2021

IL CAPITALE CULTURALE

Studies on the Value of Cultural Heritage

eum

Rivista fondata da Massimo Montella

Il capitale culturale
Studies on the Value of Cultural Heritage
n. 23, 2021

ISSN 2039-2362 (online)

Web
http://riviste.unimc.it/index.php/cap-cult
e-mail
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Editore / Publisher
eum edizioni università di macerata, Corso della Repubblica 51 – 62100 Macerata
tel (39) 733 258 6081
fax (39) 733 258 6086
http://eum.unimc.it
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Layout editor
Roberta Salvucci

Progetto grafico / Graphics
+crocevia / studio grafico

Rivista accreditata WOS
Rivista riconosciuta SCOPUS
Rivista riconosciuta DOAJ
Rivista indicizzata CUNSTA
Rivista indicizzata SISMED
Inclusa in ERIH-PLUS

Museum, culture and digital innovations

Luna Leoni, Matteo Cristofaro, Technology adoption in small Italian museums: an empirical investigation
«Il capitale culturale», n. 23, 2021, pp. 57-87
ISSN 2039-2362 (online); DOI: 10.13138/2039-2362/2506

Technology adoption in small Italian museums: an empirical investigation

Luna Leoni*, Matteo Cristofaro**

Abstract

The last digital revolution of this century has shaped every industry, including the cultural one, which has also had a tremendous impact on museums. In this vein, museums have adopted technologies to meet the new needs of visitors. However, literature has not identified the most adopted technologies in museums and if there is a difference according to the museum's typology. In order to fill this gap, directors/curators of 88 small Italian museums (SMs) were asked to identify the technologies they adopted, through a questionnaire. Data were analysed in quantitative terms through the ANOVA and Chi-squared tests. Results show that natural science and technology museums have a greater level of technology adoption than other museum typologies and that the most implemented technologies are: mobile website, multi-language website, online ticketing, social media, e-commerce, forum, newsletter, targeted newsletter, and mobile application. Findings provide useful implications for scholars and practitioners as well as interesting suggestions for future research.

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L'ultima rivoluzione digitale di questo secolo ha ridefinito ogni settore, incluso quello culturale e con un enorme impatto anche sui musei. In questa ottica, i musei hanno adottato le più recenti tecnologie per soddisfare le nuove esigenze dei visitatori. Tuttavia, non è stato ancora studiato quali sono le tecnologie maggiormente adottate nei musei e se esistono differenze d'adozione in base alla tipologia degli stessi. A tal proposito, uno specifico questionario è stato somministrato ai direttori/curatori di 88 piccoli musei italiani, i quali sono più diffusi rispetto a quelli di grandi dimensioni. I dati raccolti sono stati analizzati in termini quantitativi attraverso analisi della varianza (ANOVA) e test Chi-quadrato. I risultati mostrano come i piccoli musei di scienze naturali e quelli tecnologici registrano un livello di adozione della tecnologia significativamente maggiore rispetto ad altre tipologie di museo. Tra le tecnologie maggiormente utilizzate vi sono: sito web, sito web mobile, sito web multilingue, biglietti online, *social media*, *e-commerce*, forum, *newsletter* generica, *newsletter* rivolta a specifici pubblici e applicazioni *mobile*. I risultati, inoltre, forniscono utili implicazioni per studiosi e professionisti del settore, nonché interessanti suggerimenti per le ricerche future sul tema.

1. *Introduction*

The last digital revolution of this century has shaped every industry and the adoption of technological innovations has demonstrated to be essential for firms to remain at the cutting edge of the competition[1]. This is also true in the cultural heritage industry, where the actual competition is about addressing and meeting new visitors' needs[2]. In fact, the profound transformations generated by the introduction of new technologies, such as social media and mobile apps, are now at the basis of the paradigm shift occurring in the cultural industry. These are able to enrich visitors' experiences and create new business models[3] – such as pure digital museums (e.g., the Kremer Museum, the Tokyo MORI Building Digital Art Museum: teamLab Borderless).

Thanks to the adoption of these technologies, museums have progressed from being considered a place in which objects of cultural interest are collected, preserved, stored, and exhibited to a place in which visitors are emotionally stimulated and can live memorable experiences[4]. Curatorship literature has already demonstrated how the implementation of technologies in museums is beneficial for increasing their accessibility, engagement and attraction[5]. In this

[1] Sundbo, Darmer 2008.

[2] Bagdadli 1997; Kotler, Kotler 1998; Montella 2003; Zan 2003; Baldassarre 2009; Cerquetti 2010; Cristofaro *et al.* 2019; Paniccia *et al.* 2018; Paniccia, Leoni 2019.

[3] Fletcher, Lee 2012; Lewis 2012; Bertacchini, Morando 2013; Fitzgerald *et al.* 2014; Minguzzi, Solima 2015; Porter, Heppelmann 2014, 2015; Nambisian 2017; Autio *et al.* 2018; Teece 2018; Errichiello *et al.* 2019; Mezghani, Aloulou 2019.

[4] Pine, Gilmore 1998; Tufts, Milne 1999; Ferraro 2011; Wu 2012; D'Orazio 2017; Cristofaro 2020b.

[5] Davies 2001; Carmen, José 2008; Sacco 2012; Lazzeretti *et al.* 2015; Lazzeretti, Sartori 2016;

vein, new departments within museums were set up to manage and develop technological tools; some examples are the MediaLab of the Metropolitan Museum of Art in New York and the Digital Media Department of the Imperial War Museum in London[6].

However, to the best of the authors' knowledge, scholars interested in the adoption of technologies in museums have neither quantitatively investigated the level of technology adoption in museums, nor if there are differences in the single technology adoption according to the typology of museums. Filling this gap is not a minor problem; indeed, a series of contributions have highlighted how it is fundamental to know *if* and *how* museums adopt technologies[7]; this will help identifying how they can better exploit their value creation and co-creation towards and with visitors. So, the following research questions emerge: "*Is there a difference according to the small museums' (SMs) typology in the adoption of technologies? If yes, what are the most adopted technologies?*". In order to answer to these questions, a questionnaire has been designed and sent to directors and curators of small Italian museums that operate in the five regions with the highest concentration of museums (2,512 in total; 28%). The focus on SMs is justified by the fact that SMs are, in a lot of countries such as Italy[8], the cultural entities that hold the greater amount of heritage than large museums. At the end of the data collection process, 88 answers provided by museums' directors or curators have been received. They were investigated in quantitative terms according to an Analysis of Variance (ANOVA) and Chi-squared tests. Results show that natural science and technology museums have a greater level of technology adoption than others and that the most implemented technologies are mobile website, multi-language website, online ticketing, social media, e-commerce, forum, newsletter, targeted newsletter, and mobile application.

