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Conceptual Framework for On-site Digital Interpretation Developments in Cultural Heritage Sites

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ABSTRACT

On-site heritage interpretation plays a vital role in cultural heritage sites in conveying the significance and multiple heritage values to the visitors. In an era where the world is transforming with innovative digital applications, the heritage sites are also being integrated with digital interpretation techniques to deliver a better interpretation and new dimensional experience to the visitors. Though multiple digital solutions are available, not all the techniques are appropriate, applicable and feasible to every site. Besides, neither proper worldwide principles nor framework has been exerted for these digital heritage interpretation developments. Therefore, this study is focused on building a generic conceptual framework to select the most appropriate digital interpretation technique(s) that fit the context of the heritage site, giving special reference to the six Cultural World Heritage Sites of Sri Lanka. The relevant qualitative and quantitative data were gathered via in-depth interviews, field observation, literature survey and a visitor survey questionnaire. The main themes and sub-themes derived through the thematic analysis were adopted as the theoretical framework for the research to analyze the collected data of the six Cultural World Heritage Sites and the selected digital techniques. Based on the results, the study recommends appropriate digital techniques for each Cultural World Heritage Sites of the country. Further as aimed, the study presents a conceptual framework for on-site digital interpretation developments for cultural heritage sites by categorizing the 24 criteria derived for data analysis under five phases namely 'Prepare', 'Assess', 'Design', 'Implement' and 'Sustain'.

1. Introduction

Heritage Interpretation plays an important role in delivering the significance and multiple heritage values of the cultural heritage sites. According to the International Council on Monuments and Sites (ICOMOS) Charter for the Interpretation and Presentation of Cultural Heritage Sites (2008), '*the public explanation on a discussion of a cultural heritage site encompassing its full significance, multiple meanings and values'* is considered as 'Interpretation' (ICOMOS, 2008). Thereby, the heritage managers use different techniques for on-site heritage interpretation such as physical interpretation signage, guides, audio tours, guidebooks and publications, etc. According to the Visitor Lifecycle Model of Davis (2014), a heritage visit is not merely considered as an incident but a process of 3 stages: Pre-visit, Visit (On-site) and Post-visit. Pre-visit means the stage of 'Fact-finding and planning', in which the visitor looks for information to plan the visit and creates a personalized context. Visit (On-site) stage includes 'In-visit interaction and content delivery', where the visitor obtains the cultural experience. Post-visit refers to 'Feedback and recommendations', in which the visitor follows up any information and shares experiences through feedback and recommendations (Davis, 2014). Accordingly, during the 'Visit stage', visitors interact and obtain cultural experience with the cultural objects, monuments and sites; hence, the heritage information delivery shall be highly effective.

Since the world is now moving towards the 4th industrial revolution where the 'fusion of technologies' happens, modern digital technologies and sharing of information have become a part of human lives. In parallel, with the development of ICT, several emerging digital techniques such as Interactive Digital Screens (kiosks), Mobile Apps, Augmented Reality (AR), Virtual Reality (VR), Digital Sound and Light Shows, etc. have been integrated into the heritage sector. The integration of these digital techniques with the conventional interpretation practices have created a new dimension in the heritage interpretation sector and provided an innovative experience to the visitors at cultural heritage sites. In due course, the on-site heritage interpretation becomes more effective and subsequently enhances the heritage sites as well.

In order to provide a better interpretation and new dimensional experience to the visitors, different countries have integrated many on-site digital interpretation techniques at their heritage sites. Though multiple digital solutions are available, not all the techniques are appropriate, applicable and feasible to every site. Therefore, this research is focused to build a conceptual framework to select the most appropriate digital interpretation technique(s) that fit the context of the cultural heritage sites. Giving particular reference to the six Cultural World Heritage Sites (CWHS) of Sri Lanka, the research question has been taken as, '*How to assess the feasibility and applicability of digital interpretation techniques for cultural heritage sites to enhance the level of on-site interpretation?'* The objectives of the present paper are to assess the current level of on-site interpretation, explore the potential on-site digital interpretation techniques to enhance the effective interpretation in the CWHS of Sri Lanka and propose a generic conceptual framework for the on-site digital heritage interpretation developments.

'Digital Heritage' is referring to any 'born digital' or 'digital surrogate' objects that contain unique resources of human knowledge and expression while 'Heritage Interpretation' is referring to effective learning, communicating and managing that increases visitors' awareness of and appreciation of the heritage. Accordingly, the 'Digital Heritage Interpretation' is a process, which the said digital formats of heritage are used for interpretation' (Rahaman, 2018). Although

these digital techniques can enhance heritage interpretation and presentation, UNESCO or ICOMOS has not exerted any proper worldwide principles or guidance so far on this Digital Heritage Interpretation. *'Although the contribution of digital technologies to the conservation and safeguard of cultural heritage has been widely acknowledged, their role in the interpretation and presentation remains to be assessed more in depth'* (Sartori & Lazzeretti, 2014). Therefore, the digital heritage projects mostly remain descriptive, their objectives are diverse while their works presume the technologies deliver a greater interpretation (Rahaman, 2018). Thus, scholars research on proposing conceptual models, frameworks, and guidelines to fill this gap between theory and practical applicability of such uses of digital techniques for heritage interpretation. The conceptual framework for interpreting digital heritage (PrEDic) proposed by Rahaman (2018) is noteworthy among them. However, since all the research conducted so far in this regard are by foreign scholars referencing their contexts, an appropriate conceptual model/ framework and guidelines for the Sri Lankan context is in the need. Accordingly, there is space to propose a suitable conceptual model/framework and some guidelines for the on-site digital heritage interpretation projects carried out in Sri Lanka.

2. Materials and Methods

2.1 Data Collection and Sampling

To ascertain a better insight on the heritage interpretation, digital techniques and cultural heritage sites within their actual context, diverse data were collected from multiple aspects. This study collected both relevant qualitative and quantitative data (during Dec 2019-Dec 2020) via in-depth interviews, field observation, participatory observation, literature survey and a visitor survey questionnaire (Table 1).

Table 1. Methods Employed in Data Gathering (Source: Developed for the present study)

	Data Collection Method	Participant/Event/Materials	Sample size	Tool
Primary Data	**In-depth interviews**	Heritage Management Professionals	05	Semi-structured questions
		Technical Experts	05	
		Professional Tour operators	03	
	Field Observation	Cultural World Heritage Sites of Sri Lanka	06	-
	Visitor Experience Survey Questionnaire	Heritage Site Visitors (Local & Foreign)	505	Google form
Secondary Data	**Literature sources**	CWHS Management Reports, Books, Relevant Charters and Guidelines of UNESCO and ICOMOS, Scholarly Research Articles, Academic Journals and reports, Websites, Newspaper articles	-	-
	Other sources	Sessions of International Symposiums, Public lecture series by ICOMOS, ICCROM, etc., Mobile apps, Virtual tours, social media pages of heritage sites	-	-

The 'Purposive sampling' method was employed to select in-depth interviewees to obtain the most relevant and plentiful data for the selected phenomenon. To study the

on-site status of the cultural heritage sites, the six CWHS of Sri Lanka namely, *Sacred City of Anuradhapura, Sacred City of Polonnaruwa, Ancient City of Sigiriya, Temple of Tooth relic in Kandy, Old Town of Galle and its Fortifications,* and *Rangiri Dambulla Temple* were taken as a sample, out of the hundreds of heritage sites in Sri Lanka, upon the 'purposive sampling' method. Out of the digital techniques identified through the literature survey, *Mobile Apps, Augmented Reality (AR) Technology, Virtual Reality (VR) Technology, Interactive Digital Screens* and *Digital Sound and Light Shows* were considered. The visitor experience survey received 505 valid responses via google forms and out of them, 439 were local respondents and 66 were foreign respondents. Those visitors responded to the questions mainly about their experience with existing on-site interpretations at the CWHS and the potential digital interpretation techniques.

