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Pioneering the digital readiness for Malaysian museums: custom framework

Rehman Ullah Khan, Sabine Chung Sze Yee, Oon Yin Bee
Faculty of Cognitive Sciences and Human Development, Universiti Malaysia Sarawak, Kota Samarahan, Malaysia

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ABSTRACT

A museum is a hub for public exploration and education of community or country culture and traditions. Digital technologies transform museums into interactive experiences, engaging visitors and bringing cultural values to life. However, Malaysian museums struggle to adopt digital technologies due to limited infrastructure, expertise, exhibition technology, and budgets. These constraints hinder effective audience engagement and limit growth and modernisation efforts. To help Malaysian museums in digitalisation, this study aims to contextualise a digital readiness index (DRI) questionnaire. The findings of this pioneering study have yielded a unique and customised version of the DRI questionnaire specifically designed for Malaysian museums, marking the first-ever initiative of its kind in the country. The DRI serves as a pivotal scale or tool for managers and researchers, facilitating the evaluation and validation of a museum's digitalisation status while guiding strategic planning for future advancements. This questionnaire enables researchers and museum managers to gain insights into the museums and understand which dimensions require focus and enhancement to ensure a successful and comprehensive transition towards digital transformation.

Corresponding Author:

Sabine Chung Sze Yee
Faculty of Cognitive Science and Human Development, Universiti Malaysia Sarawak
Kota Samarahan, Malaysia
Email: sabinecsy28@gmail.com

1. INTRODUCTION

The International Council of Museums (ICOM) [1] defined a museum as "a not-for-profit, permanent institution in the service of society that researches, collects, conserves, interprets and exhibits tangible and intangible heritage. Open to the public, accessible and inclusive, museums foster diversity and sustainability. They operate and communicate ethically, professionally and with the participation of communities, offering varied experiences for education, enjoyment, reflection, and knowledge sharing". As stated, museums operate on a "not-for-profit" basis. Some researchers [2]-[4] posit that museums act as agents of economic impact agents. This perspective suggests that museums, by attracting tourists and stimulating interest among visitors, contribute to the overall growth of the tourism sector in a country. This can be supported by the tourism performance report of tourism Malaysia [5], where visiting museums (38.5%) is the main activity tourists engaging worldwide. Padzi and Bahauddin [4] showed that the museum has a total of five roles where: it acts as collecting and preserving material heritage, a place for knowledge, an economic agent, a space to socialise, and an agent of change and development. To be relevant, most museums have adopted digital technologies to develop products and services like online exhibitions, new processes for researching, displaying, and managing collections, new organisational structures to accommodate an increasingly digital environment, reaching new markets, and tapping into existing resources to generate new capital [3].

The digitisation of artefacts started way back before the outbreak of the pandemic. The digital technologies museums adopt to enhance visitors' experiences are mobile, multimedia elements, Kinect, headset, touchscreen, and tabletop [6]. In addition, museums also adopt interactive technologies such as virtual museums, emerging technologies such as augmented reality (AR) and virtual reality (VR), and accessible installations for disabled visitors [7]. The COVID-19 pandemic has accelerated digitalisation and driven organisations to undergo this process [8]. During the pandemic, museums in the UK and the USA offered the public different types of digital offerings, such as digital collections, virtual tours, learning materials, home activities, events, funding, and communications [9]. Some museums that offered virtual tours during the pandemic due to the cessation of physical tours are the New York Botanical, the Eiffel Tower, and the Vatican Museums [10]. Museums also used social media, like Facebook, Twitter, YouTube, and Instagram, to interact with their audience during the pandemic and the lockdown period [11]-[15]. After the pandemic, the museums still carried out digital initiatives to attract visitors to return to physical museums, such as the National Museum of China, Metropolitan Museum of Art, British Museum, Tate Museum, National Gallery in the United Kingdom (UK), Natural History Museum (UK) and Smithsonian National Museum of Natural History (USA) that used AR technologies after the pandemic [16]. Similarly, Chinese museums adopted online exhibitions in the form of VR/AR, live and video presentations, picture-text exhibitions and online lectures to promote their physical museums [17]. These digital technologies attract museum visitors to enquire more about the museum's collections and offer engaging visitor experiences and motives to revisit the museums.

