

DIGITAL SPATIAL EXPERIENCE OF MEDIEVAL CITY IN PRESENT-DAY CONTEXT

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1. INTRODUCTION

Mobile phones today are a lot more than communication devices. The platform with its integrated Internet connectivity brings a whole gamut of possibilities to the developer. Because of the ease of programming these platforms and the rich user experience possible with them, mobile applications have been transformed from simple-minded gaming or content delivery platforms to encompass complete content creation platforms. These applications have now come to fulfill a variety of daily needs such as banking, shopping, social media, travel booking, news, entertainment, etc. Even though the platform's small screen size and limited keyboard area pose challenges for data input, there exist a variety of simple yet rich mechanisms for accepting and validating data that make the task of crowd participation intuitive, fun, and useful. Building such a capability for heritage conservation in digital form is a core idea behind our work.

In the last few decades, heritage conservation has moved from physical restoration to virtual reconstruction, often because of a variety of limitations encountered during physical conservation. Such digitization has opened avenues where close-to-real reconstruction of structures and landscapes have been made using information derived from literature, excavations and historic accounts. However, this is often limited to sites or structures for which systematic information is available, and to projects with adequate funding and technological advances. Besides a few glamorous examples, digital reconstruction of local heritage is rare in most parts of the world, often because of the lack of material or literary evidence, lack of funding, or local administrative lethargy. In many instances, heritage sites or structures have completely vanished with urbanisation. Digital conservation of local heritage is often a challenging task because information is often only available in an unorganised form such as folklores, local history, old books, maps and in collective social memory.

Our current work is an effort to bring this information from diverse sources to people in the form of a mobile app so that people can experience the lost heritage and also contribute to it. Our app gives a composite experience of past overlaid with the present. GIS is a natural choice because among the body of unorganised information, location is the common thread running through all.

2. CASE STUDY

This paper uses Pune, a medieval city in India, as a case study for the workflow involved in digital conservation. Situated on the banks of Mula and Mutha rivers, Pune is central to the Deccan region in peninsular India from both the geographic and political points of view. It provided an ideal location for Bajirao Ballal, popularly known as Peshwa Bajirao I (CE 1700-1740) to shift his base from Satara and develop Pune as the capital city of the Maratha Empire. Prior to this move, Pune existed as a small village whose oldest references date back to 800 CE. Few excavations take back the antiquity of the settlement to the beginning of the christian era (Jogalekar, 2007). It was however well established as the capital city during the time of the Peshwas. Under Peshwa administration, due importance was given to Pune city planning,

hitherto a small village. Major highlights of the city planning included multi-storied mansions, paved roads, 20+ km long underground aqueducts, more than 1200 wells in an eight sq km expanse. More than 300 temples with state-of-the-art *Kalasha* and standard plan existed. A majority of these structures and layouts have vanished in the course of rapid urban growth in the 20th and 21st centuries.

According to the information gathered from the Gazetteer of the Bombay Presidency circa 1885 (Gazetteers of Bombay Presidency, Poona District, 1885), the total area of Pune comprising the wards was 9,828,000 square yards i.e. 8.22 sq km with a total population of 99,421. Present-day Pune refers to the modern city of approximately 240+ sq km and a population exceeding 3 million. The area considered in our work is restricted to the oldest part, which comprises of wards locally known as *Peths*. This gives a rough idea of the current expanse of the city and its growth in less than 150 years.

There are numerous scholarly works available about the royal dynasty of Peshwas, Pune's history under their rule, which includes descriptions of the old city. However, there is little progress in the systematic mapping of the city in the post-colonial period. While Pune and other heritage cells (working under the local municipal corporation, historians, social/non-governmental organisations) have worked on mapping the medieval city, their scope has been limited to identifying well known heritage sites in the city. Their intent is to grade them for their cultural/antiquarian importance which helps prioritize their conservation work.

