Method Article

Methods for evaluating the adoption and use of digital technologies in GLAMs

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A B S T R A C T

This article provides a method from which the breadth of adoption and use of digital technologies may be evaluated. Whilst the method can be used for individual devices, it was designed as a means for understanding the well-being of all devices within a site, and especially as an overview method for multiple institutions within a city or in far larger studies involving multiple organisations over large geographical distances. Our method is digital technology neutral. Digital technologies may be of any types, belonging to any category but can be extended to include both emerging and unconventional systems as long as the variables provided in this article can act as metrics for their evaluation. The approach used here is a mixture of quantitative and qualitative evaluation.

Qualitative evaluation using thematic analysis is applied for the understanding of phenomenon identified within our quantitative methods.

● Technology neutral approach to understanding the institutional adoption and use of digital systems
● Broad evaluation method suited to the evaluation of multiple digital technologies at the institutional level, or large studies involving multiple organisations over large geographical distances.
● Uses a mixture of quantitative analysis for revealing trends and qualitative evaluation for understanding phenomenon

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A R T I C L E  I N F O
Keywords: Digital technology, Technology adoption, Technology use, Galleries, Libraries, Archives, Museums
Article history: Received 17 March 2019; Accepted 14 May 2019; Available online 4 December 2019

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https://doi.org/10.1016/j.mex.2019.05.015
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Specification Table

| Subject Area:          | Computer Science          |
|-----------------------|----------------------------|
|                       | Psychology                 |
|                       | Social Sciences            |
| More specific subject area: | Museum Technology, Digital Technologies, Museum Computing, Digital Heritage |
| Method name:          | Evaluation of digital technology adoption and use |
| Name and reference of original method | Ch’ng, E., Cai, S., Leow, F.T., & Zhang, T. (2019) [1]. Adoption and Use of Emerging Cultural Technologies in China’s Museums. Journal of Cultural Heritage, 37, pp.170-180. Ch’ng, E., Cai, S., Leow, F.T., Zhang, T. (forthcoming) [2]. Datasets on the evaluation of the adoption and use of digital technologies in China Museums, Data in Brief. GitHub: Data, figures, R scripts and observation sheet template: https://github.com/drecuk/DigitalSysBroadEvaluation |
| Resource availability: | Data, figures, R Scripts (software code), observation template |

Method details

Background

This article provides the method from which the adoption and use of generic digital technologies may be evaluated. The majority of past researches evaluating digital technologies in GLAMs (Galleries, Libraries, Archives and Museums) have been at the device level, often conducted within a single site. These were studies aiming at depth of understanding of devices and contents, and how users have engaged with them via user interfaces. We believe that evaluating GLAMs at the device level will not provide an overview of trends across institutions, sites and at the national level meant for planning, strategic investment and digital transformation. Breadth of evaluation is needed for understanding and benchmarking the overall health of digital technology adoption and use. In the method proposed in this article, digital technologies may be of any type, belonging to any of the categories listed in the sections below but could be extended to both emerging and unconventional systems as long as the variables provided in this article can act as a metric for their evaluation. The approach used here is a mixture of quantitative and qualitative evaluation. Qualitative evaluation using thematic analysis is applied for the understanding of phenomenon identified within our quantitative methods.

A framework for evaluating users and digital technologies

The evaluation of the adoption and use of digital technologies proposed in this article is focused on how well users have used such technologies adopted by GLAMs, and whether technologies adopted are suited to a range of audiences. By mapping the observed interaction of users with digital technologies within their contexts, we may be able to gauge the overall health of digital technology adoption across institutions and sites. It has become a priority to evaluate the adoption and use of digital technologies in GLAMs as a means to understand their digital wellbeing, and as a measure for gauging the distance between the initial adoption of digital technologies, and the success in effective audience engagement in any digital transformation activities. GLAMs wishing to adopt the methodology covered in the next section should first ask questions relevant to institutional aims, which may include the following questions:

1 What are the categories of digital technologies that have been adopted and are they appropriate for our range of audiences? Have new technologies been adopted and how have they been used?
2 What are the proportions of demographics groups that have visited GLAMs across sites and institutions, and how well have digital technologies designed and purpose for exhibits engaged with audiences?
3 What is the overall quality of our digital exhibits and are the contents relevant to their contexts?
4 Are the digital technologies visible to the range of audiences in the exhibiting environment?
5 Are the digital technologies that have been adopted accessible to the range of audiences and groups?
6 Have we considered appropriate temporal lengths of digital contents and how well have digital technologies been able to attract users as well as sustain user engagement?
7 Are particular digital exhibits in higher demand than others, and do users have to queue up in order to use them?
8 Can digital technologies be shared, and used synchronously or asynchronously in the same session between groups of users? Is there a need to design particular digital technologies for multiple users and groups?

