



A Comprehensive User Experience Analysis of Cultural Heritage Progressive Web App Using A Hybrid UEQ-IPA Approach

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This study utilised a user-centred design (UCD) approach integrated into the Agile framework to develop Sarawak Cultural Heritage Progressive Web Apps (SCHPWA). The user experience (UX) of SCHPWA was evaluated using a combination of the User Experience Questionnaire (UEQ) and Importance-Performance Analysis (IPA) to measure six dimensions of UX. The evaluation involved 239 participants, comprising 184 females and 55 males. The results indicated that the SCHPWA scored above average in attractiveness, perspicuity, efficiency, and stimulation. However, the dimensions of novelty and dependability scored below average. Therefore, the attributes related to attractiveness, efficiency, stimulation, and perspicuity are grouped using IPA under Quadrant 2 (Possible Overkill), while novelty and dependability fall under Quadrant 3 (Low Priority). The study highlights the benefits of using a combination of UEQ and IPA for evaluating Progressive Web Applications (PWA). Furthermore, it suggests the potential to improve the UX of cultural heritage PWAs. These findings offer insights for designers and developers in optimising the UX of cultural heritage PWA.

CCS CONCEPTS•Human-centered computing~Ubiquitous and mobile computing~Empirical studies in ubiquitous and mobile computing •Information systems~Information systems applications~Collaborative and social computing systems and tools

Additional Keywords and Phrases: Cultural Heritage, Digitization, Progressive Web Apps, User Experience

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1. INTRODUCTION

Culture is an integral part of a person's identity and is intricately linked to their sense of belonging, background, and heritage. Cultural assets can be broadly classified into two categories: tangible and intangible. Intangible cultural heritage comprises practices, representations, expressions, knowledge, and know-how passed down from one generation to another within communities. These practices are continually evolving and transformed by communities based on the environment, history and interaction with nature [1]. In contrast, tangible heritage refers to physical artefacts such as sculptures, manuscripts, monuments, archaeological sites and shipwrecks. However, both tangible and intangible heritages are susceptible to extinction over time.

The advent of the internet has enabled the preservation of cultural heritage by converting analogue data into digital form. The concept of digital cultural heritage is based on the understanding that cultural heritage is fragile and vulnerable to destruction during times of war [2, 3, 4, 5] and disasters [6] or environmental pollution [7, 8]. Digitisation involves creating digital artefacts by converting pictorial, graphical, or textual inputs from their original physical attributes using electronic devices [9]. Digitisation is crucial in cases where cultural heritage sites have been destroyed or damaged, such as the destruction of the Temple of Baal, one of the oldest and most culturally significant pieces of architecture, by terrorism in 2015 [10].

Digitisation involves using electronic devices to convert physical items into digital forms. This includes selecting and preparing the analogue originals, creating metadata, and submitting the digital resources to the management system and depositories [9]. Cultural heritage digitisation aims to safeguard and preserve assets for the long term and make cultural content more widely accessible [11]. An information system collects hardware, people, and processes in gathering, processing, storing, and distributing data [12]. In recent years, digital libraries and archives have been largely replaced by information systems in terms of how information is presented and accessed [13, 14, 15].

Digital Library Systems (DLS) are specialised information systems that store, manage, and preserve digital content over time [16]. As more historical artefacts are increasingly digitised, DSL will facilitate easy access to this information, ensuring that digital content is preserved for future generations.

Web-based information systems significantly benefit cultural heritage stakeholders, the tourism industry, and the national heritage repository [17]. From the tourism perspective, an information system can make information more understandable and presentable, as well as retain and improve tourism quality of services provided by tourism providers. From a national heritage repository perspective, a digital information system can aid in managing heritage resources [15].

Digitalising cultural heritage is not new globally or in Malaysia [18, 19, 20, 21]. However, there is a lack of studies focusing on digitising cultural heritage in Smartphone applications, Web Apps, or Progressive Web Applications (PWA) in Malaysia. PWA is a term to describe applications that take advantage of accessing browsers offline, accessible across different devices, and provide the experience of a native app [22]. Hu and Zhu [23] have demonstrated that implementing PWA into cultural information systems can improve user experiences (UX), provide more modern application

features, and facilitate user-friendly data management. Their study supports the notion that web-based applications can help increase the intellectual and physical accessibility of cultural heritage.

Web-based applications have been criticised for their lack of security, inability to access device hardware and incomplete UX when users primarily perform actions or transactions on their mobile devices, whilst native mobile applications, on the other hand, have been praised for their dependability, independence from connectivity, and consistent UX [79]. However, native apps have high development costs, are platform-specific, and require more user data and storage. PWA offers several advantages, including dependability, speed, offline functionality, cross-platform availability and discoverability, and the ability to keep up-to-date knowledge upon refresh. Furthermore, PWAs can be added to users' home screens and launched like native apps while still offering the convenience of web applications. Therefore, PWA is the ideal solution for the current study due to the shortcomings of both native and web-based platforms. It provides the best of both worlds, offering a seamless UX with native-app features while also being accessible through the web.

Multiple studies have been conducted in Malaysia to digitise the country's cultural heritage, as evidenced by previous works [18, 19, 20, 21]. Ariffin's [18] study highlights the dearth of literature on digital local cultural content in mobile learning, especially in Local Cultural Studies, and underscores the need to bridge the gaps. The study concluded that it is crucial to establish awareness and strategies for sustainable local content development in Malaysia to encourage the utilisation of mobile devices for learning.

Malaysia takes pride in its diverse cultures and heritages, yet more efforts are necessary to preserve and promote them. For example, cultural treasures such as the intangible performing art of Mak Yong [21], a virtual tour of the tangible site of Kellie's Castle [19], and documenting the local knowledge and culture of Semai [20], Malaysia's indigenous people community, should be digitised. Similar studies on Sarawak's cultures have been conducted to achieve this objective [24, 25, 26, 27]. Sarawak is the largest and most diverse state located on the island of Borneo. It is home to more than 40 ethnic and sub-ethnic groups, each with a legacy of physical artefacts and intangible attributes passed down through generations. Sarawak has a population of around 2.81 million [74] (DOSM, 2020). Despite its rich heritage, a well-established and entirely digitised information system for Sarawak's cultural heritage has not been established. Previous studies [24, 25, 26, 27] have been insufficient in documenting and integrating the state's cultural assets. Digitising Sarawak's cultural heritage can benefit the tourism sector by promoting Malaysia's uniqueness in arts, culture, and heritage, advocating conservation and preserving this tangible and intangible heritage. For example, one ethnic minority in Sarawak is the Kelabit which mainly resides in the remote and rural areas of Borneo Highland. In 2020, British Museum showcased on its website the 137 artefacts gathered by Dr Monica Janowski, a social anthropologist who conducted comprehensive research on the Kelabit ethnicity [75]. Other digitisation effort studies conducted by various researchers, such as [24, 25, 26, 27], could provide more information on the Sarawak Cultural Heritage. Furthermore, the SCHPWA developed in this study can provide detailed information on Sarawak Cultural Heritage (interested readers can access this at <https://sarawak-dch.firebaseio.com/>).