3. METHODOLOGY

3.1 Data Creation

The Peshwa rule followed by the British colonial era is a topic of detailed study for both Indian and international historians. Many scholarly works describe Pune as the capital city of the Peshwas, elaborating on its prominent features of royal importance (Joshi, 1868; Karmarkar 1925; Diddi, 2000; Tikekar (Ed), 2000). Some notable texts present Pune through the eyes of a geographer and sociologist (Kosambi, 1980, Gokhale, 1988).

Bharat Itihas Samshodhan Mandal (BISM), a local organisation established for historical research in India has published a set of survey reports titled *Pune Nagar Samshodhan Vrutta* (PNSV Vol. 1-4,) between 1943-52 (Ed. Karve, 1943-52). A group of committed citizens voluntarily undertook a detailed survey of the city. Their aim was to document the remains of the Peshwa's capital. The British took control of the city in 1818 marking the end of Peshwa rule. So the PNSV survey was carried out after 125 years of the political shift to the British. Even though the survey did not use a formal methodology of surveying, it described relative locations of the then existing structures, created detailed notes of their conditions, categorised the information and also gave historic descriptions wherever possible. The level of detail and the method of describing features along the roads has immensely helped this project in locating these features. A prominent example is that of the surroundings of the Peshwa royal palace, Shaniwar wada. The residence of noblemen belonging to the royal palace were located in the vicinity and a chapter in PNSV describes them when the authors circumnavigated the palace and recorded the details based on the remains and what could be gleaned from collective social memory. Most of these details exist today only in the text or social memory. Many other texts which provide descriptive accounts of the historic city were also used during this textual data collection. These are listed in the bibliography.

Acquiring the source data in the forms of maps, charts, and sketches is an important step. The Gazetteer of the Bombay Presidency (1885) contains the first authentic administrative record of the city and a map with its ward boundaries that was part of the Bombay Presidency at the time. A 1 Inch: 200 Ft scale map (Light, 1869-72) in the BISM museum helped us understand the overall layout of the old city. Important places and roads identified on this map were used as references to tentatively locate other places. The description of some of these places with reference to nearby temples, mansions, cisterns, etc. from PNSV volumes and other texts helped populate the spatial data. A series of maps titled Poona City Survey (PCS)(Poona City Survey, 1876), from 1876 played a crucial role in pinpointing land structures and underground aqueducts. These maps are drawn to a scale of 1 Inch: 50 Ft and depict plans of big mansions, layouts of temples, burial ground details, etc.

Following the standard georeferencing procedure, we captured features by correlating textual references and maps, resolving conflicting information, performing field verification and connecting with natives. This has resulted in an attribute-rich GIS database. The captured features are categorised in layers of roads, land-use, religious places, public places, administrative buildings, mansions, gates, ward boundaries, natural drainage, artificial underground aqueducts, overground water outlets such as wells, cisterns, dipping wells, etc. The entire exercise is carried out using QGIS and its plugins (QGIS, 2016).

3.2 Conceptualising a Mobile app



The core idea of the paper is to conceptualise the use of a mobile app as a platform for local heritage conservation in digital form.

Careful study, analysis and segregation of unorganised information in the GIS database has made it attribute-rich with spatial accuracy within a few meters. In the present app, for our case study of Pune, the total number of features across all the layers displayed in the map is close to 1000. The application is designed to consume this data in various formats. The idea of providing an experience of the historic past through an app is modelled through this digital mapping. The content creation feature of the app is a mechanism for people participation, as seen in Figure 1.

The information which passes through generations with little or no documentation, or lesser known facts can now be captured, verified, organised and consumed by this local heritage conservation platform.

Figure 1 - Mobile app introduction

At present there are many apps which provide informative content about places from a tourism point of view including information about the place, road/air connectivity, hotels, things to do/see etc. Our mobile app time-slices the data. Local heritage and sense of involvement and

pride in people are its essential components. Many of these places may also not be popular tourist attractions today. This is because either they are completely or partially erased from the landscape, or they are not significant in present day city. However, they may have played a significant role in the past in building the city and that is certainly for Pune as we see today. The prototype app framework is built on AppSheet (AppSheet, 2017). The following sections describe different features available in our mobile app.