The restrictions imposed by COVID-19, such as the connection between museums and the public, have accelerated museums' planning of a digital transformation and adoption of suitable digital technologies to connect with the public [18]. Digital transformation is a process designed to enhance an entity by causing significant property changes via information, computing, communication, and connectivity technologies [19]. Using digital technologies in museums simultaneously provides benefits and new challenges [20]. Addressing the connectivity challenge between museums and the public necessitates a strategic emphasis on the digital transformation of museums. Some researchers have proposed digital transformation frameworks [21]-[23] that allow researchers to acknowledge the components that influence museum changes while utilising digital technology. These frameworks do not focus mainly on the technologies but on other aspects such as people, processes, customers, and museum strategies while using digital technologies. Moreover, the digital readiness of museums can aid in their digital transformation. The term "digital readiness" is defined as the tendency and willingness to switch to and adopt digital technology and a desire to create new innovative opportunities using digital technologies to help an individual, organisation, industry, or country achieve their goals faster and with tremendous success [24]. But how do the museums know what to change and how to change? Therefore, assessing the digital readiness index (DRI) is crucial for museums to identify strengths and weaknesses in various dimensions. Soomro *et al.* [25] supported the DRI and shared that a digital readiness model is required to lead the digital transformation path and continuously self-evaluate themselves. It can help managers understand the significance of digital technologies. Based on scholarly inquiries supported by academic databases, only two articles [23], [26] distinctly focus on the digital readiness of Italian museums. Both articles shared different approaches to understanding the digital readiness of museums in Italy; one article proposed a digital readiness questionnaire (DRQ), while another offered a three-stage framework to learn about the current state of museums.

Malaysian museums increasingly adopt technology to enhance museum performance and improve visitors' satisfaction. While adopting digital technologies to strengthen museum performance, there are issues like the lack of infrastructure (connectivity), human resources and expertise, hardware or software for museum exhibitions, and budgets in Malaysian museums [27]. Researchers endeavour to customise the DRQ due to the distinctions in museum operations between Malaysia and Italy. This adaptation is crucial for researchers and museum managers in Malaysia, as it addresses the unique aspects of the local context, cultural nuances, and operational disparities between the two countries. The goal is to provide a nuanced tool that allows for a more accurate assessment of the digital readiness of Malaysian museums, emphasising the need for a localised approach that aligns with Malaysia's specific cultural and operational landscape. This localisation process is essential for acknowledging and addressing the particular challenges and opportunities that arise within the Malaysian museum ecosystem, ensuring that the DRQ remains a relevant and effective tool in the local context.

2. RESEARCH METHOD

The research was conducted within the duration of May to July 2023. The research design of this study consists of qualitative and quantitative research methods. The quantitative part is the collection of the content validity index of all three content validations (CV I, CV II, and CV III) while the interview in CV I is qualitative. Only experts in museology can validate the content. Therefore, we collaborated with the Sarawak

