Capturing the Floating World: Digital Documentation of a Kelong in Singapore

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Abstract:

This paper presents the digital documentation of Kelong E63, one of Singapore's last remaining kelongs, or offshore fishing platform. As a dynamic, vernacular structure, the kelong was documented using a hybrid methodology combining LiDAR, photogrammetry, sonar, 360° video, and other spatial media, incorporating knowledge gained from traditional fieldwork. Technical and environmental challenges such as tidal shifts and structural instability required an adaptive, multi-phase approach to digital documentation. Beyond structural accuracy, the project aimed to capture the intangible rhythms of kelong life. Adopting a transmedia perspective, the project integrated spatial datasets with oral histories, archives, and media, allowing user-driven exploration of the site. This work-in-progress demonstrates how immersive digital tools can preserve not just the technical form, but the lived experience and "aura" of maritime heritage.

1. Introduction

1.1. Background and Historical Significance of the Kelong

A kelong is a large offshore or inshore palisade trap ubiquitous to the Southeast Asian maritime region (Burdon *et al.*, 1954). It is distinguished from other trapping methods by its large size and fixed location, often serving as a dwelling for its operators. In its peak in the 1940s, kelongs in Singapore produced 60% of its inshore catch, with 254 licensed kelongs extant in Singapore waters (Reeves and Reeves, 2005). Rich Malay-Bugis and Chinese cultural practices and beliefs were wrought around the operation of a kelong (Chou, 1986; Awang bin Osman 1984).

Figure 1. An aerial view of Kelong E63 in the background, with Fish Farm E63C in the foreground

In the latter half of the 20th-century, factors such as the decreasing viability of fishing as an economic practice and the halting of the issuance of new licenses for kelongs led to a significant decline in kelongs. Contemporary circumstances such as the advent of more efficient seafood farming methods (as opposed to wild-catching), environmental change, and development needs in Singapore's foreshores have further caused the decline of kelongs in Singapore's waters. This decline can be linked to Singapore's wider historical processes, which shifted from material privation in early post-colonial times to efficient, productive modes of industry, often trading off traditional methods of life and livelihood (Chua, 1995). This context adds to the urgency of pre-emptive "rescue" digital documentation (Addison, 2008), especially of traditional itinerant maritime structures such as the kelong, in Singapore.

Today, there are three known kelongs extant in Singapore waters. In anticipation of the expiry of their operating license, the operators of Kelong E63 reached out to the National Heritage Board (NHB), and it was decided for documentation work to be carried out while the kelong is still in operation. The findings of the digital documentation are discussed in this paper.

1.2 Digital Heritage Work in NHB

Since the official inception of a digital heritage initiative in 2021, whose key pillars include digital heritage for conservation, education and accessibility, and capability development, NHB has digitised and documented over 700 heritage assets of various typologies in Singapore as part of building a national 3D and digital heritage asset repository. These span across both tangible and intangible cultural heritage assets, including national monuments, buildings and sites, objects from the National Collection, and intangible cultural practices. To this end, the NHB has developed digital documentation guidelines and data standards for the production of high-quality digital assets. Access to this produced data is also planned for longevity through data interoperability guidelines.

Buildings and sites comprise the largest object typology in NHB's digital documentation. Significant challenges are posed in their digitisation, such as complex building geometry, the variety of materials employed on different building and site types, variable weather in monsoon-prone Singapore, and the difficulty in accessing the various parts of a site. This in turn affects the manpower, time, and resources required for the project and ultimately the scope, quality, and quantity of the gathered data.

1.3 Digitising Kelong E63

Kelong E63 is the first off-shore site that NHB is digitising. This necessitates a technical approach radically different from typical approaches to terrestrial sites. Methods employed have to be considered based on how effective they are above, under, and over the structure.

Furthermore, unlike the often vacant, static heritage sites typically documented by NHB, the kelong presented a unique opportunity to document an operational site rich with intangible cultural heritage. Traditionally, digital heritage efforts often prioritise the precise capture of architectural and structural features. This has since been replaced with the new impetus to effectively capture the "living" essence of heritage structures (Economou, 2015).