2.2 Data Analysis

Since the research is exploratory, where no previous studies had addressed the issue directly, the 'Thematic Analysis' (Braun & Clarke, 2006) was mainly employed to fully grasp the significations emerging from the primary and secondary data. Opting the inductive approach, this study analyzed for themes by looking at the explicit (surface) meaning of the data and the latent meaning (underlying ideas, assumptions and concepts) (Figure 1). Secondly, by adopting the derived results as the theoretical framework for the research, the collected data of the six CWHS of Sri Lanka and the selected digital techniques were analyzed against the derived main themes and sub-themes.

3. Results and Discussion

Upon the first data analysis, the present study identified six main themes and 24 sub-themes that have to be considered as factors for on-site digital interpretation development for cultural heritage sites and are depicted in figure 1. The results of the feasibility and applicability analysis carried out on selected digital techniques in relation to the six CWHS, based on the identified factors are (Figure 1) as follows.

3.1 Site Condition

3.1.1 Availability of adequate heritage information [i]

All the CWHS have an acceptable level of information regarding their heritage values, to be delivered via the proposed digital techniques. However, in some sub-sites, adequate heritage information is unavailable, for instance, the heritage data required for conjecturing the initial appearance of a present-day ruined monument such as dimensions, elevations, architectural styles, building materials, textural colours, environmental context, etc. Therefore, it is important to note that even if a sub-site within a CWHS is of high significance yet does not possess an adequate level of information, it shall not be virtually reconstructed (ICOMOS, 2008) and interpreted via the means of AR and VR. For such sites, general information can be delivered via Mobile apps and Interactive Digital Screens if necessary. Further, extensive research shall be encouraged for identifying such information gaps.

3.1.2 Current Nature of the Site [ii]

The heritage sites are commonly categorized as 'Living sites', 'Archaeological sites' (some call it 'Dead sites') and 'Partly ruined and partly living sites' (mix nature). The present-day nature of the site does not affect the techniques of Mobile apps, AR, VR and Interactive Digital Screens, but is substantial when introducing Digital Sound and Light Shows.

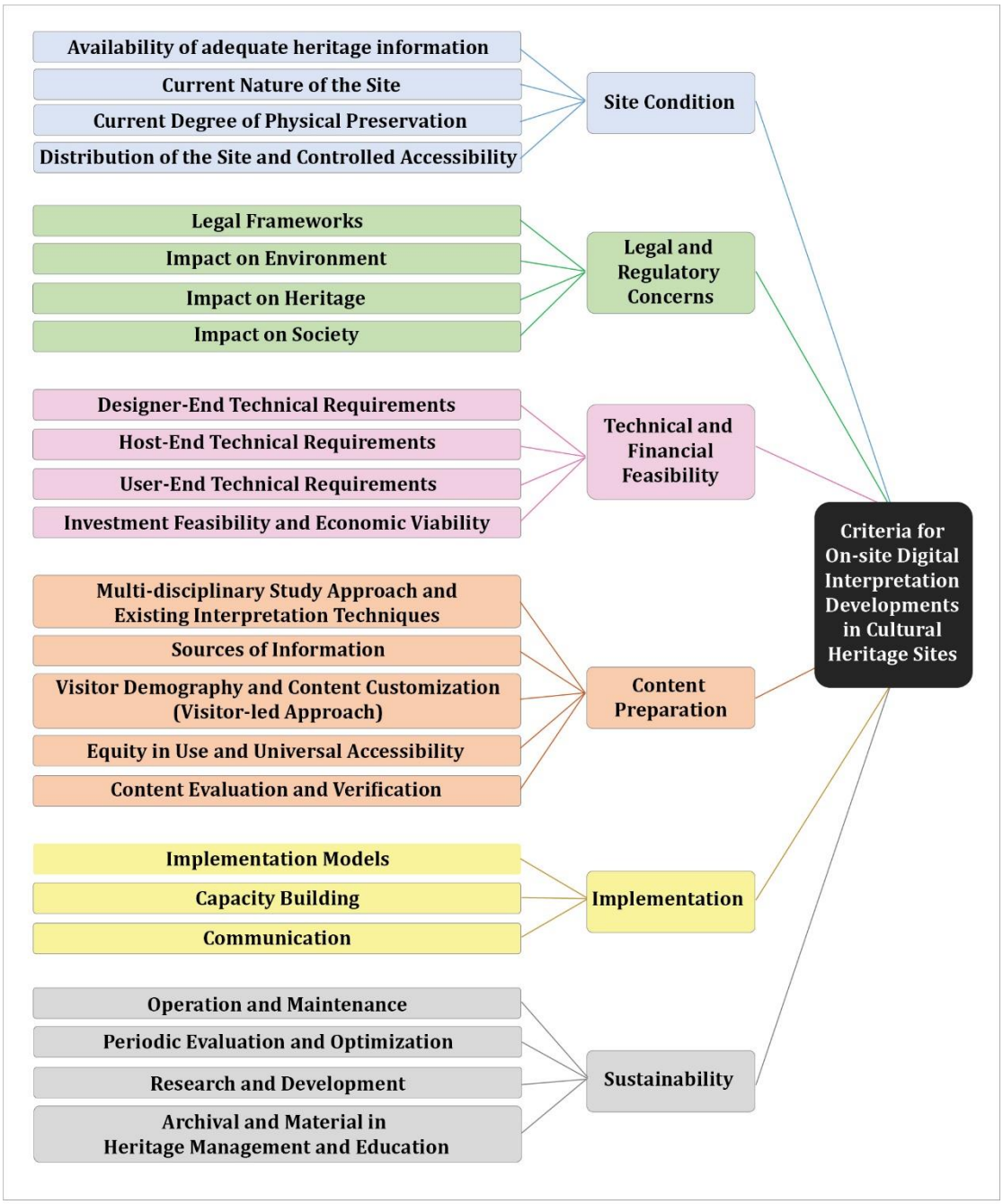

Figure 1. Author-defined relationship of the derived themes and sub-themes (Source: Developed for the present study)

In the socio-cultural context of Sri Lanka, special considerations are to be taken in selecting the digital techniques for 'living sites' where the religious value occupies a major position. Despite having several heritage values, the religious value is dominant in Anuradhapura, Polonnaruwa, Kandy and Dambulla CWHS, where religious

functions have been continuing since inception. Accordingly, having a Digital Sound and Light show in a religious site in the Sri Lankan context is hard to achieve, unlike the implementations at Dhamekh stupa in Saranath (India), Konark Sun temple (India), Sukothai historical park (Thailand) and Notre-Dame cathedral (France), which are also religious sites. Although Galle is a 'living city' with residential settlements and other functions, unless they are disturbed, Galle is a potential site for Digital Sound and Light Shows to interpret its historical and military heritage values. Sigiriya, which is an 'archaeological site' at present, is also suitable for such Digital Sound and Light Shows.