Museum Department, which assigned museum experts to review and validate the questionnaire adapted from Agostino and Costantini's proposed framework [23]. Content validity (CV) means how well a test or questionnaire matches what it is supposed to measure. It helps show that the questions are suitable for the topic being studied [28]. Two museum experts rated each question's relevance on a 4-point scale. If they gave a question a score of 1 or 2, it meant they thought the question was not relevant for measuring digital readiness. A score of 3 or 4 meant they thought it was relevant. These scores were then simplified: 1 and 2 were changed to 0 (not relevant), and 3 and 4 were changed to 1 (relevant). The converted scores were then used to calculate the content validity indices, which are item-level content validity index (I-CVI), scale-level CVI based on the average method (S-CVI/Ave) along with scale-level CVI based on the universal agreement method (S-CVI/UA). The I-CVI is the percentage of museum experts giving the question a relevance rating of 3 or 4. It was calculated by dividing the number of experts who rated a question as relevant by the total number of experts. The S-CVI/Ave is the average of the i-CVI scores for all questions on the scale or the average proportion relevance (PR) judged by all experts, where the PR is the average of the relevance rating by individual expert. It was calculated in two approaches where one is the sum of I-CVI scores divided by the number of questions and another is the sum of PR rating divided by the total number of experts. The PR rating is the average of relevance rating by individual experts. The S-CVI/UA is the percentage of items on the scale that all experts rated relevant (score of 3 or 4). The UA score of 1 was given if all experts agree on the questions' relevance while 0 if not all of them agree. It is calculated by the total number of universal agreed questions divided by total number of questions. After that, an online interview was conducted where the questions asked were "What is the meaning of digital readiness based on your understanding?" and "Based on the questionnaires, is it suitable for determining the digital readiness of the museums at the organisational level?". The experts provided feedback on improving or modifying the question that scored below the benchmark of 0.8 in the interview. The modified questions then went through second validation (CV II) and there are still some questions fell below the benchmark that were then modified. The final validation (CV III) was conducted and the question were finalized. The research flow of the study is summarized in Figure 1.

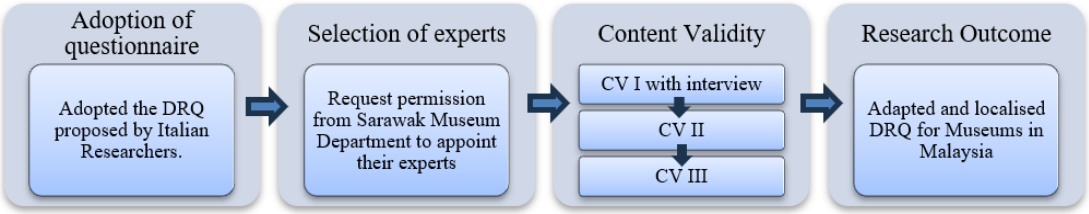


Figure 1. The research flow of the study

3. RESULTS AND DISCUSSION

3.1. Results

Degree relevance of the CV are used to score the relevance of the questions in DRQ to measure the digital readiness of museums in Malaysia. For the questions that was given the score of 1 or 2 were converted to 0 indicadting the questions are not relevant to measure the DRQ, while questions that were gicven the score of 3 or 4 were converted to 1 showing the questions are relevant to measure the DRQ. The degree relevance scores of the questions in DRQ given by the museum experts (ME) were collected and converted to calculate the I-CVI of each question in the DRQ, the S-CVI/Ave and S-CVI/UA. Scores of the I-CVI, S-CVI/Ave and S-CVI/UA in all three content validations were calculated and tabulated in Table 1. Table 1 depicts the content validity scores of the questionnaire for all three validations.

In the Table 1, the first column depicts the question numbers. The second column is CV I which consists of the converted value of the validation of museum experts (ME1 and ME2), the number of agreement (NoA) and I-CVI while the PR, S-CVI/Ave and S-CVI/UA of CV I were calculated in the row after the 19 questions of DRQ. The third column is the scores of CV II and the fourth column is the scores of the CV III. Based on the scores in the table, the I-CVI, S-CVI/Ave and S-CVI/UA scores in CV I are much lower compared to CV II and CV III. As proposed by Davis [29], the minimum accepted CVI value is 0.8 when the number of experts to validate the questions is 2. The low scores of the CV indices that did not passed 0.8 indicated the questions may not be suitable for validating the digital readiness and the modification or removal of the question was considered. In CV I, only three questions' I-CVI scores passed the minimum accepted CVI value (0.8) while the remaining questions' I-CVI scores and the S-CVI/Ave and