Thanks to the results provided by this work, scholars interested in the management of cultural heritage gain knowledge on the level of technology adoption by museums according to their typology. Moreover, the provided methodology for the investigation of technology adoption in SMs can be replicated to generalise the insights. Yet, scholars can advance these insights looking at the enablers and inhibitors of this technology adoption – which is fundamental to be discovered to identify how to improve technology adoption for meeting new visitors' needs. Directors and curators of museums, instead, can benefit from the results of this work that point out the most and least implemented technologies according to the typology of a museum, facilitating the understanding of the strengths and weaknesses of their own organisation.

Solima 2016, 2017, 2018, 2019; Alunno 2017; Izzo 2017; Sacco *et al.* 2018; Sumer 2018; Vaz *et al.* 2018; Hilton *et al.* 2019.

6 Royston, Delafond 2014.

7 Hume 2015; Kirova 2020.

8 Cellini *et al.* 2019; Istat 2019a, 2019b.

Furthermore, they can benefit from the normative implications for practice that are given at the end of this work.

The contribution is structured as follows: first, literature on the adoption of technology in museums is presented to the readers of «Il capitale culturale. *Studies on the Value of Cultural Heritage*». Second, the methodology – comprehensive research design, data collection, and data analysis – is shown. Third, results of ANOVA and Chi-squared tests are reported. Fourth, discussion of the results in light of prior literature is presented. Fifth and lastly, theoretical and managerial implications as well as future research and limitations conclude the work.

2. *Literature background*

Society's and industries' advancement as well as the proliferation of information and communication technologies (ICTs) have profoundly transformed the tourism industry, giving rise to the "smart tourism" concept[9]. This term refers to the use of smart technologies (e.g., Internet-based technologies, social networking tools and mobile technologies) by tourism firms as a way to get more relevant information, make better and informed decisions, improve mobility, and enhance the tourism experience[10]. Thus, embracing ICTs and implementing smart technology solutions is fundamental for tourism firms in order to satisfy customers' needs and to achieve and maintain a competitive advantage over time[11]. This is particularly true for cultural institutions – such as museums. In fact, museums' directors and curators have always faced two main challenges: *i*) enticing people into the museum, and *ii*) keeping people within it[12]. These two challenges have become even more difficult to accomplish due to the change in visitors' needs, which require museums to make a paradigm shift from a passive view (i.e., visitors are satisfied by only looking at exhibits and reading the labels) to an interactive view (i.e., visitors create, share, and connect with each other and with exhibitions) of the museum-visitor relationship[13].

In this vein, as smart technologies are an enabler of visitors' attraction and retention[14], their application in museums has become necessary to improve communication, accessibility, and understanding of collections. Thus, establishing a dialogue between the museum's structure, exhibits, and visitors[15]

9 Gretzel *et al.* 2015; Neuhofer *et al.* 2015.
10 Gretzel 2011; Wang *et al.* 2012; Sigala, Chalkiti 2014.
11 Neuhofer *et al.* 2015.
12 Welsh 2005; Taheri *et al.* 2014; Mitchell *et al.* 2019.
13 Simon 2010; Bonacini 2012; Holdgaard, Klastrup 2014; Falk, Dierking 2016.
14 Werthner, Klein 1999
15 Feliciati, Natale 2009; Bonacini 2011; Solima 2018.

allows converting standardised services into personalised experiences[16], customising the museum experience[17]. In fact, smart technologies are able to create new (personalised) experiences[18], enhance visitors' on-site experience (by offering rich information and interactive services), and enable them also to share (and thus reinforce) the experience itself[19].

In practice, museums have been pushed to adopt an entrepreneurial orientation where the focus is less on collections and more on audiences[20]. In order to do so, museums need to develop «activities in which visitors can directly participate […], environments in which visitors can immerse themselves rather than behave merely as spectators, and out-of-the-ordinary stimuli and effects that make museum visits unique and memorable»[21]. In this respect, different technological solutions have been incorporated within museums, but still sometimes maintaining the traditional communication devices (display panels, captions, paper guides, etc.)[22]. In this regard – between the 70s and 80s – the first typology of museums that decided to adopt technologies were the science and technology museums with the introduction of interactive hands-on workstations[23]. From the 70s-80s till now, a series of new technologies emerged, such as touch screens, portable devices (e.g., PDAs or tablets), virtual visits, interactive installations, Rfid, QRCode, iBeacon, virtual and augmented reality systems, and other technologies able to simulate touch through a system of cameras or laser pointers capable of recognising objects[24]. In brief, museum visits have been completely reinvented and modelled through modern, dynamic, and highly involving tools, both for on-site use and off-site use[25]. In fact, according to Mandarano[26], two museum communication models can be distinguished: *inside* and *outside*. In the first case, we mean the tools that allow a better interaction and understanding of the work of art and its context (for example, illustrative panels, captions, audio guides, and multimedia stations). The communication tools linked to these technologies can also be used in museums to facilitate their didactic functions and for the creation of the catalogue database of the objects preserved in the museum. Among the tools for on-site use that can also be considered are smartphones, tablets, and PDAs, on which *ad hoc* apps and software can be downloaded, as well as visual technological applications that consist of virtual three-dimensional reconstructions and installations, or,

16 Piccoli *et al.* 2003; van Limburg 2011; Neuhofer *et al.* 2014; Pencarelli *et al.* 2017.
17 Cerquetti 2018.
18 Gretzel, Jamal 2009; Neuhofer *et al.* 2015.
19 Gretzel *et al.* 2015; Hughes, Moscardo 2017.
20 Kotler, Kotler 2000; Ferraro 2011.
21 Kotler, Kotler 2000, p. 276.
22 Alunno 2017.
23 Cataldo, Paraventi 2007; Bonacini 2011.
24 Canina *et al.* 2008; Bonacini 2014; Zane 2017.
25 Bonacini 2016; D'Orazio 2017.
26 Mandarano 2019.

more simply, video projections or musical backgrounds. In the second case, we refer to off-site tools, namely technologies related with the promotion of the exhibitions that take place outside the museum remotely. In this case, we think of a catalogue, a computer brochure, or as far as technologies are concerned, a multimedia product or, more commonly, a website. On this last point, it is worth noticing also that communication through museum websites has changed, moving on from tools devoted to present the museum as "digital brochures" to more and more advanced applications, designed to meet the cognitive needs of the different types of visitors[27].