3.1.3 Current Degree of Physical Preservation [iii]

The heritage monuments and sites of Sri Lanka are in different degrees of physical preservation such as whole (intact), half-ruined, skeletal form and foundation state. The current preserved degree of the monument/site is important for digital content developers in deciding the method of creating 3D models for virtual reconstructions, whether to derive from 3D scanning or create a whole new model. Accordingly, the virtual reconstructions of the places in Anuradhapura, Polonnaruwa and Sigiriya, where most of the monuments are found in half-ruined, skeletal and foundation states, need a combination of the above two methods. However, having almost intact monuments like in Kandy, Galle and Dambulla do not necessarily imply that virtual reconstructions are not needed. They can be adopted to interpret the unaddressed heritage values, phase-wise evolution/ degradation, contemporary socio-cultural and environmental context, etc. For instance, although the monuments and traditions of Kandy CWHS are well preserved from the religious perspective, in the aspect of the royal palace complex, its design principles and cohesion with the Sacred Tooth Relic Temple, town planning, etc. need a proper address. Similarly, although the physical monuments of Galle CWHS remain mostly intact, the initial socio-cultural and environmental context is changed. Therefore, the contemporary military context needs to be interpreted (Figure 2). These developed contents can be delivered as immersive experiences (AR and VR) or via Interactive Digital Screens.

3.1.4 Distribution of the site and Controlled Accessibility [iv]

Dispersion of a heritage site is a factor for considering the order of prioritization in content creation. Largely dispersed sites like Anuradhapura, Polonnaruwa, Sigiriya and Galle, need prioritization in selecting sub-sites/monuments for digital content creation and implementation. In addition, the places with access restrictions within the heritage sites shall be identified and properly interpreted with suitable media: photos, videos, maps, 3D models, etc. Black Fort of Galle, inside of the two-story Tooth Relic chamber building of Kandy, Circumambulatory passage and Upper stories of Tivanka and Thuparama image houses in Polonnaruwa, Ruins of the shrine beneath the Siva Devala No.01 in Polonnaruwa (Figure 3) are some of such examples.

Figure 2. Artillery gun and carriage planned to be replicated at Triton Bastion, Galle Fort (The Sunday Times, 2020)

Figure 3. Ruins of the shrine beneath the Siva Devala No.01 in Polonnaruwa (CCF Office, Polonnaruwa)

3.2 Legal and Regulatory concerns

In order to carry out any project in or nearby a heritage site, it is obligatory to adhere to the existing laws and regulations.

3.2.1 Legal Frameworks [v]

As there are no direct laws created for digital heritage interpretation as of now, the *World Heritage Convention (1972), ICOMOS Charter for the Interpretation and Presentation of Cultural Heritage Sites (2008)*, *UNESCO Charter on Preservation of Digital Heritage (2009)* are the main international policy frameworks pertaining to the interpretation of the sites. They encourage the heritage interpretation and education of the public while securing the heritage values/OUV, authenticity and integrity of the sites. Since the proposed techniques, Mobile Apps, AR, VR, Interactive Digital Screens and Digital Sound and Light Shows do not violate any of the above, they can be adopted in the six CWHS of Sri Lanka as appropriate. Similarly, none of the techniques violates any legal provisions in the national acts and ordinances such as the *Antiquity Ordinance No. 9-1940 Sri Lanka Ceylon (1940)* and its succeeding amendments *(No. 2 of 1955, No. 22 of 1955, No. 24 of 1998)*, *Central Cultural Fund Act (No. 57 of 1980)*, *Cultural Property Act (No. 73 of 1988)*, *Galle Heritage Foundation Act (No.7 of 1994)* and *Sigiriya Heritage Foundation Act (No. 62 of 1998)*.

3.2.2 Impact on Environment [vi]

Out of the proposed digital interpretation techniques, the Mobile Apps, Interactive Digital Screens, AR and VR do not negatively impact the environment. However, an Environmental Impact Assessment (EIA) is found essential for the Digital Sound and Light Shows, which are potential for the sites of Sigiriya and Galle. In Sri Lanka, EIA is required under 03 acts, namely, *Coast Conservation (Amendment) Act No. 57 of 1981, National Environmental (Amendment) Act No. 56 of 1988* and *Fauna and Flora (Amendment) Act No 49 of 1993* (Central Environment Authority, 2014). Although Galle Fort is located within the 'coastal zone', as Digital Sound and Light Shows do not cause any impact to the coast, no EIA under *Coast Conservation* Act is required. As Digital Sound and Light show is not a project that extracts resources, clear lands nor any other type of project prescribed in the respective gazettes, no EIA is required under the *National Environmental Act of Sri Lanka 47/1980*. However, since Sigiriya-Pidurangala wildlife

sanctuary is collocated with the Sigiriya CWHS, an EIA is required to assess any impact caused by the light rays, sounds/noise and vibrations of Digital Sound and Light Shows to the wildlife, under the EIA provisions of *Fauna and Flora (Amended) Act No. 49 of 1993.* In addition, written approval should be obtained from the Director-General of the Department of Wild Life Conservation prior to the implementation of such projects (Central Environment Authority, 2014).

3.2.3 Impact on Heritage [vii]

In Sri Lanka, this process is covered by 'Archaeological Impact Assessment (AIA)' upon the provisions of *'Antiquities (Amendment) Act (No.24 of 1998)'* and the *Special Government Gazette of No.1152/14.* Accordingly, any of the proposed digital interpretation developments do not need an AIA. However, the process has been widened as Heritage Impact Assessment (HIA) at the international level, consuming a broader scope such as *probable effects on the heritage values (including OUV), cultural life, institutions* and *resources of communities* (ICCROM & WHITRAP, 2012). The ICOMOS Guidance on Heritage Impact Assessment (ICOMOS, 2011), has introduced a 9-scale descriptor (figure 4) based on two parameters, *'scale or severity of impacts/changes'* and *'significance of the effect of change'*. According to the HIA process introduced by the ICOMOS (2011), Mobile apps, Interactive Digital Screens, AR and VR cause no changes to the heritage values but gain beneficial changes by enhancing the level of on-site interpretation. However, unless the Interactive Digital Screens are located in suitable positions, the aesthetic value of a site could be negatively impacted. Proper technical/scientific analysis is needed in terms of any harm to the physical strength of the architectural facades, surface deterioration, fastening of micro-organism activities by the impact of noise, vibration and light rays when deploying Digital Sound and Light Shows.