Beyond the technical challenge of recording such elements, this is an epistemological question of translating the intangible life on the kelong into a digital format that respects authenticity and accuracy. This paper uses NHB's work-in-progress to demonstrate that addressing these questions requires a unique approach to digital heritage practice, moving beyond purely structural documentation to embrace a user-centric, transmedia approach that acknowledges and intentionally incorporates the ephemeral and dynamic aspects of living heritage.

2. Process Considerations and Challenges

This section outlines the considerations and challenges the team had in the early phases of planning and executing the digital documentation.

2.1 Planning

The design and structure of the site was initially unclear to the team. Aside from conceptual drawings drawn by past academics used to illustrate how these fishing traps might have worked (Burdon, 1954; Chou, 1986), these frequently itinerant, vernacular structures did not have associated technical reference material such as architectural drawings or building blueprints. This necessitated good fieldwork to be done on the site as an advanced survey prior to the digital documentation and lent an impetus to the technical documentation of Kelong E63.

2.2 On-Site

The off-shore site posed logistical access challenges. The small boat used to access the site ferries a limited number of people and equipment, necessitating multiple trips. The restriction of important kelong activities to specific times of the day according to the tides, which changes daily, frequently undermined the possibility for consistent capture times. The timing of our works were thus subject to the rhythms and unpredictability of nature. This temporal unpredictability, combined with the site's relative inaccessibility and instability, highlighted the value in creating a digital surrogate that enables virtual access to the kelong regardless of timing or physical ability.

These insights from the early phases of documentation work gave the team a clearer understanding of how the digital methods should be scoped, accounting for both breadth and depth in documentation, as well as other factors such as timeline, budget, and manpower availability. In planning the scope of the digital documentation work, the team focussed on the following aspects: (1) capturing data with high potential and versatility for post-production, such as point-cloud data; (2) employing methods offering the best price-to-value ratios, such as Matterport, 360-degree videos, and general and aerial photography and videography; (3) employing more complex and technical methods, including photogrammetry and sonar scanning; and (4) capturing and documenting the process, which was especially important as this was a novel project.

The combination of these methods meant that different personnel needed to be on site at different times. This was a double-edged sword: while the protracted process involved many phases, each phase benefited from the lessons learnt in the previous. These methods will be discussed in more detail in the next section (3. Methodologies and Preliminary Results).

2.3 Post-Processing and Integration

The primary intended output of this documentation is to aggregate and consolidate different data sets – point clouds, high-resolution 3D models, reality captures, photos, and videos – into one cohesive, publicly-accessible experience. The nature of the structure, which reveals itself in parts over- and underwater, meant that some data needs to be waited on before the next set of data can be processed. For example, the full underwater sonar scan was required before a BIM model of the kelong could be created as the submerged elements of the structure were unknown.

The complexity, comprehensiveness, and "completeness" of the final output will ultimately be determined by the types of data captured. A good variety of captured data leads to a higher-quality integrated experience – this will also provide a range of options to curate and work with for the final digital experience. More data, however, also requires more time and resources to process. In some cases, data fatigue can introduce noise and lead to diminishing returns, where the effort invested in the creation of excess data no longer translates proportionately into improved outcomes (Huggett, 2022).

3. Methodologies and Preliminary Results

This section details out the methods of documentation executed in chronological order, including the traditional fieldwork done before digital documentation. It will also address the challenges faced at the point of data collection and their impact on the quality of the data captured.

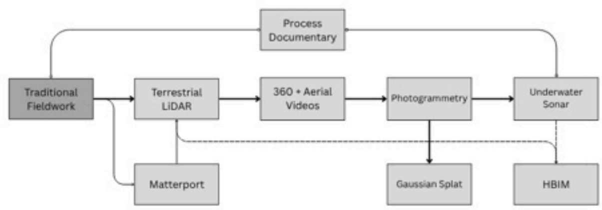

Figure 2. Process flowchart of methods employed with "by-products" from the data collected

3.1. Traditional Fieldwork and Archival Research

These digital methods were introduced to complement anthropological fieldwork, including anthropological illustration, oral history interviews, and observation. The "traditional" fieldwork was done by NHB's Heritage Policy and Research (HPR) team and laid the foundational groundwork to the digital documentation of Kelong E63.