3.2.1 Map View

The map view in Figure 2 and Figure 3 shows places of historical importance overlaid on Google Maps, viewable in various categories.



Figure 2 - Categorized information



Figure 3 - View of Mansions

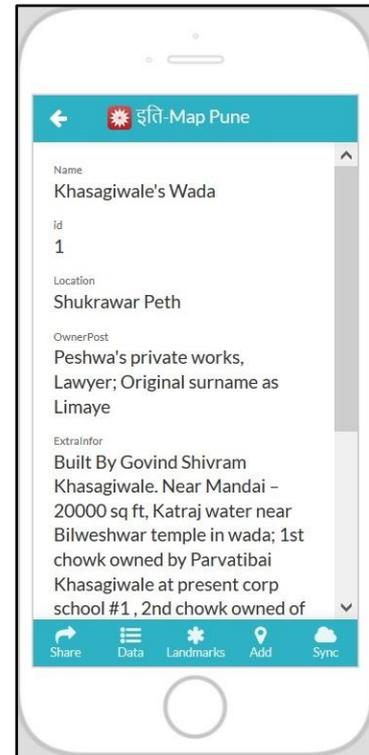


Figure 4 - Information for one of the mansions

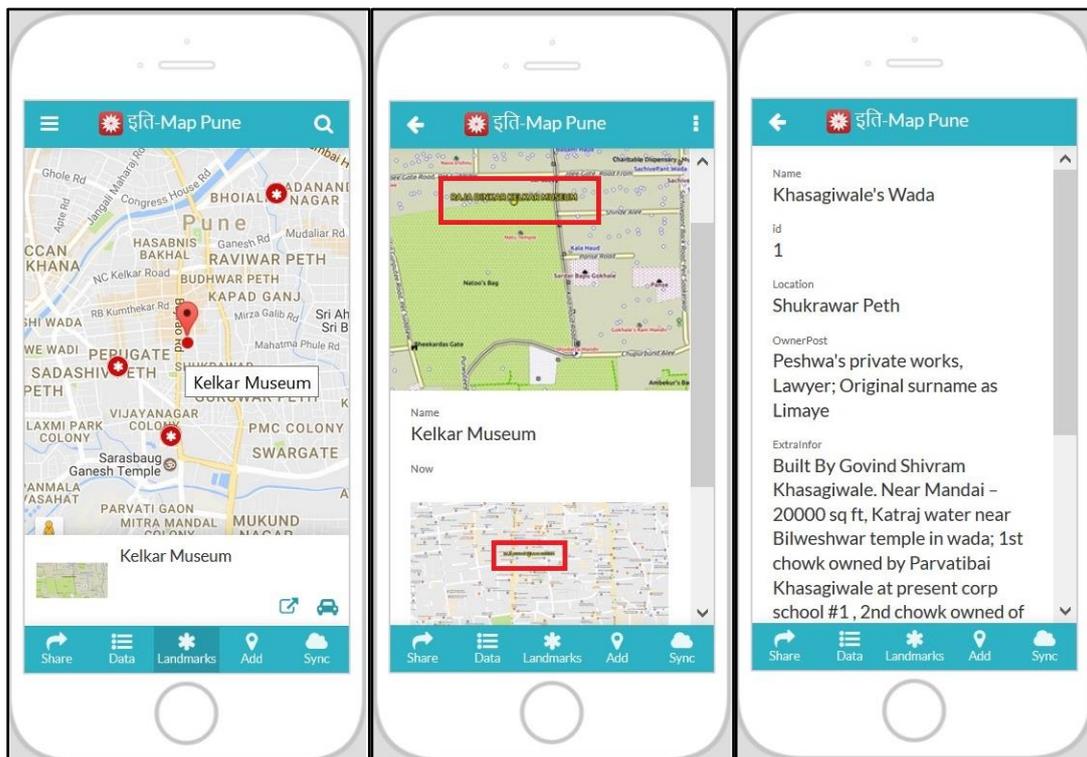
As and when the user navigates the city, documented locations in the vicinity are seamlessly presented on the familiar Google Maps navigation view.