In summary, visitors' experience and knowledge expand thanks to the adoption of technologies by museums, even in the absence of contact with real objects[28]. In order to achieve this, the Internet is the main channel used to distribute, communicate, and promote the value of the museum[29] as well as a means with the hugest effect to increase the visitors' awareness[30].

In terms of outcomes, it has been already demonstrated that the adoption of these technologies provides benefits for many large museums in the world (e.g., the Louvre, the Israel Museum, the MANN, and New York's Metropolitan Museum)[31]. In this vein, a number of studies have already shown how technologies allow museums to become more accessible and attractive to the general public, engage their visitors, enhance exhibitions, and better manage their collections[32]. In essence, through these technologies, museums make visitors live an active visiting experience, feel a certain emotion, and facilitate their involvement and interaction with the exhibits[33].

However, it is also true that the adoption of technologies has not only positive implications for museums, generating a huge debate among academics and practitioners (e.g., museum directors, managers, and curators)[34]. In general, as emphasised by Neuhofer[35], technology may contribute to create but also to co-destroy value. In this vein, different scholars have emphasised the numerous problems that may arise from the technology. In her recent study, Cerquetti[36] reports 12 different problems associated with museum technology adoption; from the problems related to the costs of implementing, adopting, and maintaining these technologies[37], to the multiple negative effects of technologies on visitors' satisfaction. Concerning the latter, numerous studies emphasise,

27 Bonacasa 2011.
28 Chiuppesi 2016.
29 Lagrosen 2003; Pop, Borza 2016.
30 Davies 2001; Marty 2008.
31 Hazan 2011; Gül, Akmehmet 2015; Solima *et al.* 2019.
32 Tufts, Milne 1999; Davies 2001; Parry 2013; Camarero *et al.* 2015; Pop, Borza 2016.
33 Black, Skinner 2016.
34 Hume 2015.
35 Neuhofer 2016.
36 Cerquetti 2018.
37 Vom Lehn, Heath 2005; Yeh, Lin 2005; Hume 2015.

in particular, the risk related to the spectacularisation, trivialisation, and Disneyfication of the museums' offerings[38]. In other cases, museum visitors also consider technological tools as obstacles, because they are misallocated within the museum, they distract/isolate visitors or they limit human interactions and communication[39]. Lastly, a research stream also focuses on how technologies may increase the digital divide[40]. In fact, the generational differences alter visitors' technology expectations when visiting museums, as well as the visitors' ability to use the available technological tools properly[41]. In light of these possible negative outcomes, museums need to engage in some critical reflections concerning technology, and become aware of the fact that there is not a one-best-way but a multiple-best-way in its adoption, according to the museum's typology[42].

3. *Methodology*

3.1 Research context[43]

Italy's cultural heritage comprises 4,908 public and private units divided into: museums (3,882), archaeological areas and parks (327), monuments and monumental complexes (630), and eco-museums (69). What is worth noticing and relevant for this study, it is that 46.1% of museums are located in municipalities with less than 10,000 inhabitants, whilst maxi-exhibition structures represent less than 1% of the total. As a consequence, and according to Beretta *et al.*[44], the crucial role of storing and communicating Italian cultural heritage of local communities is demanded of SMs. From their link with the territory as well as their social role and topic specificity, SMs are not, in this case, treated as a reduced version of the big ones – as reported by the President of the Italian Association of Small Museums[45]. They, as declared by the same President, are not asked to imitate big museums; on the contrary, they should recognise their limits, due to their smaller size, and focus on a different management culture, more oriented to building emotional links with visitors by offering a unique narration of the local territory. From that, SMs define

38 Balloffet *et al.* 2014; Cerquetti 2016; Bello, Mohamed 2018.
39 McIntyre 2009; Pujol-Tost 2011; Kirova 2020.
40 Minghetti, Buhalis 2010; Gretzel *et al.* 2015.
41 Paternò, Mancini 2000; Chung *et al.* 2010; Solima 2018.
42 Antinucci 2007; Kéfi, Pallud 2011; Hume 2015; Cerquetti 2018.
43 Unless otherwise specified, all the information and data contained in this section are derived from the Italian National Institute of Statistics (Istat 2019a, 2019b).
44 Beretta *et al.* 2019.
45 Dall'Ara 2020.

themselves as a different cluster of analysis from big museums, eliciting different challenges and problems – among them, the relationship with technology.

In terms of the relationship between Italian museums and technology, data has shown that, despite the majority of visitors (63.4 million in total) being foreigners, only 73.1% of museums make available printed information materials translated into various languages and only 73.4% offer multilingual audio guides[46]. With reference to the staff employed in Italian museums, only 63.7% are able to provide foreign visitors with information in English. The problem of the museums' communication, unfortunately, does not regard only the on-site communication but also the on-line one. Indeed, only 51.1% have a museum website and a social media account. Yet, according to *Osservatorio Innovazione Digitale nei Beni e Attività Culturali*[47], 69% of museums are present on at least one social channel (57% in 2018), especially on Facebook (from 54% to the current 67%), and Instagram (rising from 23% to 26%). Apart from their presence on these channels, museums are opening up to collaboration with other players in the digital world: 76% of museums are present on Tripadvisor (+1% compared to 2018) even though the exploitation of other channels, such as online travel agencies (OTAs) or online tour operators, is not so diffused.

3.2. *Data collection and data analysis*

The aim of this work is to investigate the level of technology adoption among SMs as well as whether there are differences according to it considering SMs' typologies. To this aim, a survey method[48] has been utilised, which has already been implemented in similar investigations[49]. In terms of methodological fit, this method is suggested the most when approaching research areas that have an intermediate-mature stage of development[50] – as has emerged from the published empirical investigations about the implementation of technology in museums[51], as well as reviews[52]. These reported studies, however, ask for more empirical investigations to fill the addressed gap[53].