The parameters defined in the next sections are meant to answer the questions above. A graphical abstract is provided below (Fig. 1) as a guide, which demonstrated the approach for collecting and analysing both qualitative and quantitatively data. By using the method proposed in this article, institutions would be able to evaluate the overall trend and wellbeing of the adoption and use of digital technologies across institutions or sites.

Software and equipment

We used MacOS’s Numbers spreadsheet (provided in our GitHub repository with sample data), as our standard software for recording our observations. Recording were conducted on iPads with split screens (Fig. 2) so that we could both time our observation of user interactions and engagement with digital systems. The Microsoft Excel equivalent of the Numbers spreadsheet is also provided in our GitHub repository.

Categories of technologies

The criteria for data collection is that the system is digital and interactive. Digital technologies in any of these categories may be evaluated, although the list could extend to emerging and unconventional systems.

- Augmented Reality (AR) – any devices which augment virtual objects onto the real world using QR code, images, or spaces (e.g., HoloLens)
Virtual Reality (VR) – any displays which completely immerses a user into a virtual world (e.g., headsets, CAVE), this includes 360 videos

Projection Displays – displays which provide a narrative and are not only a video

Interactive 2D – this includes 2D interactive systems and 1990s era multimedia systems or touch screens

Multitouch2D - this includes multiuser, multitouch displays which supports at least two users within a single session of use.

Interactive 3D – 3D interactive environments either with an interactive device (i.e., Mouse) or touch screens and gestures

Mobile Exhibit – a mobile device (i.e., mobile phones, iPad, etc.)

Miscellaneous – any unexpected interactive devices

Breadth of evaluation

As opposed to various other methods in use, the method presented here is designed as an overview benchmark. It is designed with breadth rather than depth in mind. Breadth of evaluation of adoption and use as opposed to depth is needed to understand and benchmark the overall health of digital technology adoption and use in an entire institution, or across several institutions within a locality, or spread out across different cities in a country.

Site of evaluation

The method in the original article were used for evaluating museums and archaeological sites with digital technologies, however the method can be adopted by any institutions within the GLAM
categories, e.g., Galleries, Libraries, Archives and Museums wishing to understand the overview of the use and adoption of digital technologies.

**Ethical issues and interaction with users**

There are no interactions with users in our approach as any intervention will influence the behaviour of use. Instead, all observation shall be covert. The Ethics Board of your institutions will need to be sought for the use of this method. As no interviews will be conducted, user observations will naturally be unrecorded and anonymous.

**Time allocated for the observation of digital systems**

For each digital system, 30 samples of use or, up to 2 h of observations should be recorded whichever comes first. A system yielding 30 samples in 30 min may be judged as a popular system. For sites with more digital systems, you may record up to 20 samples or up to 1 h of observations so that more types of exhibits can be covered. The total sample size for each museum counts toward the aim of evaluating the breadth of technology adoption across an entire site, a city or an entire country.

**Data collection**

Data collection activities consist of identifying a digital system of interest and finding a location from which to observe the system from. All observations shall be carried out covertly so that the users are unaware and therefore will not be influenced by the observation. Each of the field within the spreadsheet shall be filled in as all variables contribute indirectly to the evaluation of digital systems.

**Quantitative analysis**

This section and its subsections use R Scripts to preprocess data, generating graphs for analysis which as a whole contributes to the evaluation of the adoption and use of digital technologies in GLAMs.

```r
# remove all R objects and data
erm(list=ls())

# getting the path of the current directory where this script is
current_path = rstudioapi::getActiveDocumentContext()$path
dirwd(dirname(current_path))

# reads raw data from the current directory and produce a summary report
d = read.table("workingData.csv", header=TRUE, skip=0, sep=",")
$summary(d)

# prepare colour ramp and plot a graph
colfunc=colorRampPalette(c("yellow","red"))
plot(rep(1,50),col=colfunc(50)), pch=19,cex=2)

# preprocess raw data
dSAge2 <- as.character(dSAge)
dSAge2[dSAge2 == "75-90"] <- 90
dSAge <- as.numeric(dSAge2)
```

**Variables for an individual digital system**

These variables are directly relevant to each single piece of digital system. Identification variables are necessary when all files were collated as a single file. Distinction between cities and institutions are necessary for data analysis using the R Scripts provided.