With a single click the user can see detailed information about the locations, old photographs, drawings, map views etc. This data has been collected by collaborating with individuals and organisations, in some cases from open source repositories. The textual information and map views are created using GIS as described in previous sections. This view as seen in Figure 4 is available in view-only mode for the user.

3.2.2 Landmarks View

Historic structures have been replaced or abutted by new establishments over the time. Hence, the present day city is mix of modern urban landscape with traces of historic structures. Today's landmarks significantly vary from what defined the Peshwa's capital in 18th century. Some of these landmarks have been identified for this view. The legacy of their location is portrayed by creating views with an overlay of historical maps generated in GIS, depicted in Figure 5 and

Figure 6. 3D views of this information provide realistic picture of the historic landscape. Figure 7 shows 3D view of aqueducts built during Peshwa period.



**Figure 5 -
Landmarks view**

**Figure 6 -
Then and Now View**

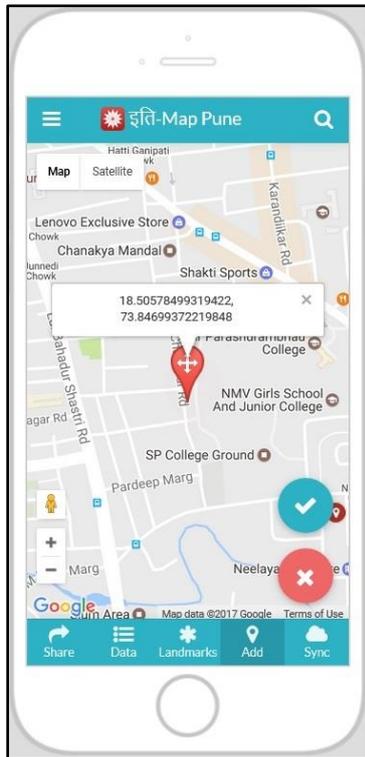
**Figure 7 -
3D view - Aqueducts**

3.2.3 Crowdsourcing view

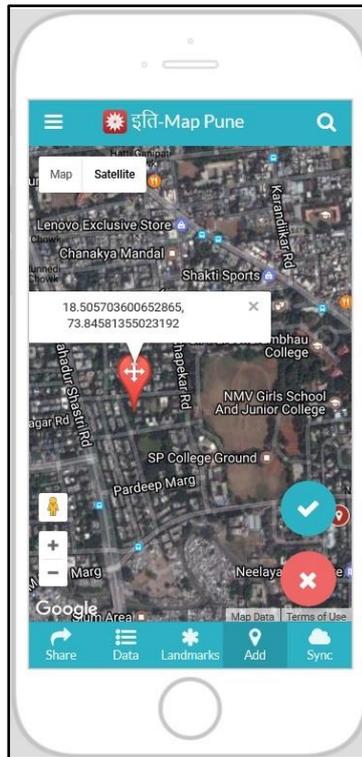
It is clear that the task of information capture for such densely populated, feature-rich and well planned city cannot be a single person effort. It is also understood that in a city like Pune, a number of historic structures are well known only to the people in close vicinity of those structures. For people outside the neighbourhood, they are almost non-existent. Using crowdsourcing by using the local population to contribute to the available information becomes invaluable in such situations.

The mobile app is designed to capture the stories and information which are often passed on through generations in those localities. Users are equipped to locate themselves in the present-day map and the historic city at the same time and then contribute information by simply adding a point on the map at the correct location as shown in Figure 8 and Figure 9. Users can also use mobile inbuilt GPS for locating themselves.