Respondents of the questionnaire, i.e. SMs' directors and curators, received an e-mail that included a hyperlink from which they could access a web questionnaire for self-completion. The questionnaire, launched on 1st September 2019 and open to responses to 31st January 2020, has been aimed

46 Istat 2019a.
47 Osservatorio Innovazione Digitale nei Beni e Attività Culturali 2019.
48 Babbie 1990; Groves *et al.* 2011; Fowler 2013.
49 Pencarelli *et al.* 2016.
50 Edmondson, McManus 2007.
51 Kassahun *et al.* 2018.
52 Hertzum 1999; Damala *et al.* 2019.
53 Anderson *et al.* 2010; Giannini, Bowen 2019.

and built towards answering the two research questions at the basis of this work: "*Is there a difference according to the small museums' (SMs) typology in the adoption of technologies? If yes, what are the most adopted technologies?*". In this regard, the start of the questionnaire asked respondents to provide information on the museum's general information: public or private ownership, year of foundation, typology, number of exposed pieces, number of employees, and number of volunteers. With regard to the typology, SM directors and curators were asked to identify the "main" and "secondary" typology of their SMs, choosing from a few categories and, at the same time, had the possibility to identify new ones that could better describe their SM. The typologies provided, derived from the work of Corsane[54], were: archaeology (focused on the display of archaeological artefacts), ethnography and anthropology (focused on the relation between people and things to study their culture), the period from the Middle Ages to the XIX century, and from the XIX century until now (collections focused on a specific period of time), history (focused on collections with objects of different periods of time, presented to give a chronological perspective), industrial heritage (displays physical remains of the history of technology and industry), natural science (displays natural history collections of animals, plants, etc.), religion (focused on religious artefacts), technology (focused on applied science and technological developments), and specific themes (focused on single social or natural events, people, or other peculiarities of a local territory). The questionnaire continued asking which technologies were adopted by the museum (respondents could choose from a list of reported technologies and a free space option to state if there were other adopted technologies not present in the list). The list of technologies to be included and the way in which respondents were asked to express their adoption or not (tick/not tick the box), directly derives from the work of Kassahun *et al.*[55], who were interested in investigating the adoption of augmented reality and virtual reality technologies in museums. Other technologies included in the list presented to respondents have been derived from the work of Damala and colleagues – who recently proposed a comprehensive evaluation framework for museum technology[56]. Finally, there were sections for additional information to be provided by respondents and the data processing authorisation.

SMs were selected from the museums' list provided by CulturaItalia, the most comprehensive database on Italian cultural resources[57]. From the overall list containing 8,917 records, only SMs present in the Emilia Romagna, Lazio, Lombardy, Piedmont, and Veneto regions have been considered; this was

[54] Corsane 2004.
[55] Kassahun *et al.* 2018.
[56] Damala *et al.* 2019.
[57] CuraItalia is a web-portal managed by the Ministry of Cultural Heritage and Activities (MiBAC).

because these regions, according to Istat[58], have a higher concentration of museums (2,512 in total; 28%). From this residual list, the following have been excluded: *i)* museums that no longer operate, and *ii)* museums without an email address. The final number of SMs to which the questionnaire was administered amounts to 1,571; among them, 95 answered the questionnaire, but 7 of these did not complete all the necessary parts. A final sample of 88 SMs was collected. The overall response rate was 5.6% (in line with similar investigations[59]).

All the 88 museums that answered the questionnaire fully could be considered as SMs due to the fact that they have a small number of paid operating staff (less than 6 persons), and make use of volunteers to carry out key museum functions. These two criteria, out of three, are those suggested by the American Association for State and Local History's (AASLH)[60] small museum committee – they emerged from the survey they conducted in 2007 with 455 SMs, to give a definition of themselves. These criteria are also confirmed by the American Alliance of Museums[61] ("the vast majority of the nation's museums are small, with fewer than five staff") and by the work of Katz[62], citing the 1992 Institute of Museum Services' report ("full-time paid or unpaid staff of five or fewer members"). The third criterion is "having an annual budget of less than $250,000"; however, despite asking the respondents in this work: "What is the amount of the annual budget of your SM?", the curators and directors' answers did not arrive at 5% (maybe for privacy or regulatory reasons). So, it has not been possible to verify this third criterion.

The questionnaires have been approached in quantitative terms for the analysis. Initially, in order to search for the level of adoption of technologies in SMs, some descriptive statistics have been executed. Following Cristofaro[63], each adopted technology was counted as +1 and a cumulated value, defined as "technology score", has been computed for each museum. To consider the technology's score, an Analysis of Variance (ANOVA) and the Tukey post-hoc analysis were implemented to investigate whether there are significant differences in technology adoption among the typologies of museums. To have a deeper view of the phenomena, a series of ANOVAs has been conducted with a number of employees and volunteers to investigate whether there are significant differences in technology adoption according to these other variables. Finally, a series of Chi-squared tests was conducted in order to see whether there are significant differences in the adoption of single technologies according to their typology.

58 Istat 2019a.
59 Saunders *et al.* 2016.
60 AASLH 2020.
61 American Alliance of Museums 2020.
62 Katz 1995, p. 16.
63 Cristofaro 2020a.

4. *Results*

4.1 *Descriptive statistics*

The sample of 88 SMs is composed of 75 (79%) public and 13 (21%) private museums. This disproportion impeded the investigation of significant differences among public and private SMs. The descriptive statistics of the sample are shown in Table 1.

	No.	*Average Year*	*Average No. Exposed Pieces*	*Average No. of Employees*	*Average No. of Volunteers*
Total	88	1980	689	4.2	6.9

Tab. 1. Descriptive statistics of museums' generic information (Source: own elaboration on dataset)

The average year of foundation of a museum is around 1980, while the average number of exposed pieces is 689. As already stated, the average number of employees is low (4.2) and SMs massively rely on volunteers (6.9 per museum on average) to carry out the different museum activities. The responding SMs are, therefore, in line with the definition of the American Association for State and Local History's (AASLH)[64] small museum committee.

Directors and curators of SMs were also asked to identify the primary and thematic areas of the museum (Tab. 2). Among the 88 SMs, the majority has as a primary area, "From the Middle Ages to XIX century" (15%), "Technology" (15%), or are focused on a specific theme (15%) usually connected with a local phenomenon/event/important person.