The importance of medium to long-tail anthropological fieldwork and close engagement with the stakeholders involved cannot be understated (Chan and Cai, 2023). Aside from building the prerequisite trust and rapport with the kelong operators that enabled the documentation works to take place at all, this preliminary fieldwork informed how the digital documentation is devised and formed the bulk of the resources incorporated to provide contextual information within the digital experience.

Site visits were conducted from June to August 2024, where observation and participatory fieldwork was conducted by NHB personnel. A diagrammatic site plan of the kelong and several illustrations of life and work on the kelong were instructional to the devising of the digital documentation. Two oral history interviews (OHI) were conducted – one with the kelong owners at NHB offices and another on-site with the two workers who live full-time on the kelong (Figure 3). These two OHIs and the fieldwork conducted proved indispensable insight into how the kelong operates, and subsequently guided the digital documentation by signposting what the important activities that should be digitally documented are, where they take place on the kelong, and when they take place.

Figure 3. An oral history interview with Kelong E63's workers

HPR also dug extensively into archival records and academic and historical sources in order to establish a canonical history of kelongs in Singapore, as well as compile the previous information built up around the structure of the kelong. Aside from technical drawings and oral accounts, there was a dearth of detailed insight on the method of construction of the kelong and the kelong's structure. This literature review identified the gaps that the team focussed on addressing in the digital documentation of Kelong E63.

3.2. Terrestrial LiDAR Scanning

Terrestrial LiDAR scanning provided high-precision point clouds of the above-water structures of the kelong. To achieve this, a high-resolution terrestrial laser scanner mounted on a tripod was used. This method is crucial for capturing the fine geometry in the kelong's architecture and structure, ensuring that a 3D model with precise dimensional accuracy is obtained as the foundation for this documentation project.

In ideal conditions, structures the size of the kelong can be captured relatively quickly, with only a handful of scan points required. The site of capture can be divided roughly into three sections: Kelong E63, the attached Fish Farm E63C, and the "wings" of the kelong (Figure 4). The kelong is usually driven deep into the seabed and thus there is little motion to the structure. The fish farm, however, is a floating structure that is subject to the movement of waves and tides. In the course of the team's works, there were no issues scanning the fixed structure of the kelong. However, upon conducting some initial scans, significant ghosting was observed in the results at some areas for the fish farm (Figure 5). The 'movement' of the fish farm was something that was not apparent during the pre-work site visits as there were no strong tides then. Unfortunately, the tide movement was strong enough on the day of work to pose a significant problem when scanning the floating fish farm. At this juncture, the team decided to continue scanning the fish farm, 'timing' the scans during minimal tide movement to reduce the chances of further ghosting. While this alleviated the ghosting issue for some scan points, ghosting still occurred in others as movements may suddenly happen during scanning.