**Exhibit ID** – coding for identity, e.g., i2D.Beijing.Storytelling, i3D.Chengdu.HeroModels, and etc.
Location of Exhibit – name of institution and the city.
Length of Exhibit – The length of time it takes to browse through all contents, including length of video, reading through texts, accessing links, interaction and etc.
Relevance to Contents – the system’s use of contents and how it differs from the subject. If a system introduces superfluous, unnecessary contents or interfaces that do not contribute to the learning of the contents, the system is judged as not relevant (1), a score of 5 has highly relevant contents, but the contents may be purely informational.
Quality of Exhibit – the quality of the system in terms of its overall design, user interface, system navigation, and 2D/3D contents. This is a subjective evaluation, however, the expert panel approach can be used whereby a team of experts in the design, development and use of many interactive systems co-conduct the evaluation. Biases can be minimised via debriefing sessions.
Info – used for recording our thoughts and comments on the digital system.
The data collected from the variables associated with individual digital systems generates four types of graphs in Figs. 3 and 4. These gauge the types of digital technologies adopted and their overall quality. It also segments the content type into three categories – informational, game-based and narratives, and the quality of the contents associated with each category.

# generates the piechart in Fig. 3

```r
# counting number of unique systems
numSys <- length(unique(d$Exhibit))

# counting number of each unique system in the digital systems category
numAR <- length(unique(d$Exhibit[d$Exhibit$Type == "AR"]))
numVR <- length(unique(d$Exhibit[d$Exhibit$Type == "VR"]))
numProj <- length(unique(d$Exhibit[d$Exhibit$Type == "Projection"]))
numM2D <- length(unique(d$Exhibit[d$Exhibit$Type == "Multitouch2D"]))
num1D2D <- length(unique(d$Exhibit[d$Exhibit$Type == "1D2D"]))
num1D3D <- length(unique(d$Exhibit[d$Exhibit$Type == "1D3D"]))

# drawing the piechart with the data prepared above
piepercent<- round(100*c(numAR,numVR,numProj,numM2D,num1D2D,num1D3D)/numSys, 1)
pie(c(numAR,numVR,numProj,numM2D,num1D2D,num1D3D), labels=piepercent, main="Digital System Types", col= c("red", "yellow", "green", "violet", "orange", "blue", "pink", "cyan"), radius=1.5)
legend("topleft", title="Type", legend=sort(unique(d$Exhibit$Type)), fill=c("red", "orange", "violet", "blue", "green", "yellow"), box.lty=0, cex=0.7)
```

# exhibit quality constructs data directly and draws the pie chart in Fig. 4

```r
dQ <- c(7, 18, 11)
types <- c("Games (19.4%)", "Information (50%)", "Narrative (31%)")
pie(dQ, labels = types, main="Distribution of Content Types", col=c("red", "green", "blue"), cex=0.6, cex.main=0.8)
```

# exhibit quality constructs data directly and draws the bar chart in Fig. 4

```r
dE <- read.table(text="
1 0 0 0
2 0 5 2
3 5 8 4
4 1 4 3
5 1 1 2
*", header = TRUE)

heatcols <- heat.colors(5)
barplot(as.matrix(dE), main="Quality of Exhibits", xlab="Quality Ranking for Exhibits (1 to 5)", legend = c(1:5), col=heatcols, bside=TRUE, cex.main=0.8,
Variables for user demographics

Users may be a single person, or a group with multiple users. In the scenario of group access, the sex and age of the dominant person is recorded. Age is difficult to judge without deliberately asking the user which we strictly refrained from. Age is therefore binned in the range: \(< = 12, 12–17, 18–24, 25–34, 35–44, 45–54, 55–64, 65–74, > = 75.\)

Data collected from variables associated participant group size can provide a means of understanding group size frequencies. **Fig. 5** is a plot of observed user group size within the population of digital systems users.

# draws data from the NumberOfPeople field and categorise them into a data frame
Variables for engagements, user interaction and social interaction

**Family** – ticked if the group appears to be a family, which are usually parents and children and occasionally relatives as determined by conversations.

**Discussion** – a binary value which records any discussions taking place.

**Teaching** – if teaching and learning took place between the members of the group.

**Guided Tour** – is ticked if there is a tour guide leading a group, usually a large group of more than 5 persons.

**Photo Taking** – is ticked if the users took photos of the exhibit.

**Description** – a record of occurrences during user interactions with as many details as possible for verifying our observations during our debriefing sessions. This includes discussions, user interactions and observed group behaviour. The data file provided contains details of the evaluation of 807 samples, 36 digital systems hosted within 22 museums across 15 cities.

**Is Crowded** – if the space around the exhibit is crowded.

**Queued** – for describing situations in which the person intending to use the exhibit queued earlier and subsequently used the exhibit.

**Attracts Queue** – is observed when a person uses the exhibit and attracted other users to watch or wait.

---