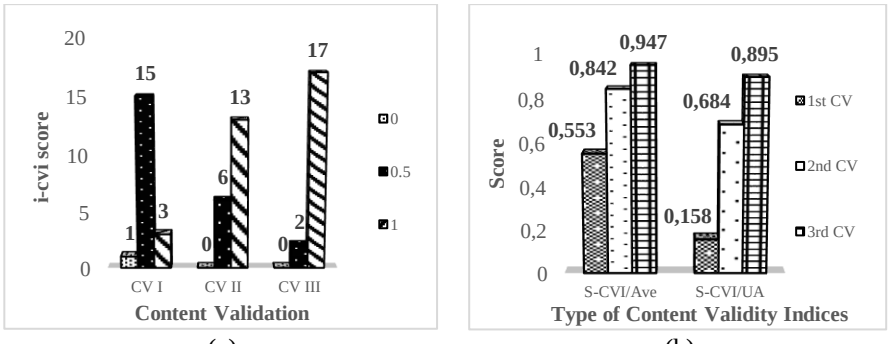
S-CVI/UA scores did not pass minimum accepted CVI value. So, the researchers conduct an interview with the museum experts to discuss on the validity of the DRQ questions. The questions that did not pass the minimum accepted value were modified to improve the validity of the questionnaire.

In the interview, both museums' experts have the similar perspective of the definition of digital readiness (first interview question). The first museum expert stated, "From my understanding, digital readiness is also defined as the level of readiness to change your manual work process into using digital software or anyways to carry on your daily routine". The other museum expert stated, "Same like what [museum expert 1] say... converting our manual process... our manual work from manual to the digital ones... to the computer things". Furthermore, in the second interview question, the CVI scores in CV I were referred to when discussing on the suitability of the questions of adopted DRQ and modification were made to the questions that scored lower than 0.8. Some of the answer selections of the questions in DRQ were revised as well.

After the first modification (Modification 1), the questions were validated the second time (CV II). Referring to Table 1, the number of questions' I-CVI score that passed the minimum accepted value increased to 13 questions. However, the S-CVI/UA did not passed the accepted value which shows there are still questions that was not 100% agreed by both museum experts. The questions that scored lower than 0.8 were then modified for the second time (Modification 2). Most of the modification is on the structure of the question. The CV III was conducted and the CVI scores have increased. The difference of the content validity indices in all three validations are illustrated in Figure 2, where the difference of I-CVI scores in all three validations is shown in Figure 2(a) and the S-CVI/Ave and S-CVI/UA scores in all three validations are depicted in Figure 2(b).

Table 1. Content validity scores of the questionnaire in all three validations

CV	CV I				CV II				CV III			
Question	ME1	ME2	NoA	i-cvi	ME 1	ME 2	NoA	i-cvi	ME 1	ME 2	NoA	i-cvi
1	1	0	1	0.5	1	1	2	1	1	1	2	1
2	1	0	1	0.5	1	0	1	0.5	1	1	2	1
3	1	0	1	0.5	1	1	2	1	1	1	2	1
4	1	0	1	0.5	1	0	1	0.5	1	0	1	0.5
5	1	0	1	0.5	1	1	2	1	1	1	2	1
6	1	1	2	1	1	1	2	1	1	1	2	1
7	1	0	1	0.5	1	1	2	1	1	1	2	1
8	1	0	1	0.5	1	1	2	1	1	1	2	1
9	1	1	2	1	1	1	2	1	1	1	2	1
10	1	1	2	1	1	0	1	0.5	1	1	2	1
11	1	0	1	0.5	1	0	1	0.5	1	1	2	1
12	1	0	1	0.5	1	1	2	1	1	1	2	1
13	1	0	1	0.5	1	1	2	1	1	1	2	1
14	1	0	1	0.5	1	1	2	1	1	1	2	1
15	1	0	1	0.5	1	1	2	1	1	1	2	1
16	1	0	1	0.5	1	0	1	0.5	1	1	2	1
17	0	0	0	0	1	1	2	1	1	0	1	0.5
18	1	0	1	0.5	1	1	2	1	1	1	2	1
19	1	0	1	0.5	1	0	1	0.5	1	1	2	1
PR	0.947368421		0.157894737		1		0.684210526		1		0.894736842	
S-CVI/Ave (based on PR)	0.553				0.842				0.947			
S-CVI/Ave (based on I-CVI)	0.553				0.842				0.947			
Total agreement	3				13				17			
S-CVI/UA	0.158				0.684				0.895			