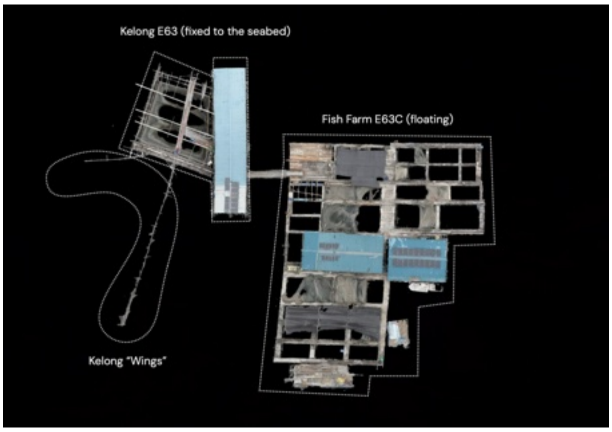

Figure 4. Three components of the documentation area in Kelong E63

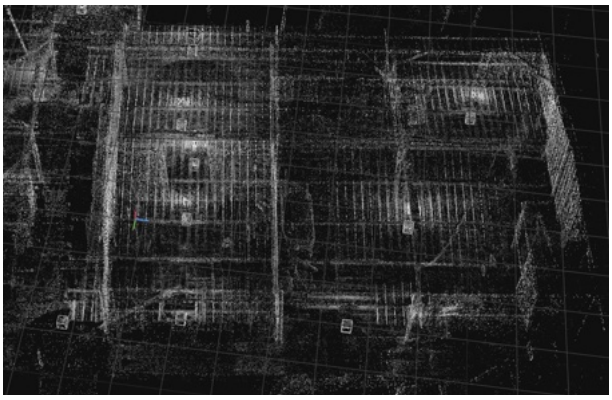

Figure 5. Ghosting observed in the fish farm point cloud data

Ghosting presented issues in the registration and auto-alignment of point cloud data, resulting in instances of inaccurate feature detection and, ultimately, registration errors. The data had to be aligned through manual transformation and the selection of equivalent points between scans. The movement of the floating fish farm made it impossible to manually register the captured scans of the "bridge" between it and the kelong. Segmenting the scan data into the fixed and floating areas eventually helped to resolve these alignment issues. This process highlighted the need to consider tidal motion for future on-site work. It informed the approach for photogrammetry and other video work; this will be discussed in the later parts of this section.

Figure 6. Dense coloured point clouds results, processed as two separate parts (Fish Farm E63C on the left and Kelong E63 on the right)

The structural integrity of the aged kelong also posed problems during the scanning work. An accident occurred when a LiDAR scanner fell into the water after an operator stepped on an unstable wooden board that gave way. Although the operator was safely extracted from the water without injuries, the scanner was unfortunately damaged beyond repair and had to be replaced. This accident also required the risk assessment of the project to be amended and additional requirements, such as the wearing of life-jackets, to be enforced, ensuring operators' safety for subsequent work on-site.

3.3. Matterport 3D Scanning

Due to the loss of the LiDAR scanner, the project faced delays, necessitating the purchase and delivery of a new set of equipment. In the meantime, a Matterport 3D scan was prioritised as an intermediary documentation method due to its speed and user-friendliness, providing a temporary solution for capturing the spaces of the kelong.

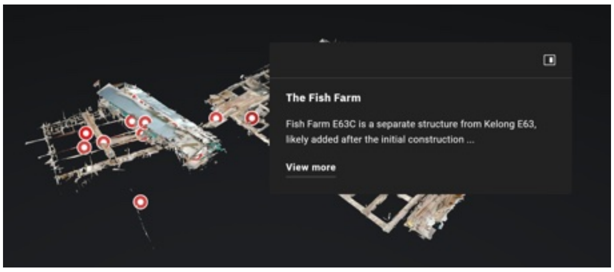

Figure 7. Dollhouse view of the Matterport 3D scan of the kelong, with hotspots

An additional UI layer was custom-designed to allow for additional contextual content to be embedded via hotspots, including relevant text, images, and videos. This documentation served as a quick and reliable reference tool for subsequent on-site work and context orientation.

3.4. 360° and Aerial Videos

In key activity points around the kelong, such as the outdoor net area, an Insta360 Pro 2 camera was used to capture 360° videos in 8K resolution. This allows for the activities to be documented in detail within the context of the environment in which they take place. Areas marked with red dots in Figure 8 indicate the filming locations, with the larger dots signifying priority areas. In particular, these areas are where key activities like fishing and sorting of fish take place.

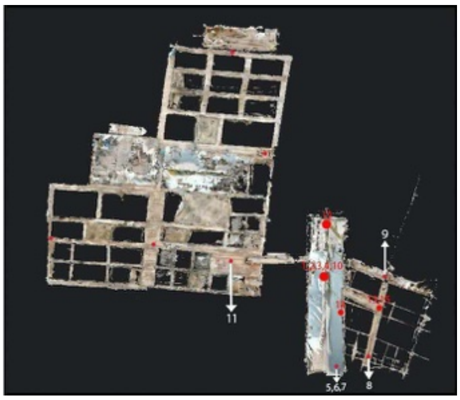

Figure 8. Markup of a site plan of the kelong indicating points for 360° video recording

The areas were selected not only as they are key activity hotspots and important locations within the kelong, but also due to their relative proximity to each other as the team wanted to explore "stitching" the 360° videos together. In a manner similar to Matterport, these 360° videos were stitched together to create a 3D space. The essence of this idea is to create a 'live' digital walkthrough, allowing users to experience synchronised activities, sounds, and movements through the 360° videos as they navigate different points in the digital space.

