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ARTICLE

Digital Specimens: A Pilot Study on the Dissemination of Knowledge via Digitized Zoological Specimens at Government Museum, Karur, Tamil Nadu

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ABSTRACT

This paper presents a preliminary study on the application of close-range photogrammetry for the digital preservation and enhanced knowledge dissemination of select dried specimens of phyla Porifera and Cnidaria from the invertebrate collections from the zoological section at the Government Museum, Karur district, Tamil Nadu. The initiative addresses the challenges associated with the fragility of these specimens and the need for improved visitor engagement and accessibility, in alignment with National Museum digitisation goals. Utilising handheld mobile cameras and open-source software, three-dimensional (3D) digital models of representative specimens of the select phyla were created and subsequently uploaded to the online 3D model repository *Sketchfab*. Further, Quick Response (QR) codes linking directly to the online 3D models were strategically placed alongside the physical specimens within the exhibition space. The impact of such QR-integrated, digitised exhibits on knowledge dissemination was assessed by observing visitor engagement time at the exhibit compared with exhibits lacking digital content. It was found that this method improved visitor engagement, as visitors were able to experience virtual manipulation and detailed viewing of the exhibited specimens without risking damage to the physical specimens. The study concludes that photogrammetry offers an economical, non-invasive solution for the comprehensive digitisation of artefacts, thereby enhancing the informational value and accessibility of museum exhibits.

Keywords: Photogrammetry, Digitisation, Artifacts, Government Museum, QR Codes

1 Introduction

Museums, in general, are great repositories of knowledge and information accessible to the public. They provide firsthand access to a wide variety of resources, including natural history, geology, and traditional, historical, and contemporary artefacts.In India, the Ministry of Culture, Government of India had initiated the Museum digitisation as early as 2014 through the deployment of '*Jatan*' software and had implemented it in ten select museums (Phase I) across the country for digitising their collections (Ministry of Culture, Government of India, 2022).

Around the world, museums are increasingly facing the critical challenge of preserving fragile collections while simultaneously making them accessible to the public. Traditional two-dimensional (2D) photography offers limited documentation, failing to capture the intricate, three-dimensional structures crucial for scientific study and public understanding (Parmentier, P., & Lebrun, P., 2017).In response to the broader national push for comprehensive museum digitisation in India (Ministry of Culture, Government of India, 2022), this pilot project undertaken at the Government Museum, Karur district, Tamil Nadu explores the efficacy of close-range photogrammetry-based scanning as a practical and accessible digitisation technique that can be easily adopted at the local level for digitising the collections. This method is chosen for its affordability (using mobile cameras and open-source software) and non-contact nature, ensuring specimen safety.The primary objective of this study is not only to document these specimens digitally but also to leverage modern technology for the dissemination of knowledge and to enhance the visitor experience. By utilising an online repository like *Sketchfab* and integrating QR codes into the physical display space, the museum bridges the gap between the static exhibit and interactive digital content.

2 Materials and Methods

A total of five representative dried specimens (Porifera – 1 No.; Cnidarians – 4 Nos.) available for display at the zoological exhibit, Government Museum, Karur, were selected based on varying degrees of structural complexity and preservation

condition (Table 1). Prior to scanning, specimens were carefully cleaned with soft brushes to remove dust and ensure optimal photographic results.Photographs (approximately 20-100 images) were then taken using a *Samsung Galaxy* A12 (48 MP rear camera resolution), ensuring substantial overlap (at least 60-70%) between consecutive images and maintaining a consistent distance from the subject while circumnavigating the target object at multiple elevations (top, middle, and bottom angles) to facilitate complete structural coverage (Remondino, 2011). The collected images were processed using open-source specialised photogrammetry mobile device application, *Polycam: 3D Scanner and Editor* version 2.1.3 (available for free in Google Play Store).All the resulting 3D models were exported in GLTF format (free version), while some of the 3D models that required mesh cleaning/processing were refined using another mesh optimisation software *Meshlab*V 2023.12 and final conversion to standard formats (.OBJ and .STL). The final processed 3D models were optimised for web viewing, with file sizes optimised to ensure quick loading times (Bruno, *et al.*, 2012).The prepared 3D models were uploaded to *Sketchfab*, a popular online platform that allows for the embedding, annotating and interactive viewing of 3D models directly in a web browser. The platform's features, such as annotation tools, allowed the museum curator/author to add scientific details and context directly onto specific parts of the digital specimens, which facilitates non-invasive sharing of valuable information about the specimen(s) and also ease of access to the visitor for interactive learning experience.To integrate this digital content within the physical museum space, unique QR codes were generated for each model's URL on *Sketchfab*. These QR codes were printed on durable labels and mounted on the display plaques next to the corresponding physical specimens in the exhibit space (Figure 1).

