Mobile GIS for Cultural Heritage Preservation: A Case Study of Monument Recording in Kandy Heritage City

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1. Introduction

The utilization of GIS in archaeology has undergone a significant evolution in the past twenty years, driven by technological advancements. This evolution encompasses visualizing historic landscapes and heritage database management to predictive modeling and comprehensive spatial analysis that interpret past human behaviors. Mobile Geographic Information System (MGIS) has become increasingly popular in archaeological data collection in recent years. The MGIS extends traditional desktop GIS beyond the offices and allows individuals and organizations to localize, collect, store, visualize and even analyze geospatial data in the field (Gao & Mai, 2017). This system is used in mobile devices such as smartphones and tablets. Handheld GPS devices which were relatively expensive and commonly used in archaeological surveys in earlier decades have largely been replaced by tablets and smartphones with inbuilt GPS (Chyla & Buławka, 2020). MGIS allows archeologists with minimal or no GIS experience to record site locations, enter attribute data on customized digital forms, and attach photographs (Lindsay & Kong, 2020). Thus, MGIS is user-friendly requiring partial training and no expert knowledge required as in traditional GIS. This method revolutionized archaeology's surveying and recording techniques making it easier, faster, and more cost-effective. Recent studies from Greece and Argentina show that efficiency and cost-effectiveness are the major reasons for using MGIS for large-scale surface archaeological surveys (Fabrega-Alvarez & Lynch, 2022; Sgouropoulos et al., 2024). In this study, ArcGIS Survey 123 has been used to record 488 historically significant buildings both religious and secular- located within the Kandy Heritage City and scattered over 28 square kilometers. Kandy, the last kingdom of Sri Lanka was inscribed in the World Heritage list as the “Sacred City of Kandy” in 1988 under the criteria iv and vi (UNESCO, 2024).

2. Materials and Methods

The workflow of this study contains four main steps as illustrated in figure 1. These four steps consist of survey design, field data collection, data management, and data analysis.

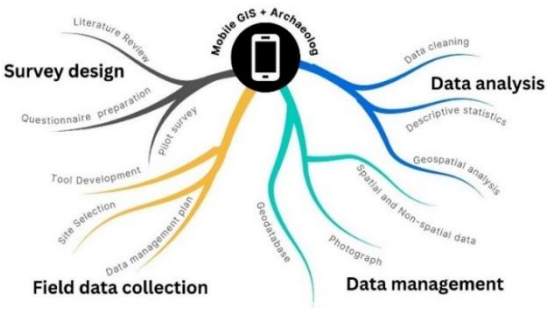

Figure 1: The flow of the study

The study begins with a survey design which involves a literature review, preparing

questionnaires, developing the survey tools, and conducting a pilot survey to test the approach. The next step is field data collection where selected sites are surveyed, data is managed systematically and a geodatabase is created to store spatial and non-spatial information. Data management included spatial and descriptive data with a photograph. Finally, the data analysis was carried out through data cleaning, running descriptive statistics, and performing geospatial analysis to achieve the objectives. In this study, ArcGIS Survey123-a mobile GIS application developed by Esri-was utilized which enables users to collect, manage, and analyze field data through a customizable survey form. It helps users to create forms with different question types such as text, multiple-choice, and geolocation-based inputs. However, the accuracy of the GPS coordinates taken by mobile phones creates a major limitation in MGIS, especially for developing countries like Sri Lanka. In this survey, a mobile GIS approach was used to record the condition of these conserved buildings and to develop a database for analysis purposes. A list of 488 listed monuments in the Kandy Heritage City prepared by the Central Cultural Fund in 1992 has been employed to identify the historically important buildings in the city.

3. Results and Discussion

By using ArcGIS Survey123, 488 listed monuments of Kandy Heritage City by the Central Cultural Fund in 1992 were recorded within a month with a minimum budget. The delays were mainly caused by heavy traffic obstructing the photography of monuments. The survey also revealed that 115 out of these 488 (23.5%) listed monuments are declared by the government gazette as monuments. Over 65% of buildings listed as monuments are commercial buildings while 15% are residential. 5% of them are shophouses with both residential and commercial characters and there were a similar amount of religious monuments as well (Figure 2). Many of these are Buddhist religious monuments located in the Sacred Area of the city which consist of the Temple of the Tooth Relic, the four *develes*, Kandy Lake, Malwatta and Asigriya Temples, and a part of Udawatta Kele forest reserve which primarily contributed to the World Heritage status of the city. While 19% of the listed monuments date back to the Kandyan period mainly being religious, the rest shows early and mid-20th-century British colonial architecture. A typical British colonial period building is two-storied with an arched verandah on the ground floor and a verandah with doric columns on the first floor, the vogue of the era which could also be seen in Colombo and Galle. The oldest monumental buildings still have half-round tiled roofs. Nearly, half of these monumental buildings are two-storied buildings despite their later modifications contributing to the overall streetscape of the city. Approximately 6.5% of the buildings have been renovated to exceed three floors which is not compatible with the traditional streetscape, given that the prescribed building height in the city is 40 feet. While 9% of the structures have remained unchanged over time, 86% have been modernized due to the commercialization and urbanization of Kandy, the second-largest city in Sri Lanka, and the economic and administrative capital of Central Province. The addition of new floors and modern glass shop windows could be seen in most of these modernized buildings despite the heritage regulations. The preservation status of religious monuments is notably superior to that of secular buildings, including shops and residential structures which are also designated as monuments. Furthermore, the adaptive reuse of some of the heritage monuments funded by the government like Giragama Walawwa in Yatinuwara Veediya has become very successful.