Figure 9. Unwrapped frame from 360° video of preparation for fish sorting on Kelong E63

3.5 Photogrammetry

Photogrammetry was implemented using two complementary approaches. Aerial photogrammetry captured broad site context via drone imagery using a DJI Mavic 3 Enterprise and Matrice 300 with a Hasselblaad camera, while DSLR close-range photogrammetry captured high-detail images for critical structural features and interior spaces. This survey was conducted by one unmanned aerial vehicle (UAV) pilot and an assistant, with ground-based photographers to coordinate and cover overlapping areas. Learning from experience in the LiDAR scanning phase of work, the team approached photogrammetry of the structure by splitting the work areas into fixed and floating sections.

The models had to be stitched and aligned as separate segments on RealityCapture with their respective point cloud data, with the final model having to be manually aligned and joined together in Blender. Due to the complex structural geometry of the kelong structure, it was a challenge to stitch the exterior and interior spaces together. The resulting model also had numerous stray meshes and artefacts due to this, with frequent and random spacing in between its wooden construction stakes. This translated to small holes and voids that led to software confusion during processing.

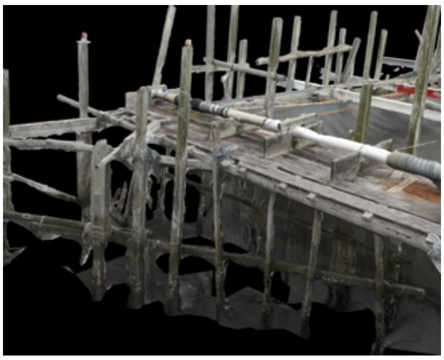

Figure 10. Close-up of a section of the 3D model of the kelong, with many timber elements intersecting resulting in noisy mesh reproduction

During this phase, there were insufficient resources to perform further cleaning on the model. The team assessed that the decimated model with some minimal mesh blending performed on Blender was sufficient to create a presentable high-resolution model. The model is hosted on Nira, a device-agnostic hosting platform for the visualisation of large 3D models in real-time, to allow for smooth and seamless web viewing without compromising on its quality.

Figure 11. Perspective view of completed high-resolution photogrammetry model

3.5.1 Gaussian Splat

Gaussian splatting was employed as an additional approach using photography data captured for photogrammetry. By applying Gaussian functions to individual points, this method smooths data irregularities and produces a continuous surface representation. This is particularly effective for visualising the complex textures and fine details of maritime heritage structures naturally.

Gaussian splatting is a relatively novel technique in the processing of images to 3D data (Kerbl *et al.*, 2023) and the team took the opportunity to use the previously accumulated datasets to perform this splatting. The team's early assessment was that performing Gaussian splatting was less effort-, resource-, and hardware-intensive compared to photogrammetry. While in general gaussian-splatted 3D models require less source photographs to generate and yield good quality results for time-sensitive and data-scarce projects, the general output quality is still less detailed than a data-rich and well-cleaned photogrammetry model (Jamil and Brennan, 2025).

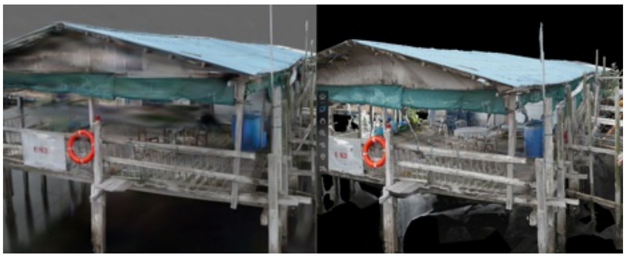

Figure 12. Side-by-side comparison of gaussian splat (left) and photogrammetry model (right)

3.6 Sonar Scanning

Sonar scanning was employed to document the submerged components of the kelong. This surveying was necessary to understand both the kelong's exposed and submerged structural elements. The survey was done on a specialised vessel equipped with a multi-beam sonar system operated by a team of four to five personnel including a diver with prior marine surveying expertise, and certified sonar operators and support technicians above water. Scans were scheduled during low tide and periods of minimal water turbidity to maximise data clarity.

A six-person diving crew, supporting one diver equipped with a BV5000 MK2 Scanner, was present on site, alongside five on-land members of the surveying team. Work was planned for three days, with two days of actual work. On the first day, a part of the scanner was damaged and the scanner had to be replaced. Despite the scheduling for low tide and clear water, the visibility underwater was still poor (Figure 13).