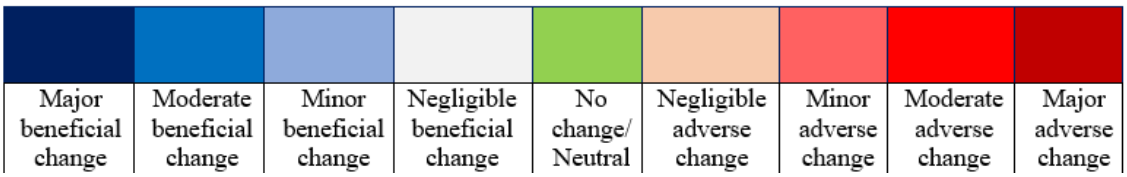

Figure 4. ICOMOS Descriptor for assessing the impact on heritage values by a new deployment (ICOMOS, 2011)

3.2.4 Impact on Society [viii]

Social Impact Assessment (SIA) is the process of identifying the future consequences of a current or proposed action, which are related to individuals, organizations and social macro-systems (Becker, 2001). It includes the people's way of life, culture, community, political systems, environment, health and wellbeing, personal and property rights, etc. Upon the analysis of social impacts caused by the proposed digital techniques in relation to the stakeholders, it has resulted that, all the property owners (state/private), custodians, statutory bodies receive a value addition to their sites, which is a beneficial impact. Since Sound and Light Shows will not be implemented in the sites with higher religious value, neither clergy nor pilgrims will be disturbed with their religious practices. Conversely, the rest of the techniques would make the pilgrims aware of the site other than their main purpose of visit. Local and foreign tourists are benefitted undoubtedly as they will receive a more value-added experience than the existing

level. The lives of the surrounding dwelling communities would not be disturbed but will gain indirect benefits from these proposed techniques. However, in the case of Digital Sound and Light Shows in Galle, the noise, light and vibration may cause disturbance depending on the place selected. Accordingly, the selecting place shall cause none or minimum impact on the dwellers. Meanwhile, these digital interpretation techniques may bring both positive and negative impacts to the trade of tourist guides.

3.3 Technical and Financial Feasibility

The technical and financial feasibility is of undeniable importance in introducing any digital interpretation technique for on-site interpretation. Moreover, these implementations are considerably high investments and sometimes require advanced technology transfers as well.

3.3.1 Designer-End Technical Requirements [ix]

The technical requirements with respect to the proposed digital techniques can be categorized mainly as Software, Hardware and Human Expertise. The software requirements from the designer-end in developing different digital interpretation techniques were found as follows (Table 2).

Table 2. Software requirements from Designer-end (Source: Developed for the present study)

Task/ Requirement	Software
Mobile app building platforms	*Flutter, Android Studio, React Native, Ionic*
Designing content for the Interactive Digital Screens (kiosks)	*Bespoke systems using HTML, specialist software such as Intuiface, pre-built templates and using PowerPoint or Prezi*
Creating 3D models of the heritage monuments, artefacts, people, etc.	*Blender, Autodesk Maya, Autodesk 3Ds Max*
Creating content for the immersive technologies (AR, VR)	*Unity, Unreal Engine*
Mobile platforms to run Mobile-based AR experiences	*ARCore (Android OS), ARKit (Apple iOS)*
For 'Projection Mapping' in developing content for Digital Sound and Light Shows	*MadMapper, Isadora, Mapio, HeavyM, Resolume Arena*

As the aforementioned content developments need advanced image processing even to render a single visual, the developers need computers with high computational power having larger RAM power, multiple-core processors, higher Graphical Processing Unit, etc. as main hardware requirements. Different devices are required to capture the data and map the environment needed for digital content such as High-Resolution DSLR cameras, Drone cameras, Mono-scopic/ Stereoscopic 360^0 cameras and Drone-based LiDAR Scanners and other 3D Scanners. The digital content development teams shall consist of expertise in 3D art designing, AR/VR development, User Interface (UI) designing/App development and heritage experts' supervision. Creativity is an essential competency in these implementations. According to the interviewed respondents, human expertise is not a limitation for these developments in Sri Lanka. Figure 5 shows a development of a 3D model from the sketch by a Sri Lankan digital content development team.

Figure 5. The process of converting a pencil sketch into a 3D Art and finally a 3D model, in the historical game *'Kanchayudha*', developed in Sri Lanka by Arimac Digital (Pvt) Ltd. (Arimac, 2017).

3.3.2 Host End Technical Requirements [x]

In most of these projects, the content development team will only develop the digital content and hand over the project to the host party (Heritage Management institution or a third party). Then, the host party must maintain web servers, especially for the Mobile apps and Mobile-AR experiences. For instance, if the Heritage Management institutions cannot host a web server by themselves, they have to rent a web server service from other parties like *Lanka Government Cloud* (ICTA), *Akaza (SLT-Mobitel)*, *Cumulus (Dialog Axiata),* or an international service like *Amazon Web Services, Microsoft Azure, Google Cloud Platform*, etc. However, the selecting web server service should be reliable as well as scalable with high bandwidth connectivity. For VR experiences, a separate VR unit and VR headsets (i.e. *Occulus, HTC Vive, Google Cardboard, Pansonite 3D*) are required to be set up in a suitable location at the site and such locations are required for the Interactive Digital Screens as well. The sites of Sigiriya and Galle will need powerful projectors and other relevant hardware devices to perform the Digital Sound and Light Shows. Moreover, the on-site lighting condition is important in rendering 3D models in AR experiences, as good lighting conditions will allow the users' device camera to recognize the surface properly to render the models. In addition, all these sites proposed for VR, Digital Sound and Light Shows and Interactive Digital Screens require a constant electricity supply at the site. As for the on-site infrastructure requirements, adequate mobile data signal (preferably 4G) or Wi-Fi coverage is required for a better experience. According to the mobile data coverage map of the Telecommunication Regulatory Commission of Sri Lanka (TRCSL), the main heritage sites of Sri Lanka have adequate signal strength. Furthermore, competent human resources are highly required for Database Management, System Administration, Operation, and Information Security from the host party. Furthermore, a data access authority and ownership policy has to be developed along with these types of digital interpretation projects.

3.3.3 User End Technical Requirements [xi]

The technical requirements in the user-end are mainly the hardware devices of the users (i.e. Mobile phones, tablets) and these devices must meet the minimal requirements asked by a mobile app. Moreover, the Mobile-based AR experiences (apps) can be downloaded from *Google Playstore* or *Apple Appstore* only if the user's device is compatible with *ARCore* or *ARkit (*for Android and Apple iOS devices

respectively). Hence, either the visitors of six CWHS shall have the devices with themselves or have the opportunity to rent one at the site.

3.3.4 Investment Feasibility & Economic Viability [xii]

These digital interpretation developments are usually of high cost. Thereby, having a proper assessment of investment feasibilities, return on investment and gaining social benefits are important. When heritage management institutions are not in a position to self-fund these projects, looking for suitable funding options and grants is a better alternative. Private-Public partnerships, grants from foreign funding agencies, CSR activities with private enterprises, obtaining funds from Heritage funding institutions such as Getty Foundation, Global Heritage Fund, Aga Khan Trust, etc. and UN agencies are feasible options. Moreover, assessing the economic viability for bearing the operational expenditure in the long-term continuation of the systems (i.e. web server hosting, bugs and errors fixing, content revisions, equipment maintenance, etc.) is also highly important.

