | http://webgis.buildingsofireland.ie/niahviewer/index.html | An esri-powered GIS that enables the display and search of surveyed buildings. Each record has a photograph, some basic information, and a description. |
| National Registry of Historic Sites & Structures in the Philippines | http://nhcphistoricsites.blogspot.com/ | Photos and descriptive information of sites and structures on the National Registry in blog format, searchable by grouped category. |
| New South Wales Heritage Inventory | http://www.environment.nsw.gov.au/heritageapp/heritagesearch.aspx | This searchable inventory contains records for 25,000 heritage items from different agencies/governments within the Australian state of New South Wales. It also features a map-based search for items on the State Heritage Register only. Each record features detailed narratives and photos for each item. |
| SAHRIS - South African Heritage Resource Information System | http://www.sahra.org.za/allsitesfinder | Searchable inventory of heritage sites, including a map based search. |

| | | |
|--|---|--|
| Saint Helena Historic Environment Record | http://www.blackfreighter.net/sainther/ | An searchable inventory of more than 1000 sites and structures on the island of Saint Helena. The search is via name, reference number or significance grade or via the interactive map. Each record contains basic information, historic context and significance, condition, photographs and drawings and possibilities for reuse. |
| UNESCO World Heritage List | http://whc.unesco.org/en/list/ | An interactive map and list of 981 heritage resources that are UNESCO World Heritage-listed. Each record includes photos, narrative descriptions, key information, and map location. |
| US National Register of Historic Places NPS FOCUS | http://nrhp.focus.nps.gov/ | A searchable inventory of heritage resources on the National Register of Historic Places. It features an advanced search on geographic location, subject, name, keywords, and dates. Each record contains information for the searchable fields and links to downloadable PDFs on the resource image and National Register Nomination Form. |
| Victorian Heritage Database | http://vhd.heritage.vic.gov.au/vhd/heritagevic | A searchable inventory of Heritage Places and Precincts within Victoria. Each record contains statements of significance, physical descriptions, historical information, builder, architectural style, photographs and heritage overlay number. A link to a window with Google Map and Street View locations is also included. |
| WISAARD, Washington Information System for Archtiectural and Arcaheological Records Data | https://fortress.wa.gov/dahp/wisaard/ | Architectural and archaeological cultural resource GIS containing locations/records for register and inventory properties. |
| ZIMAS - Zoning Information and Map Access System | http://zimas.lacity.org/ | A GIS powered by the Planning Department of the City of Los Angeles. It features parcel-based information on jurisdictional, planning and zoning areas, tax assessment, and seismic hazards. It also provides basic information indicated whether a parcel has a historic designation or eligibility for designation attached to it. |
| National Heritage List for England | http://list.english-heritage.org.uk/mapsearch.aspx | A searchable inventory of National Heritage Listed buildings, via advanced search and map search. Each record has some descriptive information. |
| Texas Historic Sites Atlas | http://atlas.thc.state.tx.us/index.asp | An esri-powered GIS that displays historic county courthouses, National Register propertoes, State Antiquities Landmarks (Buildings only), Historical Markers, cemeteries, museums, military sites, sawmills, and neighborhood surveys for the State of Texas. Each record has a polygon or point map location and one or more reports, each corresponding to a designation or survey program. |