In order to assess the visitor engagement, the average time visitors spent (during the period of 30 days from 15th October 2025 to 13th November 2025 including holidays and non-visiting hours) at the zoological exhibit displaying similar invertebrate specimens with and without interactive QR code digital integration) and their engagement (via virtual viewing,

manipulation and interaction with the digital model on their device) were recorded and assessed for estimating the impact of digital integration on improvement in visitor engagement at the exhibits. This specific duration was selected to encompass a complete monthly operational cycle, capturing natural footfall variations across weekend spikes, public holidays, and institutional closed days, thereby ensuring a highly representative baseline of public engagement. Further, in order to prevent the Hawthorne effect (where subjects alter their natural behaviour when they know they are being monitored) all data collection during the 30-day study period was conducted via unobtrusive, distant behavioural tracking by the author. No direct engagement, photography, or feedback surveys were introduced, ensuring that the recorded interaction times reflect completely genuine, unadulterated public engagement with the digital interface.

Data collection, tabulation, statistical analyses and graphical art was done using Prism 8 (GraphPad software) version 8.0.2 (263) for Windows, GraphPad Software, San Diego, California USA, (www.graphpad.com).It is also important to point out a caveat here that, school student groups visiting the museum on free-entry were explicitly excluded from the tracking matrix. Because institutional rules and group dynamics meant these tours lacked independent mobile device access, they could not engage with the QR codes. Excluding them right from the research design stage ensures that the tracking isolates independent, device-ready visitors to evaluate authentic user-driven engagement.

Table 1: Representative specimens used in the present study

Phylum	Representative specimen
Porifera	*Hyattella* sp. (Lendenfeld, 1888)
Cnidaria	*Acropora* sp. (Oken, 1815)
Cnidaria	*Gorgonia* sp. (Linnaeus, 1758)
Cnidaria	*Turbinaria* sp. (Oken, 1815)
Cnidaria	*Pocillophora* sp. (Lamarck, 1816)

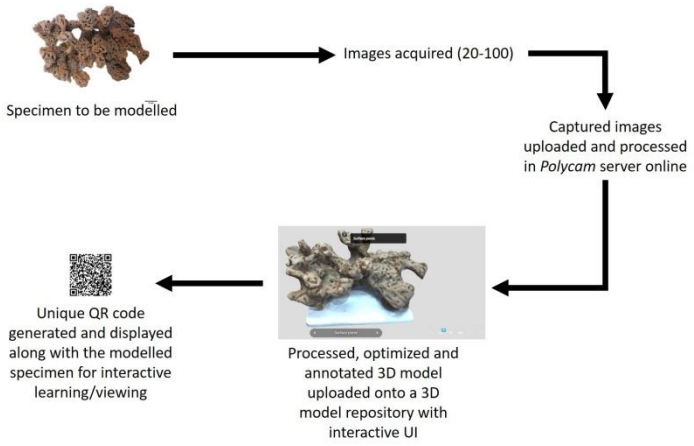


Fig. 1: Workflow of data acquisition, modelling and display alongside exhibit

3 Results and Discussion

The photogrammetry process successfully yielded high-resolution 3D models of all five specimens, capturing delicate morphological features that are difficult to discern through glass display cases. The total number of visitors logged during the 30-day study period i.e., from 15th October 2025 to 13th November 2025 are given in Table 2. Out of the total 284 visitors logged, 206 school students were excluded for reasons mentioned earlier and the remaining 78 visitors (69 adults and 9 children) were included in the tracking dataset. The exact same pool of 78 visitors (69 adults and 9 children) were monitored sequentially as they interacted with both the Control (static) and Treatment (QR-integrated) exhibits during their gallery visit. This approach eliminated individual visitor background noise as a confounding variable, allowing for a high-fidelity, direct comparison of engagement times stimulated exclusively by the digital interface. The ability of visitors to digitally rotate, zoom, and inspect specimens from all angles significantly enhances the learning experience beyond static observation. The Mean ± SEM of the engagement times of the tracked visitors (N = 78) recorded for the Control (static) and Treatment (QR-integrated) exhibits were 0.29 ± 0.07 minutes and 0.65 ± 0.16 minutes respectively, over a