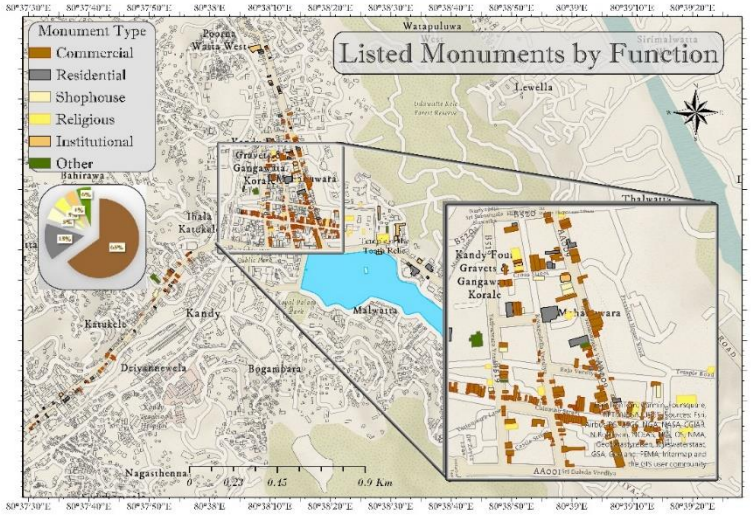

Figure2: Listed monuments (1992) by current function, Kandy Heritage City

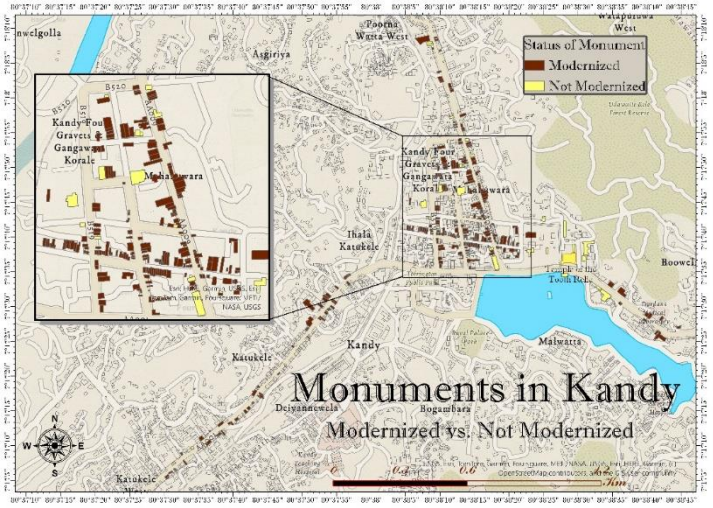

Figure 3: The current condition of listed monuments (1992): modernized vs. not modernized

4. Conclusion

This research confirms that ArcGIS Survey 123 is an efficient and cost-effective MGIS method to record and analyze a large number of monuments scattered over a large area. Variations between the actual and recorded coordinates through mobile GIS reduce the accuracy of the data, posing a major limitation in this study. Moreover, the absence of a geospatial database to accurately cross-reference addresses within the study area to their exact coordinates poses an additional challenge throughout the study. Despite these limitations, the study demonstrated that MGIS is a cost-effective and efficient method for low-budget heritage monument recording projects, particularly in countries like Sri Lanka which is currently experiencing an economic crisis. The survey revealed that over 85% of the listed monuments by the Central Cultural Fund at the inception of World Heritage in Kandy have been modernized, nonetheless the strict heritage regulations. 85% of the listed monuments are privately owned shops, houses, and shophouses that have evolved over three decades to prioritize contemporary business and living standards. This is a natural process that happens in any city with the time being. In contrast, the religious monuments of Kandy are well preserved when compared to the secular buildings. The Sacred Area of the city, which includes the Temple of the Tooth Relic, four

devales, Kandy Lake, Malwatta and Asgiriya Temples, and part of Udawatta Kele, is recognized as a World Heritage property in legal terms. Consequently, the monuments in this area receive more consideration in terms of heritage conservation. Thus, religious buildings are prioritized in the conservation process as they contribute to the authenticity of the World Heritage City with spiritual significance attracting visitors. Although height restrictions are mostly maintained in the streetscape, the older appearance of listed monumental buildings in the commercial area, primarily the shops and shophouses has diminished leading to ordinary modern streetscapes in Kandy which is notably a historic city. The research emphasizes the requirement of initiating proper monitoring mechanisms to protect the listed monuments as well as the ability to use cost-effective and efficient methods like MGIS in this process. However, the modernization and the change of the conserved secular buildings also show the requirement of heritage laws that can address the contemporary needs of the city dwellers and the business community. The work also shows that the adaptive reuse of a few commercial buildings identified as monuments has been remarkably successful which has slowly created a sustainable trend to renew business places protecting the heritage value. In conclusion, this research, based on MGIS data collection and analysis techniques, emphasizes the importance of giving considerable attention to protecting the traditional streetscapes of Kandy, as the city's historicity lies not only in the Sacred Area but in the whole city itself as a historic urban landscape.

5. Acknowledgment

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