Figure 13. Diver positioning the sonar scanner and anchoring it to the seabed facing the underwater structure

The scanner had to be manually lowered into position, with underwater operations guided by communications from the survey team on land. However, communication was often hampered by audio quality and reception issues, and it took time to align the diver's movements with instructions from the surveyors regarding the placement and orientation of the scanner.

Each scan required the diver to take cues from land-based surveyors on the kelong to know where to position the scanners. Underwater, scanning had to be anchored well before the scan cycle to avoid shifting in the scanner position. A typical scan cycle took approximately 45 minutes, including the diver's descent, positioning, scanning, and return. The scanning pattern followed a 180-degree horizontal sweep with tilts at 15°, 45°, -15°, and -45°. Fatigue began to set in during subsequent dives, with the diver surfacing earlier than expected. On some occasions, the computer system failed to register a connection with the scanner, necessitating the diver to surface while surveyors attempted to troubleshoot the issue.

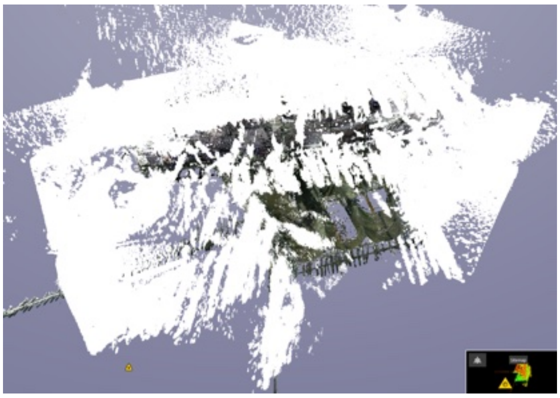

Figure 14. View from the underside of the kelong, showing captured point cloud from sonar scans in white

Despite the team's best attempts, the resulting data was very noisy and challenging to interpret (Figure 14). While the scans did yield a rough indication of the location of structural

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elements, the data had to be manually aligned with the terrestrial scan and meticulously cleaned in order for it to be usable.

3.6.1 HBIM (Heritage Building Information Modelling)

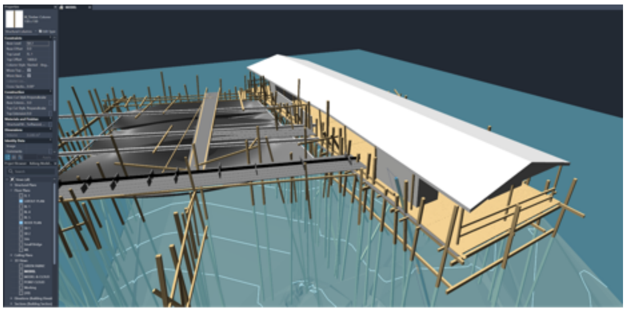

Figure 15. HBIM model of Kelong E63 developed from combined terrestrial and underwater point cloud data

For this phase, terrestrial and point cloud data from previous captures were used as foundation for the BIM modelling on Revit. A degree of manual interpretation and guesswork was required in order to identify key structural components such as the columns and stilts from the underwater scan (Dore and Murphy, 2017). The BIM model was modelled to a Level of Development (LOD) of approximately 200–300, with the primary aim of clearly identifying and positioning the main structural elements. As the structure is not architecturally complex (i.e. with ornamentation or detailing), a higher level of detail was deemed unnecessary at this stage. The focus was on ensuring that the significant and obvious elements of the kelong's structure and construction logic were captured within the model, providing a foundation for future data enrichment, such as the tagging of materials and estimated dating, once resources and capacity allow. The team is also working towards the development of 2D CAD drawings to offer a more detailed and accurately scaled reference of the structure.

3.7 Process Documentary

The works done above were captured in a process documentary. This was something the team deemed essential given the novelty of the project. Documenting the process allowed the team to both capture the technical workflow as well as the challenges and decision-making that shaped the output of the project.