30-day study period reflecting a 124.13 % increase in visitor engagement (Figure 2). In order to provide a comprehensive, multi-dimensional overview of the 30-day pilot study period, a synchronised dual-axis time-series graph was also constructed (Figure 3). The left vertical axis tracks the daily public footfall volume segregated by demographic categories (Adults, Children, and the 206 excluded School Tour students). The right vertical axis maps the corresponding daily mean engagement times (in minutes) recorded across both the Control exhibit (orange line) and the QR-enabled Treatment exhibit (purple line). This synchronised visualisation reveals a direct behavioural correlation: the introduction of the digital interface consistently maintained higher baseline interaction curves across the entire timeline regardless of daily footfall density. Even during high-volume school group excursions (visible on Days 12, 13, 23, 28, and 30), the tracking metrics for independent device-ready users remained highly stable, confirming that the digital framework successfully doubles public attention spans under varied, real-world regional museum conditions.

The integration of QR codes thus proved highly effective. Initial observations indicated that a significant percentage of visitors with smartphones engaged with the codes, accessing the digital content instantly. This method bypasses the need for the museum to invest in expensive dedicated hardware (like touch screens or tablets) for every exhibit (Carrozzino, M., & Bergamasco, M., 2010).The relative percentage share of visitor dwell time reveals a powerful demographic variation in technology adoption (Figure 4). Further, compared to adults, the average time spent (in percentage of time spent per exhibit) is about 3 times higher among children (3.17-fold increase) than in adults (2.13-fold increase) who visited this museum during the study period. This comparative distribution demonstrates that while the digital framework successfully doubles adult attention span, it is over three times more effective at holding the focus of younger audiences. This provides a clear empirical roadmap for utilising frugal 3D visualisation systems to captivate tech-native younger generations within public state museum galleries.

This is expected as it has been found that children and younger adults, who are tech savvy are likely to interact and

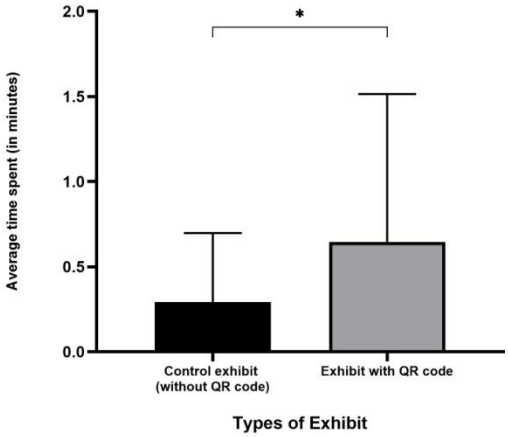
engage with digital elements than the middle aged and older adults (Mendelson & Romano Bergstrom, 2013).Rather than just be mute spectators of the exhibit, the digital integration motivated the visitors to interact with the virtual specimens via their personal mobile devices. This interaction generally manifests as exploratory behaviour in visitors who not only become more proactive in knowledge acquisition but also help them to deepen their understanding of the exhibit, often giving them a personalised experience (Kim *et al.,* 2023).Static displays are often limited by the physical space for provision of texts, labels and images. They fail to accommodate the diverse interests and backgrounds of the modern visitors. In contrast, digital content in combination with the physical display, allows visitors to dive deeper into background stories, historical context, or related resources at their own pace, making the experience more personalised and informative, thus sustaining interest for longer periods. This immersion in the technology aided display often puts the visitors sort of in a 'Flow state' wherein, they tend to lose track of time engaging for extended periods at the display or exhibit passively acquiring information and each one having a unique experience. While it has also been revealed via several research studies that the students' engagement and learning is considerably enhanced by immersive learning environments, which promote active student engagement, exploration and in turn effective knowledge transmission and learning (Leow & Ch'ng, 2021).