3.4 Content Preparation

The content planning or what and how heritage information is to be delivered must be paid greater attention as that is the ultimate deliverable that meets with the visitor. Proper content planned by the professionals in heritage interpretation shall be developed in digital formats by the digital content developers.

3.4.1 Multi-disciplinary Study Approach and Existing Interpretation Techniques [xiii]

As Tilden (1957) reminds, *'Interpretation should aim to present a whole rather than a part and Interpretation is conceptual and should explain the relationships between things'*. In planning content to be delivered via any interpretation technique, a Multi-disciplinary study approach to each site is important (ICOMOS, 2008). Upon analyzing each site, the present study identified the related disciplines needed in addressing the heritage values of each CWHS. In summary, each site needs more or less knowledge of *Archaeology, Ancient History, Modern History, Architecture, Art History, Landscaping/Town planning, Underwater Heritage, Irrigation Technology, Structural Engineering, Archaeo-Chemistry, Fortifications and Military Heritage* and *Cultural Anthropology* and these knowledge areas need to be finally incorporated with *Heritage interpretation.* In addition, the proposing content shall not be a repetition of the content already delivered through the existing interpretation strategies but an extra step beyond and address what is lacking at the site. Therefore, in planning content for the proposed digital techniques for each CWHS, it is important to study the scope of existing interpretation strategies beforehand.

3.4.2 Sources of Information [xiv]

Irrespective of the format of the content, the information should be obtained from reliable and accepted sources. As per Article 2.1 of the ICOMOS Charter (2008), *the sources of this information should be documented, archived, and made accessible to visitors and the public*. In addition, it will also be helpful for visitors who are expecting to search more on any particular monument/site. Other than gathering information through accepted scientific and scholarly methods, information can be collected from living cultural traditions as well (ICOMOS, 2008). They can be in a wide range of sources viz. material evidence, oral testimonies, alternative historical hypotheses, local traditions, legendary stories, etc. by the active members of the associated communities of these sites. For instance, the traditional art families of Dambulla and Kandy have their own hereditary knowledge, maybe in an oral format or written down in ola-leaf manuscripts. However, the content planning team has to be vigilant about

'reliability' and 'well documentation' in using this traditional knowledge (ICOMOS, 2008).

3.4.3 Visitor Demography and Content Customization) [xv]

Tilden (1977), highlights in his principles that '*the chief aim of interpretation is not instruction, but provocation*'. Therefore, interpretation should stimulate people into a form of action, which make people understand, appreciate and ultimately protect the heritage (Canal & River Trust, 2014). To achieve that, interpretation should be personal and hence, a proper understanding of the needs of the visitors is required. Department of Conservation of Wellington (2005) suggests assessing the visitor characteristics namely, *Demographics*, *Purpose of visit*, *How people visit* (with family/friends, as individuals, couples, organized tours, etc.) *Desire for knowledge at a site* (specific aspects, only visual experience, detailed information), *Personal interests* (prior knowledge and expectations, preferred learning styles [Visual/ Auditory/ Kinesthetic/ Emotional]).

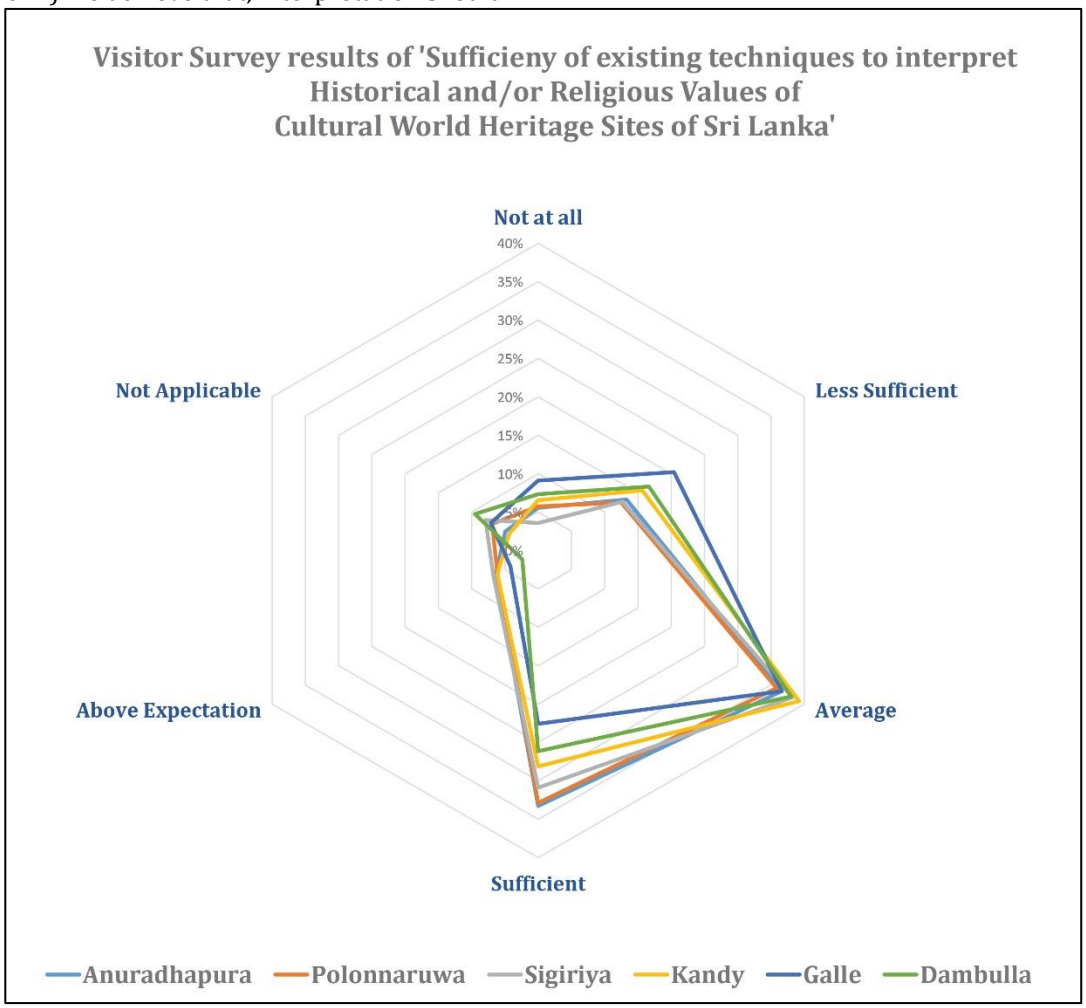

Figure 6. Sufficiency of existing techniques to interpret historical & cultural values at six CWHS of Sri Lanka ((Source: Results of the visitor survey of the present study))