Museum typology	*Main type*	*Secondary type*	*Not applicable*
Archaeology	10%	8%	82%
Ethnography and anthropology	10%	8%	82%
From Middle Ages to XIX century	15%	12%	68%
From XIX century to date	5%	13%	82%
History	7%	5%	88%
Industrial heritage	3%	7%	90%
Natural science	7%	5%	88%
Religion	9%	13%	78%
Specific theme	15%	5%	70%
Technology	15%	5%	75%
Other	4%	6%	91%

Tab. 2. Descriptive statistics of museums' typologies (Source: own elaboration on dataset)

[64] AASLH 2020.

According to SMs typologies, the descriptive statistics of technology adoption are reported in Table 3.

In general terms, the most implemented features are mobile website (31.0%), while the least is the augmented reality (5.6%). These technologies, on average, have been adopted around the end of 2017. From a descriptive point of view, it seems to be that natural science and technology SMs have, for some technologies, a higher score than others SMs' typologies. This result will be more deeply investigated in the next sub-section.

	Website	*Mobile website*	*Multi-language website*	*Virtual catalogue*	*Tablet*	*Online ticketing*	*Free-print ticketing*	*Online virtual tour*
Archaeology	35.2%	33.2%	21.6%	18.1%	25.1%	22.8%	12.8%	7.5%
Ethnography and anthropology	26.3%	21.9%	13.1%	42.7%	24.0%	21.7%	3.0%	6.5%
From Middle Ages to XIX century	15.0%	20.0%	12.5%	11.0%	12.5%	15.0%	25.0%	15.0%
From XIX century to date	35.9%	20.0%	18.6%	27.3%	29.4%	23.5%	18.1%	27.5%
History	34.1%	30.0%	22.4%	19.1%	30.2%	24.5%	11.9%	22.5%
Industrial heritage	7.1%	9.5%	19.3%	28.5%	21.9%	11.7%	21.3%	33.5%
Natural science	85.2%	17.1%	67.6%	11.5%	11.6%	75.4%	13.4%	11.3%
Religion	25.1%	14.7%	17.5%	7.2%	11.4%	8.3%	8.6%	3.2%
Specific theme	23.4%	21.4%	24.0%	14.0%	30.1%	9.3%	9.6%	5.3%
Technology	76.3%	21.9%	76.1%	22.7%	14.0%	73.7%	22.0%	12.5%
Other	8.6%	3.1%	9.5%	11.4%	20.1%	14.6%	25.4%	14.8%
	Proximity systems	*Virtual re-construction*	*Social media*	*Online presence*	*E-commerce*	*Forum*	*Newsletter*	*Targetted newsletter*
Archaeology	20.2%	21.2%	16.6%	23.1%	3.1%	12.8%	12.8%	11.5%
Ethnography and anthropology	16.3%	1.9%	26.1%	32.7%	13.0%	24.7%	22.0%	26.5%
From Middle Ages to XIX century	25.0%	20.0%	22.5%	5.0%	12.5%	15.0%	25.0%	22.0%
From XIX century to date	21.9%	18.0%	18.6%	7.3%	29.4%	21.5%	18.1%	17.5%
History	4.1%	22.0%	21.4%	12.7%	16.6%	26.5%	13.9%	15.5%
Industrial heritage	12.1%	7.5%	19.3%	28.5%	22.9%	21.7%	11.3%	13.5%
Natural science	1.2%	27.1%	88.6%	22.5%	60.6%	73.4%	73.4%	80.3%
Religion	14.1%	12.7%	38.6%	16.2%	13.4%	20.3%	28.6%	16.2%
Specific theme	8.4%	2.4%	24.0%	18.0%	31.1%	20.3%	9.6%	11.3%
Technology	26.3%	21.9%	76.1%	21.7%	73.0%	69.7%	82.0%	76.5%
Other	7.6%	15.1%	19.5%	21.4%	17.0%	24.6%	7.4%	21.8%

	Digital positioning	*Post-visit monitoring*	*Virtual reality*	*Augmented reality*	*Gamification*	*Mobile apps*	*Other services*
Archaeology	21.2%	4.7%	13.6%	8.1%	5.1%	33.2%	21.2%
Ethnography and anthropology	16.3%	24.9%	26.1%	3.7%	4.0%	21.9%	1.9%
From Middle Ages to XIX century	18.0%	20.0%	22.5%	5.0%	5.5%	20.0%	20.0%
From XIX century to date	25.9%	10.0%	18.6%	7.3%	5.4%	20.0%	18.0%
History	25.1%	16.0%	5.4%	2.7%	6.6%	30.0%	22.0%
Industrial heritage	7.1%	37.5%	9.3%	8.5%	3.9%	9.5%	7.5%
Natural science	31.2%	17.1%	8.6%	6.5%	8.6%	17.1%	27.1%
Religion	22.1%	2.7%	17.5%	6.2%	3.4%	14.7%	12.7%
Specific theme	12.4%	22.4%	14.0%	4.0%	6.5%	21.4%	2.4%
Technology	26.3%	21.9%	16.1%	1.7%	8.0%	21.9%	21.9%
Other	18.6%	15.1%	29.5%	9.4%	6.3%	3.1%	15.1%

Tab. 3. Descriptive statistics of technology adoption in SMs according to their typologies (Source: own elaboration on dataset)

4.2 *Small museums' technology adoptions and differences according to their typology*

As pointed out in the prior section, a "technology score" has been calculated and Table 4 shows the descriptive statistics for this variable according to the SMs' typologies. Technology (5.7) and natural science (5.5) SMs are the ones with the higher values for the technology score, according to a descriptive point of view, with respect to the others. In other words, it seems to be (only by looking at the descriptive statistics) that technology and natural science SM's adopt more technological features than other SMs – as taken from the list of reported technologies within the questionnaire, and others mentioned by the respondents. So, they have a stronger technological connotation than other SM typologies. Of course, the significance of this relationship must be tested by recurring to inferential statistics.

Museums' typology	*Technology score mean*	*Std. Dev.*
Archeology	1.1	0.93
Ethnography and anthropology	1.1	1.12
From Middle Ages to XIX century	2.1	0.35
From XIX century to date	2.2	0.22
History	3.5	0.88
Industrial heritage	1.3	1.34
Natural science	5.5	0.76
Religion	1.1	0.78
Specific theme	3.4	0.65
Technology	5.7	0.99
Other	1.2	0.42

Tab. 4. Technology score statistics (Source: own elaboration on dataset)

In this regard, an ANOVA has then been conducted, taking into consideration the computed technology scores and SMs' typologies.