This pilot initiative thus aligns strongly with the broader goals of the Ministry of Culture, Government of India, regarding the modernisation and digitisation of museum collections. It demonstrates that advanced digital documentation can be achieved with relatively low investment, making it a scalable solution for other district-level museums across the country. The adoption of such digitisation measures radically can transform the learning function and personalised experience among the visitors in museums.

Table 2:Total number of visitors during the study period

Visitor Demographics & Categories	Control Group (Traditional Static Display)	Treatment Group (QR Integrated 3D Visualisation)	Total Unique Visitors Logged
Adult Visitors	69	69	69 (Same Cohort)
Child Visitors	9	9	9 (Same Cohort)
School Children (Free-entry group tours)	0*	0*	206* (Excluded)
Total Tracking Subset Analysed (N)	78	78	78
Total Museum Traffic Over Study Period	—	—	284

*Not included in the final tracking dataset for reasons mentioned in Materials and methods section



(* - P<0.05; Range: 0 – No visitor; 8 – Time spent in minutes)

Fig.2: Average time spent by the visitors

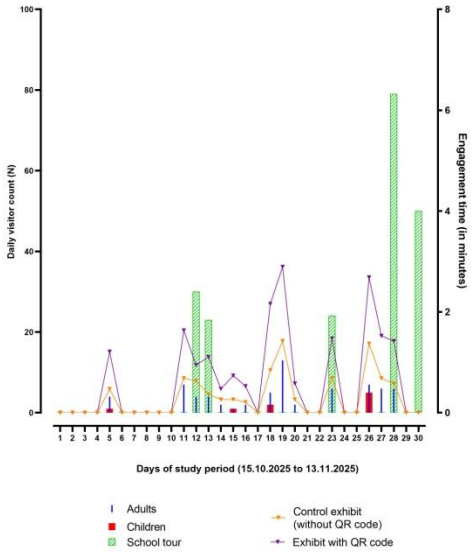
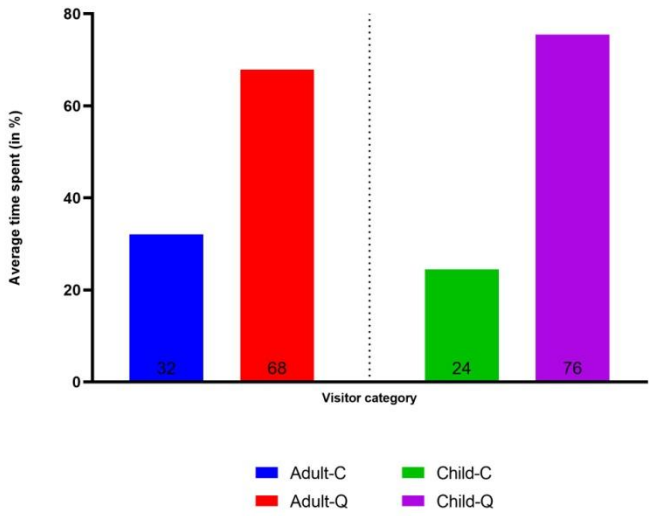


Fig. 3: Multidimensional overview of the study period

(Vertical bars represent footfall metrics segregated by demographic categories and lines represent mean engagement time on a daily basis across the study period)



C- Control exhibit without QR code; Q-Exhibit with QR code integrated

Fig.4: Average time spent (in percentage of time spent per exhibit) by the different categories of visitors

4 Conclusion

The implementation of photogrammetry-based scanning at the Government Museum, Karur district, represents a successful preliminary attempt to digitise a fragile segment of its natural history collection. By making these interactive 3D models available via *Sketchfab* and accessible via QR codes, the museum has significantly enhanced visitor engagement, knowledge sharing and specimen accessibility. This cost-effective, non-invasive method serves as a viable blueprint for other Indian museums seeking to embark on their digitisation journey, ensuring the preservation of our natural heritage while making it dynamically accessible to the public.

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Conflict of interest

The Author declares that there is no conflict of interest.

Disclosure statement

It is hereby disclosed that the concept, data collection, analysis and preparation of figures were carried out by the author. The use of AI prompting was restricted to language improvement and refinement of the article for better presentation of the study.

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