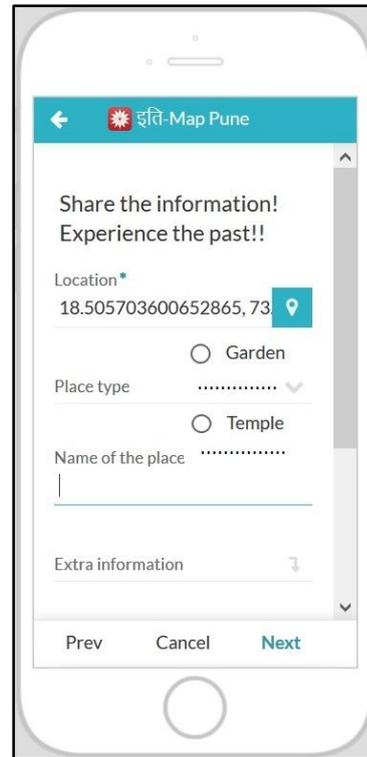
The app collects the information in a predefined format however, this is different collection than the one used in the map view. The first page of this form can be seen in Figure 10. In addition to their own contribution, users can see all the locations and information added by other users.



**Figure 8 -
Locate place with map**



**Figure 9 -
Locate place on image**



**Figure 10 -
Add Information**

The most important requirement is that users provide the source of their information, seen in Figure 11. It creates a verification pointer for the app author.

At present, the verification process is manual because the sources of information are unorganised in nature. They vary in data types i.e paper, electronic, books (some out of print today), articles, maps of different scales etc. In all these sources, the level of details and language (English, old Marathi in old *Modi* script, contemporary Marathi) are additional dimensions. After validating the details, the information is added to the main dataset which is displayed in the map view. A sample survey conducted for the design of this module gave valuable inputs relating to usability and performance. The ability to locate a place without having GPS switched on is an important add-on.

3.2.4 Walk-through view

The GIS database hosted in the cloud is made available to the app which enables providing a walk-through of the historic city. In addition to information such as point data, a walk-through also depicts old roads, residential and other land use areas, mansion layouts, rivulets, etc. As seen in Figure 12, it can locate the user based on their GPS position, the user experiences walking in the 200 year old city along with present day satellite imagery in the background.

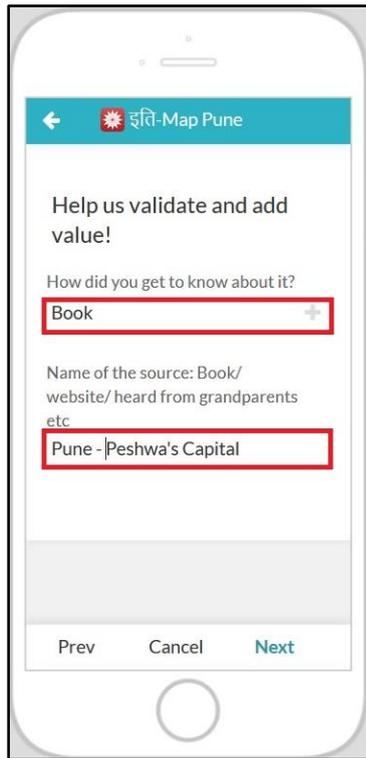


Figure 11 - Crowdsourcing - Add Source



Figure 12 - Walk-through View

4. CONCLUSION

This is probably the first time that an attempt has been made to digitally map the historic past of Pune with the intention of creating a comprehensive GIS database. Using it for heritage documentation and conservation in a mobile app framework has brought up newer prospects in the field.

4.1 The Peshwas's town-planning strategy

Spatial analysis of the GIS data has revealed several interesting facts about the functioning of the city and the Peshwa's town-planning effort for the benefit of their subjects. Some of the examples are as follows.