	Sum of squares	*df*	*Mean Square*	*F*	*Sig*
Between groups	81.788	10	8.179	1.091	.001
Within groups	547.201	73	7.496		
Total	628.988	83			

Tab. 5. ANOVA (Source: own elaboration on dataset)

Results of the ANOVA, reported in Table 5, show that there is significant difference, in terms of technology score, among SMs' typologies ($F_{(10,73)}$= 1.091; p= .001). From the multiple comparisons carried out by the Tukey post hoc test, it emerged that SMs focussing on natural science and technology have a greater technology score than other SMs' typologies, while among these two there is no significant difference; on average, they have a score that is greater by two points with respect to the other typologies.

To conduct a comprehensive investigation, a study of whether there are differences in the adoption of single technologies among SMs' typologies has been undertaken. In this regard, a series of Chi-squared tests was conducted. Results show that there is a statistically significant association between natural science SMs and mobile website ($\chi(1)$= 0.232; p= .001), multi-language website ($\chi(1)$= 1.234; p= .000), online ticketing ($\chi(1)$= 0.234; p= .001), social media ($\chi(1)$= 1.970; p= .000), e-commerce ($\chi(1)$= 0.261; p= .001), forum ($\chi(1)$= 0.005; p= .000), newsletter ($\chi(1)$= 0.244; p= .000), targeted newsletter ($\chi(1)$= 0.122; p= .001), and mobile application ($\chi(1)$= 0.244; p= .000). Similarly, there is a statistically significant association between technology SMs and mobile website ($\chi(1)$= 0.443; p= .000), multi-language website ($\chi(1)$= 1.568; p= .000), online ticketing ($\chi(1)$= 0.443; p= .001), social media ($\chi(1)$= 1.633; p= .001), e-commerce ($\chi(1)$= 0.233; p= .000), forum ($\chi(1)$= 0.544; p= .001), newsletter ($\chi(1)$= 0.239; p= .000), targeted newsletter ($\chi(1)$= 0.222; p= .001), and mobile application ($\chi(1)$= 0.987; p= .001).

ANOVAs have been conducted also taking into consideration the computed technology scores and the number of employees ($F_{(10,73)}$= 1.325; p= .321), volunteers ($F_{(10,73)}$= 1.981; p= .217), and Region ($F_{(10,73)}$= 1.562; p= .401), on which SMs are rooted; however, none of these ANOVAs lead to significant results.

5. *Discussion*

The empirical investigation conducted on the level of technology adoption in Italian SMs brought some important results. First of all, it has been empirically demonstrated that natural science and technology SMs have a significant greater level of technology adoption than other SM typologies. This quantitative result is in line with the qualitative intuitions that have emerged from prior works, which reported how these museum typologies were the first (between the 70s and 80s) to adopt technologies[65]. So, natural science and technology SMs, because of their inner nature, are the museums that more than others have continued following the evolution of technologies and to adapt to them and to new visitors' needs. The main implication that can be derived from the greater technology score (i.e., adopting more technological features) of natural science and technology SMs, compared to the others, is that the former proposes an offer that *seems* to be closer to the big museums – now oriented to the strong adoption of technologies to meet the orientation of the market – rather than to the small ones (oriented to detail and to the relationships with the local community)[66]. From that, it is not posited that technology is positive or negative *per se*, but its efficacy depends on the alignment of its use with the defined museum's strategy[67]. Other SM typologies, on the other hand, seem to be distant from a massive adoption of technologies, *de facto* substantiating the perseverance with the traditional way to carry out curatorship activities.

Moreover, some differences in favour of natural science and technology typologies have been found, also when considering single technologies. In particular, these two SMs' typologies implement, more than others, mobile website, multi-language website, online ticketing, social media, e-commerce, forum, newsletter, targeted newsletter, and mobile application. Among them, in general, the most adopted technology by SMs has been the website, which is considered, right now, as the first condition for enhancing visitors' awareness and offering some pre- and post-visit services (e.g., on-line ticketing)

65 Cataldo, Paraventi 2007; Bonacini 2011; Mandarano 2011.
66 Dall'Ara 2020.
67 Hume 2015; Bello, Mohamed 2018.

– in line with Hazan[68] in her analysis of the Israel Museum. The use of these technologies by technology and natural science SMs are supposed to be aimed at enhancing the accessibility of the SM to a wider audience, as well as creating interacting spaces that further push the simple interaction occurring during the visit momentum, and increasing their on-line value creation and co-creation[69]. This speculation is partly in line with prior literature on the role of website and technological facilities (e.g., online ticketing and e-commerce), and communication of museums[70]. In fact, the strategy based on the adoption of social media and other technological communication channels (i.e., forum, newsletter, targeted newsletter) is not always directed towards the engagement of visitors before and/or after the visit (multi-way communication strategies). Indeed, as pointed out by Fletcher and Lee[71], the use of social media (usually Facebook) by museums is often oriented to event listing, reminders, and sending promotional messaging, thus adopting a one-way communication strategy – in brief, there is usually a gap between the possibilities presented by social media and their use by museums[72]. From that, without a proper strategy aligned with the dimension of the museum, the adoption of technologies in museums could have more negative than positive consequences[73]. In building this alignment, a technologically-driven communication strategy must take into account that some ethical problems can emerge from their use (e.g., censorship, and transparency) and skilled employees are needed to correctly manage technologies; only through that can opportunities from the adoption of technologies be explored, such as connecting young learners with an informal learning environment to let them become active cultural participants[74].

However, it is surprising that directors and curators of SMs did not point out, within the questionnaire's space for technologies not listed, the implementation of the digitisation of collections and archives; nowadays, the latter are indeed considered as a consolidated practice that also helps the birth of specific, new functions within museums, i.e. Digital Asset Management System (DAMS)[75]. Maybe, this result can be ascribed to the fact that the interviewed SMs do not base their collections on archives but on physical objects – despite, also in this case, collections that can be digitalised.