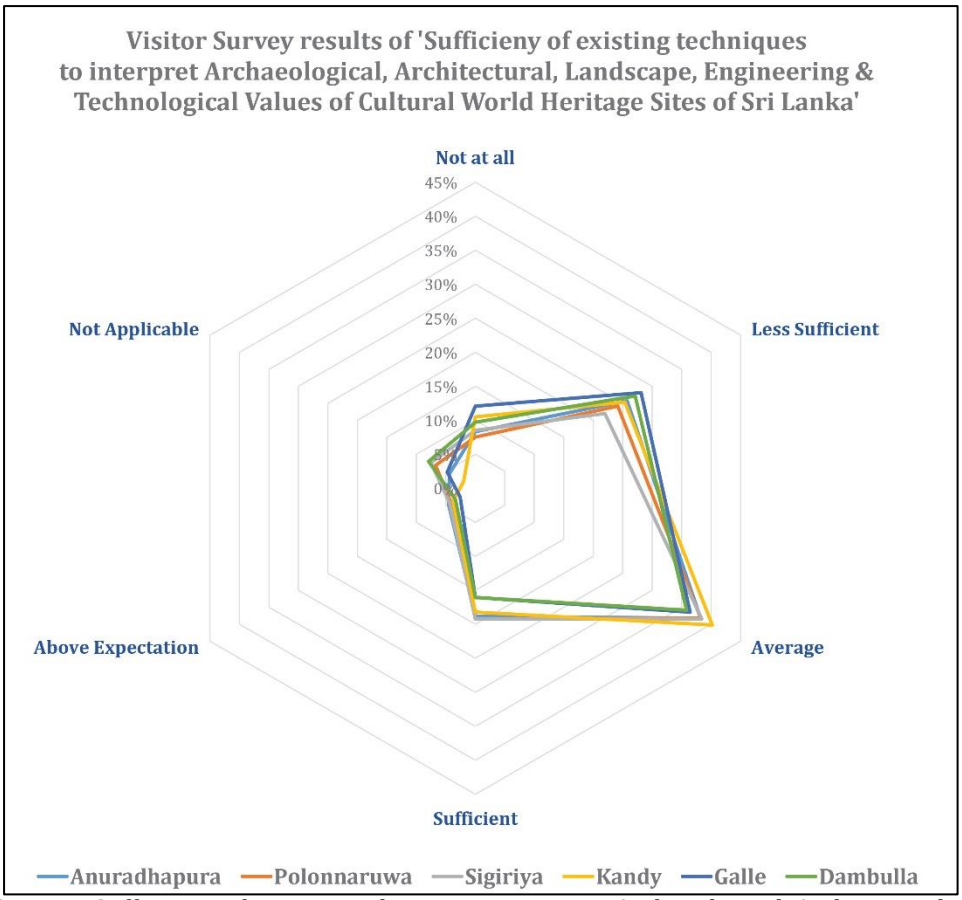

Figure 7. Sufficiency of existing techniques to interpret Archaeological, Architectural, Landscaping, Engineering & Technological values of six CWHS of Sri Lanka (Source: Results of the visitor survey of the present study)

Figures 6 and 7 show the feedback of the 505 respondents at the visitor survey of this study, on the availability of the on-site sources for them to understand the heritage values. Nearly 70% have commented that the availability of interpretation sources to understand religious and historical values are sufficient or average whereas, the sufficiency for other values (Architectural, Archaeological, Engineering and Technological, etc.) is found as 55%. Accordingly, the present study found it suitable to plan the content in two levels, especially for Mobile apps and Interactive Digital Screens, aiming at the visitors expecting general heritage information and advanced and customized information respectively. Due to the quantity of information and to provide a better interpretation service, the author suggests having separate '*AR technology-enabled Mobile apps*' for each CWHS of Sri Lanka. Apart from the usual content components, those mobile apps shall contain an '*AR-based on-site visitor navigation component*'. Even '*a Virtual tour guide*' can be used where the visitor is given the complete freedom to navigate the site and learn from the Virtual tutor. However, in-depth information and its sources shall be provided only upon a request of a visitor. Moreover, the author suggests having '*Thematic and Customizable route itineraries*' for the visitors with special interests, prior knowledge and prior visit experience. However, the '*Significance of the heritage'* shall be conveyed irrespective of the

nature of the visitor. '*AR-based virtual reconstructions of historic sites'* shall be another major component delivered for all. Since the foreign visitors are mostly not familiar with Sri Lankan history and the context, a special '*Comparison component'* has to be included. Digital Sound and Light Shows are not customizable, yet they shall be planned interestingly to all visitor categories.

3.4.4 Equity in Use and Universal Accessibility [xvi]

Article 1.5 of the ICOMOS Charter (2008) has recommended that Interpretation and presentation activities should be accessible to the public of all varieties. Accordingly, the concept of 'Universal design' describes the designing of all products, services and buildings to be usable to the greatest possible extent by everyone, regardless of their age or ability (Canal & River Trust, 2014). *'Accessibility', 'Usability'* and *'User diversity'* are major factors to be considered. Accessibility is of several types namely, Physical, Cultural, Sensory, Economic and Intellectual accessibility. *'Physical accessibility'* applies mainly to the Interactive Digital Screens and VR Tour booths, which are most convenient to be used indoors. Setting up height shall be accessible to all types of visitors and the positioning shall not block the visitor movement patterns and should have sufficient space in front of it to use them. To overcome the challenges in *'Sensory accessibility'*, the mobile apps shall include both text and audio components, allowing for the auditory impaired and visually impaired visitors respectively. A similar format can be followed in the Interactive Digital Screens. AR, VR experiences and Digital Sound and Light Shows can be experienced by all except the visually impaired, yet they can at least listen to the narration. Any means of interpretation shall avoid barriers in *'Cultural accessibility'* such as language issues, jargon/specific terminologies, non-relevance to the context, etc. Digital Sound and Light Shows can be played in one language and headsets shall be given with translated narrations. As for the *'Economic accessibility'*, the prices of any services shall be at a reasonable cost to afford.

3.4.5 Content Evaluation and Verification [xvii]

Since the content of these digital interpretation techniques is the ultimate deliverable that communicates with the visitor/public, the evaluation is extremely vital. Accordingly, the present study suggests the following criteria, developed by referring to literature sources, to be used in evaluating the developed content.

- Conveyance of the Outstanding Universal Value and other local value(s) of the site
- Accuracy and overall quality of the content
- Level of understanding
- Provision of updated information
- Adherence to accepted standards/ guidelines
- Level of Interest
- Easy and universal accessibility
- Availability/ Quantitative sufficiency of the amount

Moreover, the content verification should be done by an authorized body who can be accountable for, especially for the virtual reconstructions of heritage monuments/sites in digital formats.

3.5 Implementation

3.5.1 Implementation Models [xviii]

If the authorities of heritage management cannot implement these digital projects alone due to the challenges like sourcing, lack of technological expertise, need for advanced technology transfers, etc., entering into appropriate partnerships would be the best alternative. It has been encouraged by the UNESCO World Heritage Convention (1972) and the UNESCO Charter for the Preservation of Digital Heritage (2009). Accordingly,

Public-public Partnership (PuP) and Public-Private Partnership (PPP) are the commonly available partnership models. The *'Heritage Sri Lanka'* and *'e-Info CCF'* mobile apps created by ICTA Sri Lanka partnered with the DoA and CCF respectively are examples of existing PuP partnerships. In addition, entering into the 'Design-bid-build model' with the private sector is also a suitable alternative if funding is possible by the heritage authorities. At present, *'Frammix VR',* a private startup company, has developed a VR tour experience for the Sacred Quadrangle of Ancient City of Polonnaruwa with the acknowledgement of ICTA Sri Lanka and expecting to enter into a 'Build-own-operate model' partnership with DoA/ CCF. Due to the complex nature of Digital Sound and Light Shows, the 'Build-own-operate model' can be suggested along with profit-sharing agreements. Moreover, a phase-wise implementation strategy for each proposed technique is suggested, as the success can be assessed and gaps can be rectified before the same is implemented into the next site.