- We observe that more than 80% of the residential area was serviceable by the artificial water supply system. The underground aqueduct network was laid out to be parallel to the roads in the city.
- Gates i.e., checkpoints seem to be located at strategic locations around ward boundaries, important cross-roads etc. In well planned wards, the roads are systematically laid out in a grid pattern following cardinal directions.
- Areas were identified that appeared to be dedicated for traded goods and their market, which to some extent serve the same purpose today. Examples of these areas include Meethgunj (salt market) and Kapadgunj (cloth market).

- The temples dedicated to Hanuman/Maruti (deity worshipped as village guardians) were generally erected at the boundaries of the village. The gradual expansion of the city which happened during Peshwa rule can also be seen through the emergence of Maruti temples on the changing and expanding boundaries of the wards and the city.

The intensive data capture brought out the parity between texts and maps coming from different sources. As an example, the Gazetteer mentioned the city having 1290 wells, whereas a total of 1295 wells were located in the maps.

4.2 Mobile app experience

This mobile app extends the idea of heritage appreciation to creating a platform for people to experience the local heritage and become part of it. It does not remain in the realm of history or any specific academic faculty but becomes an experience for common people. The ability for people to contribute makes them an integral part of the system. The framework in Figure 13 for data collection, verification and visualisation - both textual and graphic, is generic. This concept of combining the past with present in a spatial context is not limited to the present study of Pune in 18th century CE. It can be extended in both space and time, capturing data across the lands going back in time.

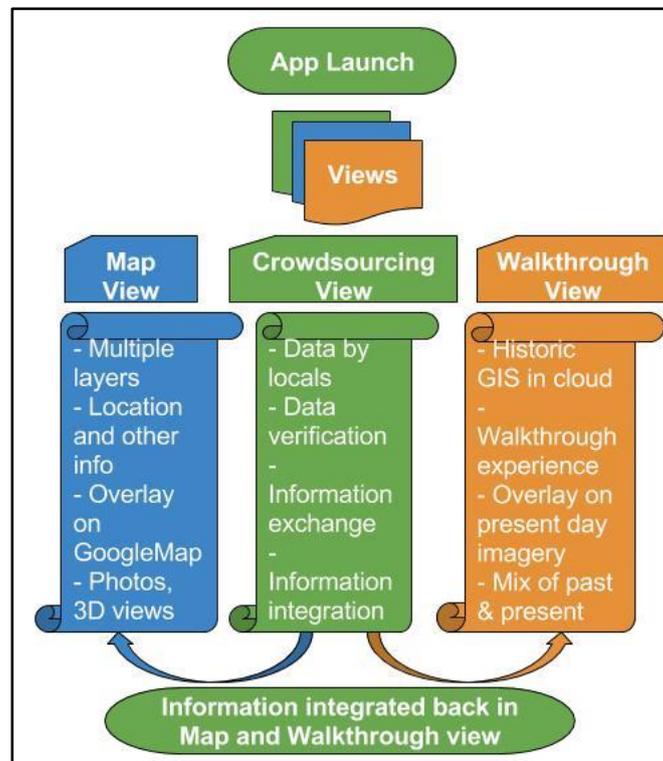


Figure 13 - Mobile app workflow

4.3 Future Scope

We have barely scratched the surface of using crowdsourcing for building a complete, robust database for digital heritage preservation. The GIS database integrated in the mobile app opens a world of possibilities. From a heritage conservation point of view, the next steps would include (1) granular time slicing, (2) immersive visualisations, (3) automated method for data

verification and incorporation and, (4) adding heritage places listed by the municipal corporation. Also, for attracting a wider user base, features such as creating location based pop-up alerts for places, virtual heritage walks can be created. There are prospects for Pokémon Go like gamification of this data. The most important and crucial part is creating a self sustaining model of this digital conservation workflow because heritage conservation is generally on lower priorities in the local municipal budgets. Sponsored competitions of photography or data collection at the heritage locations, exploring hyperlocal concepts, using this platform for advertising the local business are some of the kick-starter ideas for monetising this framework.

5. ACKNOWLEDGEMENTS

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