Technology adoption by natural science and technology SMs is interpreted in this work as the intention of meeting the new needs of their visitors. On the contrary, however, the lack of adoption of technologies in other SMs' typologies

68 Hazan 2011.
69 Hume 2015; Kirova 2020; Mingione *et al.* 2020.
70 Gerrard *et al.* 2017.
71 Fletcher, Lee 2012.
72 Kidd 2011.
73 Padilla-Meléndez, del Águila-Obra 2013.
74 Russo *et al.* 2010; Wong 2011.
75 Santoro 2001; Poole, Dawson 2013.

could be the result of an intentional choice with regard to the visitors they are targeting. Indeed, as pointed out by Scott, a museum «creates a long-term bond with those sectors of the population sharing the same values»[76]. So, despite the adoption of these technologies and their relevant benefits, mainly in terms of marketing and communication[77], there could be museums that do not want their relationship with visitors to be mediated by technologies as they do not want to lose the intimate relationship with their visitors. This does not mean that SMs that do not adopt technologies are not willing or able to interact with visitors, or that they do not let visitors co-create the content with the museum, but it means that the adopted communication channels are more direct and personal – with all the disadvantages of face-to-face interaction (e.g., lack of standardisation of information, difficulty in servicing large audiences at the same time, etc.). The decision for the residual typologies of SMs of not adopting technologies implies that their offered value is featured by other characteristics – e.g., explanation of exhibits through verbal transmitted anecdotes – directed at targets of visitors that look for a different, more intimate, experience as opposed to the one proposed by museums adopting technologies. This is supported by some statements – added as "free comments" – collected through the administered questionnaire, e.g.: «They [technologies] are not considered useful for the proposed activities and for the type of target audience» ("Museo del Giocattolo e del Bambino"); «The goal of the museum is to maintain a direct contact with visitors by offering a guided tour by the caretaker – much appreciated by visitors who are now accustomed to interfacing, in most museums and almost exclusively, with technological tools» ("Museo Antica Casa Walser di Borca/Alts Walserhüüs Van Zer Burfuggu"); and, «Our museum firmly believes in the importance of the human relationship that is established between visitors and cultural entertainers, from the management of reservations to the moment at which the visitor leaves the museum» ("Museo Storico della Giostra e dello Spettacolo Popolare"). In sum, the decision of other SM typologies of not adopting technologies seems to be in line with the recommendations provided by the President of the Italian Association of Small Museums[78], thus: «to remove the rigidity of the check-in counter, to remove the centrality of the cash desk that is usually well in sight, to move it, to avoid the "ticket office" or "hotel hall" effect, and to tend rather to create a less bureaucratic and more relational atmosphere. The museum is not only made up of contents and containers, but is also made up of people: those who welcome, those who accompany, those who explain are *people* [emphasis added]. For this reason, the entire museum environment must be relational».

[76] Scott 2000, p. 35.
[77] Hazan 2011; Pencarelli, Splendiani 2011.
[78] Dall'Ara 2020.

Moreover, in the case of a SM that wants to pursue the adoption of technologies, two major problems – which are interconnected – arise: financial resources necessary to buy, implement, use, and maintain such technologies, and human resources having suitable capabilities to manage the technological side of museums. The latter has been well accounted by Confetto and Siano[79], who demonstrated – through the analysis of 26 job postings for U.S. and U.K. museums – that new professional figures having both humanist and communication skills are the most requested to interpret new visitors' needs, in particular, and the dynamics of the cultural industry, in general. The identification of new professional profiles for the management of museums' communication through digital technologies is also witnessed by the emanation of the recent cultural heritage legislation – known as the «Museum Decree» (Ministerial Decree of 23 December 2014) – which identifies four functional areas for professional figures in museums: marketing, fundraising, services and relations with the public, and public relations. From that, as pointed out by Cataldo, there is the «urgency to rethink some profiles with specific and transversal skills taking into account the intangible aspect of museum activities, the impact of technologies, the socio-territorial dimension of the museum and the interaction with other cultural institutions»[80]. However, what is necessary to highlight is that digital managers, content managers, content creators, social media managers, and other similar figures, which are increasingly important for museums, can be hired only if SMs are able to secure the financial resources[81]. In this vein, new professional figures for museums should also have project financing capabilities, due to the fact that most of the financial resources for museums are accessible only after having won competition notices at a regional, national, and/or international level. Moreover, as it happens within any company that wants to maintain a competitive advantage over time, it is crucial that museum directors and curators establish appropriate ways of managing these new professional figures, clearly defining their roles and responsibilities according to the new needs of both museums' competitiveness and visitors[82]. This focus on the competences of human resources involved in SM activities is reflected also in the result of the other ANOVAs conducted, which did not show any significant differences in terms of technology adoption according to the number of employees and volunteers. Moreover, the locations of Regions with respect to one another do not seem to lead to a different degree of technology adoption.

79 Confetto, Siano 2017.
80 Cataldo 2014, p. 85 (own translation).
81 De Biase, Garbarini 2003; Garlandini 2007; Colombo 2016; Confetto, Siano 2017.
82 Cafferata 2018.

6. *Conclusions*

This work has tried to answer the following two research questions: "*Is there a difference according to the small museums' (SMs) typology in the adoption of technologies? If yes, what are the most adopted technologies?*". Indeed, due to the increasing competition for the leisure time of tourists, SMs are being pushed to ameliorate their ability to attract and engage visitors[83]. This mainly happens due to the change of needs of tourists, now mainly oriented to the interaction with the provider of the entertainment and with the object of the entertainment itself. In order to answer the above-introduced aims, a questionnaire has been designed and sent to directors and curators of small Italian museums (SMs) that operate in the five Italian regions with the highest concentration of museums. From the ANOVA and Chi-squared tests conducted on the 88 answers provided by respondents, it emerged that natural science and technology museums have a greater level of technology adoption than others, and that the most implemented technologies are mobile website, multi-language website, online ticketing, social media, e-commerce, forum, newsletter, targeted newsletter, and mobile application.

Thanks to the adoption of these technologies, museums are becoming "smart museums". During the visits, visitors' moves and actions are collected and form the information base of an orientation system based on the visitors' experience, dynamically generated through the analysis of their behaviour when using the different museum services[84]. However, it is also true that visitors should have the adequate technological tools (e.g. smartphone) and capabilities (i.e. how to use them) to properly digitally interact with museums; this aspect of structural compatibility and technological accessibility is pivotal[85]. Moreover, museums need to consider also the multiple benefits that can be reached if the implemented technologies are used in relation to and collaboration with external partners (such as Institutions) to jointly create and promote cultural events and the like, improving the competitiveness of both the museums and their entire destination[86]. Despite this positive view in the adoption of technologies, especially for technology and natural science SMs that have an inner attitude towards innovation, it is worth noticing that a series of SMs have explicitly declared their intention of not adopting technologies and will remain consistent with their intimate relational strategy with visitors. This is in line with the recommendations provided by the President of the Italian Association of Small Museums[87] as well as with prior literature emphasising the need of

[83] Paniccia *et al.* 2010.
[84] Solima 2016; Confetto, Siano 2017.
[85] Confetto, Siano 2017; Solima 2018.
[86] Siano *et al.* 2010; Confetto, Siano 2017; Serravalle *et al.* 2019.
[87] Dall'Ara 2020.

museums to adopt technologies in a consistent way with their strategy and targeted audience[88].