3.5.2 Capacity Building [xix]

Capacity-building or the staff training of the host party for both front-end and back-end is substantial for a successful implementation as well as for its sustainability. Front-end capacity building should include the training of site officers, who directly interact with the visitors to demonstrate, handle and guide visitors to receive an effective experience through the proposed digital interpretations techniques. Most importantly, the onsite staff and volunteers (if any) have to be aware of the abilities and needs of the audience and people with disabilities. They have to be trained appropriately to guide such visitors to have the fullest possible experience within their visit. The Back-end capacity building should include training of the staff who will be engaged in Application Management, Database Management, System Administration and Operation, Information Security, Maintenance and Content Revision, etc. of these digital interpretation applications. The present study recommends setting up an 'IT division' in heritage management institutions to handle these digital projects. These institutions can develop collaboration set up with the academia, external institutes to strengthen these activities and share the knowledge and encourage innovations.

3.5.3 Communication [xx]

Communication includes both internal and external communication related to the implementation and operations of digital interpretation developments. External communication is important in collaborating with resource persons from universities, professional institutes like SLCA, ICOMOS, ICTA, etc. and freelancers. In addition, regular updates on project progress and achievements shall be communicated to all levels of internal staff.

Moreover, effective communication with stakeholders such as custodians of heritage sites, major site management institutions (i.e. Galle Heritage Foundation), Public/Private digital content development companies, Public/Private partner companies, visitors and the public is vital. The official communication with stakeholders shall be done at each hierarchical level upon their vested authority. Moreover, there should be an effective awareness strategy to promote these new interpretation experiences among the local and foreign visitors and the public, both on-site and off-site. As for onsite, setting up hoardings at the site entrances, issuing guided visitor brochures with the entrance ticket or at information centres, awareness through on-site officers are possible actions. However, the physical awareness solutions within the site should not disturb the monuments nor interfere with the visual experience of the visitors and the aesthetic value of the site. Heritage Sri Lanka project by ICTA has currently fixed signage in Polonnaruwa CWHS with minimal interference to the site (figure 8).

Figure 8. Signage fixed by Heritage Sri Lanka project of ICTA

As for offsite awareness, separate strategies shall be followed for each target category. To address the public, especially youth, social media is more convenient and effective. The comments, recommendations and ratings by travellers on travel apps like 'Trip Advisor', 'Google Reviews', 'Guides by lonely planet' have a huge impact/influence in the field of tourism. Academic conferences and lectures are suitable platforms to convince academics and researchers on developed digital solutions at each CWHS and to encourage them for further research. It is important to get involved with the tourism authorities and tour operator companies to promote these new experiences among the visitors, especially the foreign tourists. Furthermore, hoardings, leaflets shall be kept in places where foreign tourists mostly visit, such as airports, hotels, museums, etc. In addition, the use of digital marketing means such as search ads, display ads, email marketing, etc. is also a possible awareness strategy that could be used in this regard.

3.6 Sustainability

Since both 'interpretation' and 'digital technologies' are not static but of an ever-changing and evolutionary nature, to achieve sustainability in these kinds of projects, the following important factors were identified.

3.6.1 Operation and Maintenance [xxi]

Operations Management is vital in delivering uninterrupted and smooth service. These digital projects introduce new roles and responsibilities that have to be defined clearly in the organizational hierarchies. In front-end, regular service operations shall accompany regular housekeeping practices, including cleaning individual user devices such as VR headsets or portable lending devices. Regular technical maintenance of both the front and back end is substantial to maintain better performance conditions. The maintenance must be carried out by competent and well-trained staff, either in-house or outsourced, as the responsibilities and required skill set differs from the heritage field.

The maintenance shall include fixing bugs and errors, functional checks, servicing, repairing or replacing of necessary hardware devices, periodic software updates, antivirus updates, keeping backups, building infrastructure, and supporting utilities in any installation. Accordingly, a maintenance policy needs to be developed for the proposed digital interpretation techniques and the developers should hand over a maintenance manual with instructions.

3.6.2 Periodic Evaluation and Optimization [xxii]

Evaluation is a critical quality assurance measure in heritage interpretation to be done during the project period and post-implementation (Department of Conservation, Wellington, 2005). The evaluation criteria and procedures have to be defined in the project planning and implementation stages and kept updated with the operations. Once the proposed techniques are implemented, it is important to have a periodic evaluation to further optimize the service rendered. Thereby, several aspects such as Visitor Experience, Technical System, Cost and Revenue and Impact can be periodically evaluated for its sustainable operation and optimization. These evaluations can be done via both direct and indirect methods and the data will be available in both quantitative and qualitative formats. Nowadays, sophisticated analytical tools are available to measure the post-visit experiences shared by visitors in social media, apps and web sites etc.

Considering the performance, compatibility with different OS platforms and the cost, '*Google Analytics*' or '*Flurry'* are suitable free analytic tools that can be used for the performance of the mobile apps. The same can be monitored in the proposed Interactive Digital Screens using the above monitoring apps. The data about usage, audience, technical and events are some of the data that can be collected through such a mechanism. In the direct methods, the visitors directly provide their feedback about their experience from the onsite digital interpretation techniques in each CWHS. The technical system of each proposed technique should also be periodically evaluated in terms of Tracking/ Oscillation/Positioning, Access rights, Visibility of system status, Content accessibility, Aesthetic, Consistency and standards of GUI, Terminology, Functionality and quality of graphic elements, etc. (Sylaiou, Economou, Karoulis, & White, 2008). Furthermore, it is important to closely monitor the cost and revenue generated by some proposed techniques over time. As mentioned in theme (b), impact evaluations on the environment, heritage and society shall be done at the feasibility study stage as well as after a successful implementation.

3.6.3 Research and Development [xxiii]

Once these proposed digital techniques are implemented, it is important to conduct academic research, which will help to optimize the experiences as well as to revise content if any. Apart from filling the gaps with scientific research, it is suitable to invite universities, researchers, enthusiasts to conduct research on these techniques and develop more solutions.

3.6.4 Archival and Material in Heritage Management and Education [xxiv]

As noted in Principle 2.5 of the ICOMOS Charter on Interpretation and Presentation of Cultural Heritage Sites (2008), the interpretation and presentation programs and activities should be documented and archived for future reference and reflection. Accordingly, the host party and the respective site office of each CWHS must maintain the archives of the contents and the evaluation, maintenance, content revision reports, etc. of each of these digital interpretation techniques. As described in UNESCO Charter on Preservation of Digital Heritage (2009), the content developed for digital interpretation techniques is also taken under the category of 'Digital Heritage'. Thus, continued access to these digital materials must be ensured and be used for subsequent purposes like Heritage Conservation, Education and Management.