```r
data <- c(length(d$NumberOfPeople[d$NumberOfPeople == 1]),
         length(d$NumberOfPeople[d$NumberOfPeople == 2]),
         length(d$NumberOfPeople[d$NumberOfPeople == 3]),
         length(d$NumberOfPeople[d$NumberOfPeople == 4]),
         length(d$NumberOfPeople[d$NumberOfPeople == 5]),
         length(d$NumberOfPeople[d$NumberOfPeople == 6]),
         length(d$NumberOfPeople[d$NumberOfPeople == 7]),
         length(d$NumberOfPeople[d$NumberOfPeople == 8]),
         length(d$NumberOfPeople[d$NumberOfPeople == 9]),
         length(d$NumberOfPeople[d$NumberOfPeople == 10]),
         length(d$NumberOfPeople[d$NumberOfPeople == 11]),
         length(d$NumberOfPeople[d$NumberOfPeople == 12]),
         length(d$NumberOfPeople[d$NumberOfPeople == 13]),
         length(d$NumberOfPeople[d$NumberOfPeople == 14]),
         length(d$NumberOfPeople[d$NumberOfPeople == 15]))

# plot the data and draw lines and dots
plot(data, xaxt="n", xlab="", ylab="")
axis(1, at=c(1:15), label=c(1:15), las=0)
title(main="Observed User Group Sizes (1 to 15 in a group)", sub="", xlab="Group Size", ylab="Population",
cex.main=0.8)
x = c(1:15)
y = data
smoothingSpline = smooth.spline(x, y, spar=0.05)
text(x, y, round(y, 2), cex=0.6, pos=4, offset=0.6, adj=0.2)
lines(smoothingSpline)
points(data, pch=20, col='red')
```

![Fig. 5. Plot of observed participant group size.](image)
**Time at Exhibit** – records the length of time a user spent on the exhibit.

**Engagement/Interface** – is a subjective observation of a user’s or groups’ engagement with the content/interface. The description variable provided the details but this variable ranks between 1 being weak and 5 as strong engagement. The TimeAtExhibit variable does not matter here; there is the need to look for deeper engagements with contents.

A combined measure is important for data analysis:
- 0: user did not touch the interface
- 1: user touches the interface and quickly moves away
- 2: user browses the contents but without further, deeper engagement
- 3-4: intermediate engagement
- 5: full engagement with contents, user has accessed most aspects of the interface, reading into contents and engaging deeply with multiple contents within the system, e.g., reading of texts, studying pictures, watching videos, interaction with the digital objects during the session.

Four other types of graphs can be generated from variables recording the demographics, user interaction, social interaction and engagement. These will allow an institution to see visitor age groups, age and engagement, quality of exhibits and population size, and the level of engagement in different group sizes (Fig. 6).

# generates the ‘age group and sex’ bar chart in Fig. 6

---

Fig. 6. Sex and Age Groups (Top Left), Observed Age groups and Level of Engagement (Top Right), Observed Engagement and Quality of Exhibit (Bottom Left), Engagement and Group Size (Bottom Right).
The data is drawn from the original raw file into a separate file provided in the repository.

Three other box plots can reveal the thorough use of a digital system by gauging visitor access time as compared to the time it takes to fully utilize a digital system. Temporal elements can also be mapped with engagement for better analysis of the effects of time on engagement.

**Fig. 7.** The box plot of age groups and the level of engagement.
Fig. 8. Length of time required to access all contents in the exhibits and actual visitor time spent on the exhibits (top left), visitor access time (top right), observed visitor engagement and time at exhibit (bottom).

# generates boxplot comparing length of time needed to access contents with actual visitor access time in Fig. 8