Since the end-use of the footage was not known, aside from the footage being a form of documentation and explanation of the process, the documentary team relied either on broad coverage (which is more cost and resource-intensive) or on smart, targeted filming. Being on location while the work was being done required close coordination between the different working teams and often, on-the-fly adaptation. While some elements of the documentation could be pre-planned, such as the mounting of a 360 camera on a diver during sonar scanning works, actual implementation had to be largely improvised on-site.

This mode of documentation also required NHB's judgement call in ensuring that what was captured was useful and significant, with many trade-offs made when there were time or environment-related restrictions. A consistent crew proved invaluable, as familiarity with the subject and space deepened over time. In post-production, the team faced the added challenge of balancing technical accuracy with accessibility, especially when visualising complex concepts like point clouds or LiDAR. Editing thus became a space not just for assembling footage, but for translating technical processes into a form that is meaningful and comprehensible to a wider audience.

Figure 16. A previous example of a documentary showcasing the digitisation of Thian Hock Keng temple, a national monument in Singapore, using visual effects and post-production to illustrate the transformation from raw 3D data to high-resolution reproductions

4. Digital Experience: Work-in-Progress Results

The latest outputs of the work-in-progress digital experience represents the early integration of the multiple digital assets and interpretative layers acquired thus far. Developed using Unreal Engine, the experience offers a high-quality representation of the kelong in at least six different visualisation layers, each showcasing a different aspect of the kelong (Figures 17-20).

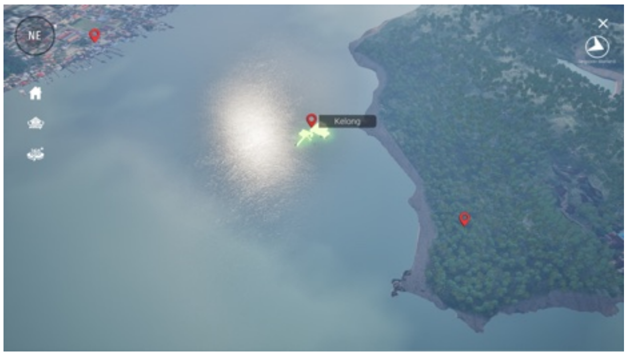

Figure 17. High-level view showing the larger context of the kelong within the Straits of Johor

Figure 18. Mid-level view in the digital experience showing photogrammetry model with options to switch to point-cloud and HBIM models

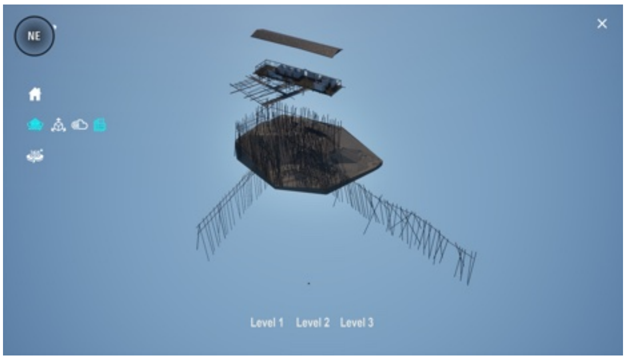

Figure 19. HBIM mode showcasing an exploded view of the different ‘levels’ and structural components of the kelong

Figure 20. Human-level view of a seamless walkthrough of point-to-point 360° video captures with interactive touchpoints

5. Discussion

5.1 A Meaningful Medium or a Technological Exercise?

The physicality of the approach to Kelong E63 by boat is integral to the sensory experience of the site — marked by sea spray, nearby fishing vessels, and the smell of fish. This embodied event (Kalay, 2008), however, cannot be replicated digitally, and no attempt was made to do so. Instead, our digital strategy focuses on two key affordances of virtual media: accessibility and contextualisation.

First, accessibility – there is no doubt that accessing Kelong E63 from home is easier than accessing the physical site itself. In addition to having to clear administrative restrictions, and having to arrange for boat transport to the location, it can be difficult to navigate oneself around the kelong, especially for those with mobility issues. The second is context – without an on-site guide, it is difficult to understand how the kelong operates and what life is like on the kelong. Incorporating the information built up over the course of the documentation work aids viewers in understanding the historical, cultural, and operational context of the kelong. Focussing on these two strengths also address two critical gaps in knowledge around the kelong – a lack of comprehensive documentation of contemporary kelong life “post-transition” (Chou, 1986), and no technical plans surrounding both the over-water and underwater structure of the kelong.