(a) (b)

Figure 2. The difference of (a) I-CVI scores and (b) S-CVI/Ave and S-CVI/UA in all three validations

The CV indices (I-CVI, S-CVI/Ave and S-CVI/UA) scores in CV III have passed the minimum accepted value and for the 2 question that did not pass, Q4 was removed and Q17 was changed to the question used in the CV II. The removal of Q4 is due to the I-CVI score in all 3 validation was below the accepted value and the weight of the 'technology presence' from 0.5 to 1. The questions were then finalized. The overall modification of questions after CV I and CV II along with the finalised questions after CV III were shown in Table 2.

Table 2. Question modifications after CV I and CV II as well as the finalization after CV III

Question	Modification 1	Modification 2	Finalised questions
1	Does your institution have employees who specialize in information technology (IT)?	No modification	Does your institution have employees who specialize in information technology (IT)?
2	Does your institution have any of these positions?	Do any of these positions are present at your institution?	Do any of these positions are present at your institution?
3	Which of these technologies are present in your museum?	Remain the same	Which of these technologies are present in your museum? (More than one answer is possible)
4	No modification	What is the estimated percentage of museum artefacts in your institution that have a digitalized version?	the question is removed as it does not meet the minimum score of the questions.
5	No modification	No modification	To what extent is your collection catalogued? (*List out the available software used by your museum if your museum handled the Cataloguing through other software.)
6	No modification	No modification	Do you gather data about visitors?
7	No modification	No modification	Do you monitor data about your museum's social network channels?
8	No modification	No modification	Do you monitor data of online reviews?
9	No modification	No modification	Does your institution have a Wi-Fi connection?
10	No modification	Is there a ticketing service at your institution?	Is there a ticketing service at your institution? (*Only answer No.17 and No.18 if you select "Yes" for this question)
11	No modification	What kind of ticketing service does your institution provide?	What kind of ticketing service does your institution provide? (More than one answer is possible) *no need to answer if you have selected "no" for question 16
12	No modification	No modification	How do you control visitors' access? (more than one answer possible) *no need to answer if you have selected "no" for question 16
13	No modification	No modification	Do you have an informatic system that support these activities?
14	No modification	No modification	Which one of these marketing activities do you perform (internally or externally)? (More than one answer is possible)
15	No modification	Which social accounts did your museum use?	Which social accounts does your museum have? (More than one answer is possible)
16	Which of these review websites are you subscribed to in order to increase the number of visitors?	Is your museum listed on any of these review websites?	Is your museum listed on any of these review websites? (More than one answer is possible)
17	Are there any ideas or efforts in your museum to adapt to digital transformation?	No modification	Are there any ideas or efforts in your museum to adapt to digital transformation?
18	No modification	In which digital activities did your museum invest in the last 2 years?	In which digital activities did your museum invest in the last 2 years? (More than one answer can be selected)
19	Which is the estimated percentage of investment you committed to digital innovation?	What is the estimated percentage of your museum's investment in digital innovation?	What is the estimated percentage of your museum's investment in digital innovation?

3.2. Discussion

This study introduces a customised framework designed to assess the digital readiness of Malaysian museums. Responding to the need highlighted by Fauzi *et al.* [27], this framework addresses the unique challenges and limitations faced by museums in Malaysia, offering a structured approach to gauge their current digital capabilities. A DRQ customised to Malaysia's museum sector has yet to be established, making this framework a pioneering step toward understanding and supporting digital transformation efforts across the nation's cultural institutions. The original DRQ, initially developed in Italy, has been adapted and

localised to suit the Malaysian museum context. To ensure its relevance and applicability, a rigorous content validation process was conducted, affirming that this questionnaire effectively assesses the digital readiness of Malaysian museums. The adopted content validity method [28] provides crucial evidence supporting the tool's appropriateness for this study. Our findings underscore operational differences between Italian and Malaysian museums, reflected in the CVI scores across all three CVs. These differences prompted essential modifications to both the questionnaire items and answer options within the DRQ, ensuring an accurate assessment tailored to the unique needs of Malaysian museums.