```r
go <- c(1, 2, 3, 4, 5, 6)
h <- c(1, 2, 3, 4, 5, 6)
boxplot(d$ExhibitLength, d$TimeAtExhibit, ylab="Time (minutes)", xlab="")
axis(1, at=seq(1, 2, by=1), labels=c("Length", "Actual"))
title(main="Exhibit Length and Actual Visitor Access Time", cex.main=1)
```

# generates detailed plot of visitor access time in minutes as compared to length of time needed to access contents

```r
boxplot(d$TimeAtExhibit-d$ExhibitLength)
title(main="Visitor Access Time", sub="", ylab="Actual Visitor Time Spent (minutes)", xlab="Length of Exhibit (minutes)", cex.main=1)
```
Logistic regression (Fig. 9) can test the predictors of user demographics and the social aspects of using an exhibit if categorical variables are used: (1=true, 0=false) – user is an adult (Adult), family units (Family), discussions taking place (Discussions), sex, space is crowded (IsCrowded), use of exhibit attracts a queue (AttractsQueue), and how long the queuing user uses the system eventually (Queued). We used access time (retention) as predictors for determining the likelihood of our categorical variables.
# graph the predictors for adult visitor and access time

```r
vmax = max(d$TimeAtExhibit)
# plot the predicted values using the sigmoid function
rs1 = glm(Adult ~ TimeAtExhibit, data = d, family = binomial, na.action = na.omit)
x <- c(0:vmax)
b = rs1$coefficients[1] # intercept
m = rs1$coefficients[2] # slope
y <- exp(b + m*x) / (1 + exp(b + m*x))
plot(jitter(d$Adult, factor=0.5) - d$TimeAtExhibit, ylab="P(Adult = 1)", xlab="Time At Exhibit", ylim=c(0,1),
     xlim=c(0,vmax))
# draw a curve based on prediction from logistic regression model
TimeAtExhibit ~ d$TimeAtExhibit
curve(predict(rs1, data.frame(TimeAtExhibit = x), type="response"), add = TRUE)
points(d$TimeAtExhibit, fitted(rs1), pch=20, col="red")
title(main="Predictors of Adult Visitors and Access Time")
summary(rs1)
# generate confidence intervals for the regression coefficients
confint(rs1)
# put the coefficients and confidence intervals onto a useful scale
exp(rs1$coefficients)
exp(confint(rs1))
```

# graph the predictors for family visitors and access time

```r
vmax = max(d$TimeAtExhibit)
# plot the predicted values using the sigmoid function
rs2 = glm(Family ~ TimeAtExhibit, data = d, family = binomial, na.action = na.omit)
x <- c(0:vmax)
b = rs2$coefficients[1] # intercept
m = rs2$coefficients[2] # slope
y <- exp(b + m*x) / (1 + exp(b + m*x))
plot(jitter(d$Family, factor=0.5) - d$TimeAtExhibit, ylab="P(Family = 1)", xlab="Time At Exhibit", ylim=c(0,1),
     xlim=c(0,vmax))
# draw a curve based on prediction from logistic regression model
TimeAtExhibit ~ d$TimeAtExhibit
curve(predict(rs2, data.frame(TimeAtExhibit = x), type="response"), add = TRUE)
points(d$TimeAtExhibit, fitted(rs2), pch=20, col="red")
title(main="Predictors of Family Visitors and Access Time")
# generate confidence intervals for the regression coefficients
summary(rs2)
# put the coefficients and confidence intervals onto a useful scale
exp(rs2$coefficients)
```

# graph the predictors for discussions and access time