On considering these twin focal points of access and context, the team concluded that both the materiality and the “aura” (Jeffrey, 2015) of the site are important and closely intertwined (Malpas, 2008). Extensive fieldwork and documentation of the intangible practices on the kelong suffers if it is enacted on an inaccurate digital version of the kelong not true to the original structure. The inverse is also true: technically accurate digital scans of the kelong mean little without depicting the life it hosts.

5.2 Future Directions: Towards a Transmedia Digital Maritime Heritage

One of Tilden’s six principles of heritage interpretation is that “(heritage) interpretation should aim to present a whole rather than a part, and must address itself to the whole man rather than any phase.” (Tilden, 2008, p. 9). This is, however, challenged by two characteristics of the digital experience. The first is that the virtual does not claim to be the real – it is missing in parts, there is therefore no “sense of the whole.” (Malpas, 2008, p. 25) Additionally, digital literacy in an increasingly technologically democratic world results in each user having a unique experience, making it challenging to create a universal narrative.

Understanding this, the team from NHB was interested instead in how “authority… and responsibility… for constructing the narrative” (Kalay, 2008, p. 7) can be invested in the user. The team sought to borrow and integrate the concept of gappages from the realm of transmedia – how ambiguity can be foregrounded (Kidd, 2019, p. 274) and let users lead their own exploration of the experience. In addition, the weaving together of various datasets – including digital assets, oral history interviews, illustrations, archives, soundscapes, and textual sources – suits the adoption of the transmedial lens.

Two integral parts of the digital experience will be discussed here: the “stitched” 360° videos and the three “layers” introduced in the digital experience. The 360° video is a technological medium essential to the execution of gappage in this experience. The user is able to navigate the space unmediated by the framing of a camera telling them where to look. There is no voice-over providing a linear narrative for what is happening in the video. Furthermore, the stitched 360° videos lets users “walk through” the space, allowing them to observe activities, sounds, and movements in synchronicity at different points in the digital space. The team is considering adding a feature that lets users pause, fast forward, or rewind the 360° video. This will let the user pause time or go back to observe details that they might have otherwise missed in the 360° video. This collapsing of both time and space within the kelong’s digital experience aims to afford the user as much agency as possible within the digital experience.

Another feature essential to this approach is the layers that offer different perspectives and different contexts. The bird's-eye view enables the users to view a macro perspective of the site in relation to the Singapore mainland and the Malaysian border, and understand how the site’s location is influenced by tide patterns and historical processes in the Straits of Johor. The mid-level view allows for a closer inspection of the kelong’s super-structure and its constructional logic. Finally, the human-level view of the stitched 360° videos allows for an exploration of the details of kelong life. Toggling between the layers enables the simultaneous understanding of the kelong in various contexts and perspectives, something that is executed well by the medium of the digital experience.

While the digital experience offers new modes of interpreting the kelong, it is not without limitations. The experience is not yet device-agnostic – its high-resolution assets and demanding processing requirements limit current accessibility across different devices. The team is considering pixel-streaming as a potential solution to enable smoother access regardless of hardware. A further technical constraint stemmed from the sonar scanning process. Due to limited time and resources, setup for the underwater documentation was suboptimal and did not produce data of sufficient quality. This affected the accuracy of the underwater sections of the model, highlighting the realities of working with novel documentation technologies under constrained conditions. Finally, limited user experience (UX) research was conducted during this phase, which involved prioritising the integration and experimentation with multiple digital data formats. As a result, the current UX design was not guided by user testing or feedback, something that the team is keen to address in future development in close collaboration with the kelong's stakeholders.

6. Concluding Remarks

In documenting Kelong E63, NHB prioritised a balancing of technical precision with attention to context and intangible human experience. The team employed a mix of digital and field methods, endeavouring to build a layered representation of a site that is both structurally complex and culturally rich. While challenges remain, particularly in relation to data integration, accessibility, and underwater accuracy, this work-in-progress suggests novel methods for documenting maritime heritage in Southeast Asia and considers more holistic, user-centric approaches. The team hopes to record not just the kelong's physical form, but to ensure that at least a part of its "life" remains accessible to the general public in digital form.

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