After the three validations, Q4 of the adopted DRQ, "Is there a digitalised version of the museums' artefacts?" was removed as the I-CVI scores of the question in all three validations failed to pass the accepted CVI value. The reason of the removal of Q4 is because it failed to provide sufficient information about whether the digitised collection refers to 2D or 3D versions of the artefacts. For example, digitising natural history collections involves the emergence of 2D and 3D images, converting transcripts to digital, image segment analysis, and studies of biochemical, molecular, and genetics [30]. Based on the conceptual relationship of digitisation and the digitalisation framework proposed by Gradillas and Thomas [31], digital technologies are under the digitalisation of digital artefacts for socio-economic transformation. This supports the idea that 'technology presence' includes digitisation of the collection. The digitisation of collections is not a new initiative for Malaysian museums [32], meaning most museums have a digitised version of the collection in the form of images. Apart from that, the types of technology present in the museums as stated in Q3 ware modified and the types of collection methods being catalogued in Q5 are reduced from 4 to 3 types. The methods, namely, the cataloguing is handled through proprietary software and 'The cataloguing is handled through an ICDD or region proprietary information system' was simplified into 'The cataloguing is handled through other software' after discussion with the museum experts. The 19 questions of DRQ was then finalised.

The finalised DRQ, consisting of its question and the listed answer selections, metrics (wk), sub-dimensions (wj), and dimensions (wi). Some of the questions, listed answer selections, wk, wj and wi have assigned values to calculated the DRI of museum which can be referred to in the supplementary file. The localised DRQ has five dimensions: people, technology, process, customer, strategy, and investment. In adapted DRQ, Q10 is open-ended and is not assigned a score, whereas remainings questions are closed-ended with options assigned scores. To calculate the DRI of museums in Malaysia, the score of the questions (Qk) will be calculated first. The Qk of both Q1 and Q2 are achieved based on the selected option. For multiple-choice questions (Q3, Q11, Q12, Q14-Q17, and Q18), the formula applied to calculate the Qk is the sum of the selected options. In contrast, the Qk of Q4 and Q13 were calculated using the multiplication of value score of the question and the score value of the selected options. For example, a museum responded that they have catalogued their collections by adopting 1%-25% paper catalogue, 76%-99% database catalogue and did not adopt software for cataloguing. The assigned value of paper catalogue, database catalogue, and software cataloguing is 0.33 each. The score value of the selected options 1%-25% paper catalogue, 76%-99% database catalogue and did not adopt software for cataloguing are 0.8, 0.8 and 0 respectively. The multiplication of '0.33 and 0.8' (paper catalogue), '0.33 and 0.8' (database catalogue) along with '0.33 and 0' (software cataloguing) was calculated and the answers were total up to get Qk. Later, the dimension score (DS) was calculated after obtaining the Qk of all 18 questions, using (1).

$$DS = \sum_{j=1}^{n} wj * (\sum_{k=1}^{m} wk * Qk) \quad (1)$$

The DS of all 5 dimensions was then used to multiply with the respective value assigned to the dimension and the total of the answers are the DRI, where the formula of DRI is shown (2).

$$DRI = \sum_{i=1}^{5} wi * (\sum_{j=1}^{n} wj * (\sum_{k=1}^{m} wk * Qk)) \quad (2)$$