```r
vmax = max(d$TimeAtExhibit)
# plot the predicted values using the sigmoid function
rs3 = glm(Discussion ~ TimeAtExhibit, data = d, family = binomial, na.action = na.omit)
x <- c(0:vmax)
b = rs3$coefficients[1] # intercept
m = rs3$coefficients[2] # slope
y <- exp(b + m*x) / (1 + exp(b + m*x))
plot(jitter(d$Discussion, factor=0.5) - d$TimeAtExhibit, ylab="P(Discussion = 1)", xlab="Time At Exhibit", ylim=c(0,1),
     xlim=c(0,vmax))
# draw a curve based on prediction from logistic regression model
TimeAtExhibit ~ d$TimeAtExhibit
curve(predict(rs3, data.frame(TimeAtExhibit = x), type="response"), add = TRUE)
points(d$TimeAtExhibit, fitted(rs3), pch=20, col="red")
title(main="Predictors of Discussions and Access Time")
x = 5 # if TimeAtExhibit is at 5, what is the probability of queued
b = rs3$coefficients[1] # intercept
m = rs3$coefficients[2] # slope
y <- exp(b + m*x) / (1 + exp(b + m*x))
as.numeric(y)
# generate confidence intervals for the regression coefficients
summary(rs3)
# put the coefficients and confidence intervals onto a useful scale
exp(rs3$coefficients)
```
Qualitative analysis

The method here analyses data through a mixed-methods approach in which both quantitative and qualitative techniques were applied for understanding trends and phenomenon. The method presented in this section can be applied to understand the reasons behind trends and phenomenon. The data can be drawn from thoughts and comments recorded from observing user interactions with digital exhibits and all relevant activities such as discussions, teaching and learning, etc. in the ‘Description’ column of our observation sheet. An example description is provided below, which can be informal. We deliberately left the grammar unchecked as it needs not be an issue for what is important is the keywords that have been recorded:

“man started by watching the video and his son and wife joined him later, talked about the design, men left, wife and son navigated to the picture section”,

“A mother touched the screen to show her son. The boy showed much interest in the content. When his mother is tired and put him down, he still wants to see more but too short to touch the screen”.

The record of these descriptions is important, for they captured all details of visitor behaviours which cannot otherwise be recorded numerically. These textual records will become extremely helpful for post-observation analysis and interpretation as it is a true description of what has been observed. This approach also removes the need for video recordings which can present issues if the Ethics Board were to be consulted. The qualitative approach here is conducted only after the R statistics has been carried out and when trends and patterns are identified. The approach used here applies thematic analysis, using NVivo, across all textual descriptions in order to explain each trend, correlation and phenomena.

Here, we use a case example to articulate our approach (Fig. 10) – if the quantitative analysis indicated that family visitors tended to spend more time at exhibits than adult visitors:

1 We imported all observation notes recorded in the “Description” column for these two types of visitors, i.e., family visitors and adult visitors into NVivo.
2 We generated an initial list of reoccurring patterns from the dataset, and coded where the patterns occurred as nodes. These nodes included events which frequently occur, e.g., “parents taught children”, “parents forced the child to leave”, “children asked questions”, “couple used the system together”, and etc.
There could be new nodes which continue to appear in the coding process. In such a case, the datasets may have to be read through again to check if the new nodes could be coded in the previous sections. This is an iterative process.

The density of each node can be observed in NVivo to obtain a clear view of the common occurrences in our observations. The related nodes can then be categorised to form one or more overarching themes for explaining phenomenon (Fig. 11). In our study, we generated themes such as “positive communication between parents and children” and “positive communication between couples or friends” in order to compare communication approaches between family visitors and adult visitors, and were therefore able to explain why family visitors tended to spend more time at exhibits than adult visitors. Thematic analysis allows the allocation of as many nodes as needed. These nodes can then be combined as themes for addressing questions raised as a result of quantitative analysis.

Fig. 10. Workflow of qualitative data analysis.

Fig. 11. A screenshot from NVivo showing the interface where our thematic analysis was conducted.
Supplementary material and/or Additional information

This method article needs to be read together with our published articles listed above. We have further provided R Scripts, the associated data files, graphs and observation sheet template as a reference. These files can be accessed via our GitHub repository: https://github.com/drecuk/DigitalSysBroadEvaluation.

Acknowledgements

The authors wish to express gratitude to the AHRC Centre for Digital Copyright and IP Research in China and the Ningbo Science and Technology Bureau for supporting the project (Grant Reference: AH/N504300/1, 2017D10035).

References

[1] E. Ch’ng, S. Cai, F.T. Leow, T. Zhang. Adoption and use of emerging cultural technologies in China’s museums, J. Cult. Herit. 37 (2019) 170–180.

[2] E. Ch’ng, S. Cai, F.T. Leow, T. Zhang. Datasets from the Evaluation of the Adoption and Use of Digital Technologies in China Museums, Data in Brief, Volume 25, August 2019, 104067.