4. Conclusion and Recommendations

4.1 Recommended On-site Digital Interpretation Techniques

Based on the results, the study recommends the following digital techniques as suitable

and feasible to enhance the on-site heritage interpretation of the six CWHS of Sri Lanka (Table 3).

In Galle, kiosks shall not be mounted on the rampart and other outdoor premises while Digital Sound and Light Shows of Sigiriya and Galle are subjected to the EIA and SIA respectively.

Table 3. Proposed digital techniques for the On-site Heritage Interpretation at six CWHS of Sri Lanka (Source: Developed for the present study)

Site	AR-enabled Mobile Apps	On-site Virtual Reality Tours	Interactive Digital Screens (kiosks)	Sound and Light Shows
Anuradhapura	✓	✓	-	-
Polonnaruwa	✓	✓	-	-
Sigiriya	✓	✓	-	✓
Kandy	✓	✓	✓	-
Galle	✓	✓	✓	✓
Dambulla	✓	-	✓	-

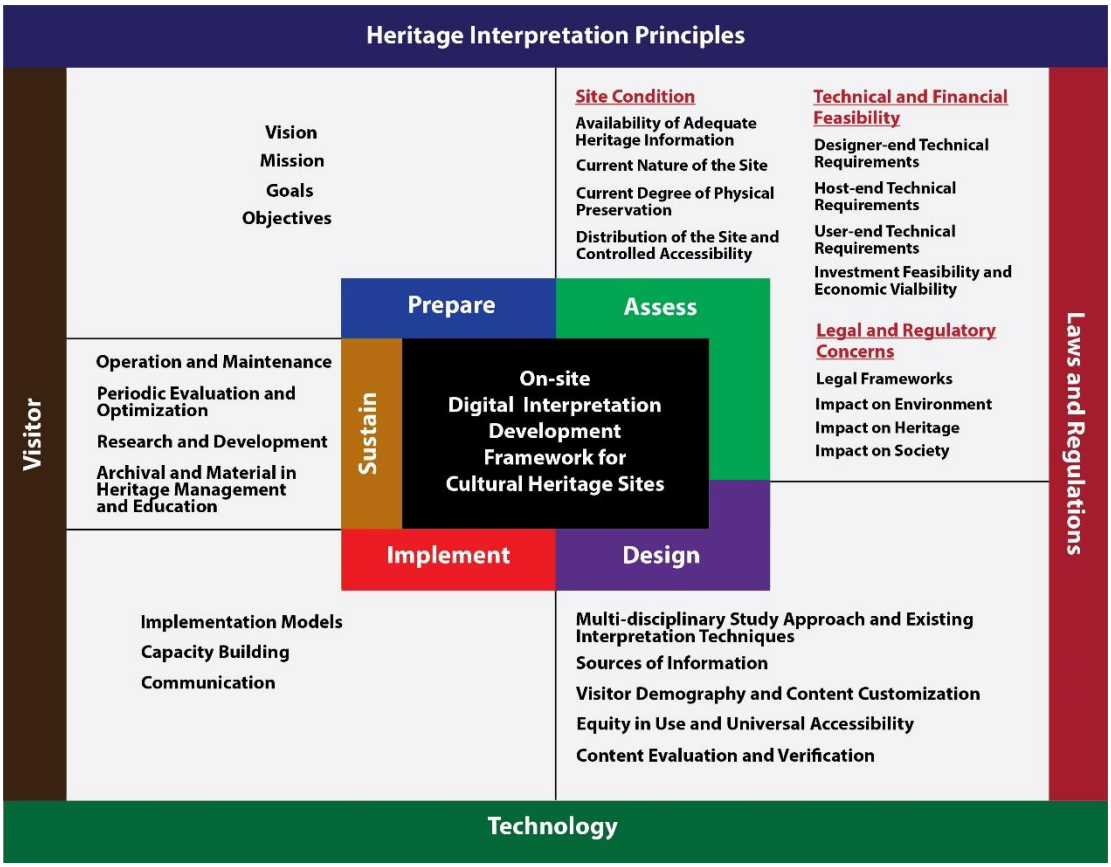

Figure 9. Proposed On-site Digital Heritage Interpretation Development Framework for Cultural Heritage Sites of Sri Lanka (Source: Developed by the present study)

Apart from implementing these digital interpretation techniques at the sites, it is suitable to have an offline mode with certain information, where the visitors can use off the sites. All the digital interpretation techniques implemented island wide can be linked into one site and serve as the 'National Heritage Tourism web portal'.

4.2 Conceptual Framework for On-site Digital Interpretation Developments for Cultural Heritage Sites of Sri Lanka

Based on the analysis results, the present study identified 24 criteria under six main themes to be considered in the process of On-site Digital Heritage Interpretation developments for Sri Lanka. Considering the accepted phases of Project Management, the said criteria (24) are assigned under 05 phases, '*Prepare'*, *'Assess'*, *'Design'*, *'Implement*' and *'Sustain'*. Moreover, four main arms namely, '*Heritage Interpretation Principles*', *'Laws and Regulations*', *'Technology'* and *'Visitors'* encompass all these phases and their respective criteria (Figure 9)

Accordingly, the ***'Prepare Phase'*** shall be setting up Vision, Mission, Goals and Objectives for the On-site Digital Heritage Interpretation developments, which should be aligned with the Management Plan of the respective heritage site(s). During the ***'Assess Phase'***, a careful feasibility study shall be carried out in the aspects of *'Site Condition'*, *'Technical and Financial Feasibility* and *'Legal and Regulatory concerns'*, which includes 12 criteria (half of the total) to be assessed. A successful feasibility study will ensure the positive outcome of a project. Next, the five criteria in the ***'Design Phase'*** shall ensure that the content of these digital interpretation techniques meets the academic and theoretical standards and the ultimate deliverable is effectively planned. Then, the ***'Implementation phase'*** takes place and is followed by the ***'Sustain phase'***, where actions are carried out to lead the developments into sustainability and optimization. In addition, it is important to undertake these phases with a participatory approach, which means the involvement of all the relevant stakeholders and interested parties. Furthermore, since both 'interpretation' and 'digital technologies' are not static but of an ever-changing and evolutionary nature, this conceptual framework shall be iterative.

It is evident that adopting digital techniques for heritage interpretation is a long and complex process, which needs to evaluate many of the social, technological, environmental, financial, legal factors and plan the implementation, operation and sustainability stages of the project life cycle in broad. The direction proposed by this conceptual framework does not limit to the CWHS but can be referred to in implementing digital interpretation projects for other cultural heritage sites. Not only this conceptual model could be used as a reference for policy makers but also would lead to the standardization of digital interpretation development of the country, which will directly and indirectly benefit the country's tourism industry as well. Further, this research will support several existing digital interpretation projects, some of which are currently at standstill. Accordingly, with these deliverables, the present study assumes that the initially set objectives of the research are met in maximum capacity despite some challenges encountered. Finally, it is recommended that the Digital Heritage Interpretation area should be researched further as improvements for on-site interpretation never end.

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