With the localised DRQ, the researchers can assess the digital readiness scores to assist museum managers in focusing their efforts and internal resources [23]. Thus, this questionnaire not only acts as a measuring tool to determine the current digital readiness of museums in Malaysia, but it can also act as a guide for museums to know where to start and which dimension they should focus on based on the DRI scores. It allows researchers to view in a retrospective approach using the DRI score to scale down the dimension or the element that needs more improvement. Aside from that, the questionnaire helps in developing or adopting digital technologies in the museums sustainably. This questionnaire enables researchers to venture into the digital technologies the museums wish to adopt, which researchers can refer to in Q3. In addition, they can learn about how many percent of museums have invested in digital innovations (strategy and investment dimension). By comparing it with the number of visitors and the visitor's satisfaction with the museum's digital innovations, researchers can determine the present digital innovations' effect on the museum before developing or upgrading the digital technologies for better experiences. It will

be a waste of time and budget to carry out digital innovations without experts or museum staff majoring in information technology (IT) to maintain digital technologies. This indicates the questionnaire benefits the museum and research field, as well as private sectors like local IT companies, where they can collaborate with museums in terms of developing management systems or cataloguing systems. Overall, the questionnaire benefits researchers, museum management, and the private sector by acting as a self-assessment tool and a guideline for achieving digital transformation. It also acts as an initial phase in designing and developing new sustainable applications and systems or adopting digital technologies by referring to the selection museum in the DRQ. The DRI and DS allow researchers to learn about the current digital readiness of museums in Malaysia.

Based on the authors' findings, there exists only two local articles studied the digitasation of museums in Malaysia where one via survey [32] and another via a literature review of past articles along with case studies on four local museums that adopted technologies [27]. Due to time limitations, the authors only managed to find 2 museum experts to validate the adopted DRQ. Even though the minimum of experts for CVs is 2, future researchers are suggested to find 6 or less than 10 experts to adopt the DRQ [28]. The authors could also not conduct a case study due to time constraints. They may research the digital readiness of museums in Malaysia using the adapted DRQ in future. Future researchers are suggested to adopt this localised questionnaire to conduct a survey on determining the DRI of museums in Malaysia or a case study to highlight the current digital readiness of the museums along with the obstacles faced by the museums before designing a user-friendly application or system for the museums activities, either for visitors or the management. Thus, the adapted and localised DRQ in this research acts as an assessment tool for future researchers to understand the situation of the local museums and venture into the dimensions that scored the lowest or required improvements to achieve digital transformation and sustainability.

4. CONCLUSION

In a nutshell, to provide an assessment tool to understand the digital transformation status of the local museums, the authors adopted the DRQ proposed by Italian researchers. They localised it by conducting content validations and interviewing museum experts. The result of the research, especially CV I, showed the need to localise the DRQ before conducting a survey on the digital readiness of museums in Malaysia. The localised DRQ questionnaire can be used to validate the local museums in Malaysia to gain insight into the museum and determine which dimensions need to be acknowledged and which need additional effort or collaboration with universities and private sectors (IT companies) to achieve digital transformation. Therefore, future researchers can adopt the questionnaire for the future DRI of museums in Malaysia. Local researchers can also adopt the local DRQ and the visitor's satisfaction questionnaire to get a complete picture of the current state of a museum before proposing a sustainable digital innovation for the museum.

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AUTHOR CONTRIBUTIONS STATEMENT

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Rehman Ullah Khan	✓	✓		✓	✓	✓		✓	✓	✓		✓	✓	
Sabine Chung Sze Yee	✓	✓		✓	✓	✓		✓	✓	✓	✓			
Oon Yin Bee						✓	✓			✓	✓	✓	✓	

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

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BIOGRAPHIES OF AUTHORS

Rehman Ullah Khan is a senior lecturer in Universiti Malaysia Sarawak, Faculty of Cognitive Sciences and Human Development. Ph.D. in mobile augmented reality, M. Phil in advanced databases, master information technology, Bachelor in computer science. He can be contacted at email: rehmanphdar@gmail.com.

Sabine Chung Sze Yee is a master's research student in Universiti Malaysia Sarawak, specializing in cognitive sciences with a Bachelor's degree in the same field in Facultly of Cognitive Sciences and Human Development. She can be contacted at email: sabinecsy28@gmail.com.

Oon Yin Bee is a lecturer in Universiti Malaysia Sarawak, Faculty of Cognitive Sciences and Human Development. Masters ergonomik kognitif, Bachelor of science (hons) cognitive science. She can be contacted at email: yinbee@unimas.my.