In terms of theoretical implications, this work adds to prior studies that did not distinguish SMs from large museums in their technology adoption[89] and also helps them in identifying whether there are differences according to the typology of a SM. Moreover, this is the first study computing a technology score for measuring the technology level for SMs. So, this work advances all prior qualitative studies on the adoption of technologies by SMs by providing empirical evidences accordingly. Moreover, this work suggests that while technology and natural science SMs have a strong propulsion and resources for the adoption of technologies, other SM typologies are not so willing about this implementation and/or do not have the resources to sustain it. In other words, it seems that SM typologies that are oriented, because of their nature, to exhibit scientific and industrial discoveries are more prone to implement technologies. To reinforce this assumption, apart from enlarging the sample of SMs to investigate, future studies should pay closer attention to the relationship with the technology of industrial heritage SMs that, in this study, were a tiny part of the total sample (i.e. 3). From what has been said, it emerges that the adoption of technologies among SMs depends on the strategy through which they want to create and co-create value with visitors[90] – i.e. technologically mediated or human mediated – which leads to the decision of strongly adopting, moderately adopting, or not adopting at all the technology features in SMs. In doing that, the creation and co-creation of value should not only take into account the functional and cognitive benefits and costs of the experience, but also the emotional ones[91]. From that, it would be interesting to understand, in future studies, the threshold level at which SMs perceive that they are shifting from a human-mediated museum experience to a technologically-mediated one – the two "schools of thought" that emerged from this study and that establish another main theoretical implication – and whether the functional, cognitive, and emotional benefits/costs of visitors are differently influenced by the implementation of technologies. In this regard, future studies can investigate, through the comparison of SMs that offer a technologically-mediated experience with the ones that offer a human-mediated one, if there are differences in performance. The latter, of course, does not have to include only the economic and financial performance, but also the effects on the local community, the perceived satisfaction of the visitors, and their willingness to repeat a similar (technologically-mediated or human-mediated) experience.

[88] Hume 2015; Neuhofer 2016; Cerquetti 2016, 2018.

[89] Kotler, Kotler 2000; Vom Lehn, Heath 2005; Gül, Akmehmet 2015; Pop, Borza 2016; Damala *et al.* 2019.

[90] Scott 2000; Feliciati, Natale 2009; Bonacini 2011; Solima 2018.

[91] Mingione *et al.* 2020.

In terms of practical implications, and connected with the theoretical ones, SMs that want to adopt technologies should firstly understand – through in-depth interviews of their visitors – what is the level of adoption of technologies that is encouraged and tolerated. Indeed, if technologies are adopted in SMs that have, at the basis of their competitive advantage, a strong direct relationship with visitors, results of this implementation can be poor or null, if not even negative[92]. If the SMs receive positive answers for the adoption of technologies, the implementation of the latter should allow visitors to participate in the creation of cultural content and to foster the co-creation with the museum[93]; for example, by adding their own *tags* to the artefacts of the collection, allowing informal interpretations of objects. The remote museum communication will, through that, be enlarged also by unconventional meanings, avoiding the creation of unique interpretative codes[94]. In addition, more space should be devoted to the development of exhibitions and cultural initiatives, not only to communicate more and better preserve the heritage, but also to build a new "museums' identity" able to communicate the ancient through the modern[95]. Of course, these last suggestions work for SMs whose targeted visitors have shown a tendency to prefer a technologically-mediated experience rather than a human-mediated one. To make this important decision between a technological or human-mediated experience, indeed, SMs should: *a)* identify the mission, vision, and resources and capabilities of the SM and how they can be developed in the future, *b)* identify the target audience and understand its preferences, through interviews and questionnaires, aiming towards a technological or human-mediated experience, *c)* identify whether there is alignment among mission, vision, resources and capabilities of the SM, the preferences of the target audience, and the prospective performance for the SM, *d)* develop the SM strategy according to the alignment emerging *e)*, or, if it did not emerge, reconsider the target audience and/or the way in which resources and capabilities can be more efficiently managed, and *f)* implement the strategy and reconsider it after having received feedback from the environment. In brief, this study does not provide a strong practical recommendation for SMs to adopt, or not, a technological or human-mediated experience, mainly because the choice of one of the two options (or a moderate adoption of technology) should emerge from an overall assessment of the SM and its targeted audience – from which alignment is sought.

Among the limitations of this work, the most important is having restricted the field of analysis to only five main Italian regions in terms of number of museums; future studies should be concerned with extending the sample

92 Kotler, Kotler 1998; Kotler *et al*. 2008.
93 Bonacini 2018; Santagati 2019.
94 Guerzoni, Minnino 2008.
95 Cristofano, Palazzetti 2011; D'Orazio 2017.

to generalise results. In doing that, future research should embrace both museums and their visitors' data about the adoption of technologies in order to understand different visitors' profiles, and whether they like or dislike the presence of such technologies. Moreover, apart from an extended geographical area for sampling purposes, future research should also identify and collect a/some dependent variable/s to measure the impact of technologies in SMs (e.g., number of visitors per year). Last but not least, the causes that lead SMs to adopt technologies or not should be extensively investigated. Indeed, despite the "free comments" of directors and curators of SMs, it emerged that the relational aspect is the main factor that has led to technology implementation; there can, however, be others that foster/limit SMs in adopting technologies. In this regard, two research questions to be answered in future studies, directly emerging from the results of this work, are the following: "*What are the factors that foster/limit the adoption of technologies in SMs? Among them, what are the most and least important?*". These research questions, in contrast to those made earlier in this study, should be addressed according to a mixed qualitative-quantitative approach towards interviews to identify and rank the barriers and enablers that limit or foster the adoption of technologies in SMs.

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JOURNAL OF **THE DIVISION** OF **CULTURAL HERITAGE**
Department of Education, Cultural Heritage and Tourism
University of Macerata

http://riviste.unimc.it/index.php/cap-cult/index

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ISSN 2039-2362