



AI and Swedish Heritage Organisations: challenges and opportunities

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Abstract

This article examines the challenges and opportunities that arise with artificial intelligence (AI) and machine learning (ML) methods and tools when implemented within cultural heritage institutions (CHIs), focusing on three selected Swedish case studies. The article centres on the perspectives of the CHI professionals who deliver that implementation. Its purpose is to elucidate how CHI professionals respond to the opportunities and challenges AI/ML provides. The three Swedish CHIs discussed here represent different organizational frameworks and have different types of collections, while sharing, to some extent, a similar position in terms of the use of AI/ML tools and methodologies. The overarching question of this article is what is the state of knowledge about AI/ML among Swedish CHI professionals, and what are the related issues? To answer this question, we draw on (1) semi-structured interviews with CHI professionals, (2) individual CHI website information, and (3) CHI-internal digitization protocols and digitalization strategies, to provide a nuanced analysis of both professional and organisational processes concerning the implementation of AI/ML methods and tools. Our study indicates that AI/ML implementation is in many ways at the very early stages of implementation in Swedish CHIs. The CHI professionals are affected in their AI/ML engagement by four key issues that emerged in the interviews: their institutional and professional knowledge regarding AI/ML; the specificities of their collections and associated digitization and digitalization issues; issues around personnel; and issues around AI/ML resources. The article suggests that a national CHI strategy for AI/ML might be helpful as would be knowledge-, expertise-, and potentially personnel- and resource-sharing to move beyond the constraints that the CHIs face in implementing AI/ML.

Keywords AI/ML implementation · Cultural heritage professionals · Cultural heritage management · Digital management of collections · Organization

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1 Introduction

Fast-pacing, technological progress has become increasingly imbricated in our professional lives, which in turn, affects not only how we think and work, but also creates the need for new strategic approaches, concerning infrastructure and qualifications, among other things. This article centres on what the state of knowledge about AI/ML among Swedish CHI professionals is, and what the related issues are. Increasingly, it is possible for heritage collections to be digitally organized and rendered, creating many new opportunities for CHIs (Geismar 2018), while at the same time nuances of past heritage contexts need to be taken into account during the digitalization process to ensure appropriate meaning-making (Risam 2018). In this article, we investigate the state of knowledge about AI/ML among Swedish CHI professionals to clearly identify key issues that they face. As opportunities for the use of AI and Machine

Learning (hereafter ML) in CHIs have increased, so has it become incumbent upon CHIs to develop related plans and strategies. In this article, we, therefore, examine in particular institutional and professional knowledge regarding AI/ML, issues associated with the specificities of their collections, personnel issues, and AI/ML resources. The overarching research question we aim to answer is: what is the state of knowledge about AI/ML among Swedish CHI professionals, and what are the related issues?

To answer this question we focus on three specific CHIs as case studies. We explain our choice of CHIs further below. Swedish CHIs are subsidized through state funding, yet are also often also dependent on private funds. Sweden counts at least one public library in every county; numerous disparate archives and around three hundred museums and heritage sites, as well as twenty national museums run by the state. In choosing the organizations we focus on we decided on three organizations that in their diversity are representative of the sector. We understand cultural heritage institutions to be organizations whose purpose is to collect, preserve and display objects (in a wider sense) of cultural significance inherited from the past (see Blake 2000; Rizzo and Throsby 2006; Vecco 2010). UNESCO proposes a broader definition of cultural heritage itself (<https://uis.unesco.org/node/3079731>, accessed 26/03/2023). Cultural heritage institutions have a wide range of designations including museums, galleries, and heritage sites. Indeed, in their 2015 report on *Digitization in European Cultural Heritage Institutions* Nauta and van den Heuvel state that.

A large number of respondents choose not to classify their institution in one of the standard categories... In total 187 respondents selected the category 'Other type of institution'. They did so mostly because of the mixed nature of the collections in their institutions probably. As in the earlier surveys, a substantial number of institutions thus self-classified were re-assigned in a post-processing adaptation of the grouping by Type. (2015, p. 4)

This indicates that cultural heritage institutions can be difficult to classify including by their own staff. But in line with Nauta and van den Heuvel's report, the CHIs we discuss conform to the four main types they identify, namely archive/record office, museum, library, and other type of institution (2015, p 9).

Concerning the specific CHIs discussed in this article, there is an additional layer that guided our selection of case studies. One key issue regarding the possibilities for the implementation of AI/ML in CHIs is the very materiality of their collections. This is because the material specificity of collections impacts digitization (that is the conversion of analogue to digital) and digitalization (other digital processes beyond mere digitization, such as classification or

automatic transcription for example), and consequently AI/ML implementation. For example, common ML methods used for textual collections and archives rather than cultural heritage artefacts (e.g. vases, or sculptures) include Handwritten Text Recognition (HTR) which enables reading and transcribing a handwritten text; Optical Character Recognition (OCR) which enables recognising characters in printed text; and Natural Language Processing (NLP) whereby large amounts of information can be extracted from a document as well as the categorization and organization of the documents themselves. NLP can further be used for the creation of chatbots or even talking holograms which can be then used for a museum exhibition, for example. This is of course not indicative of the needs of all HCI pertaining to the implementation of AI/ML technologies. Heritage collections that consist largely of government and other papers require HTR and OCR tools for their digitization, but not necessarily other computer vision tools or methods such as image recognition. ML methods and platforms for dissemination and outreach include recommender systems, such as, for example, the Google Arts and Culture website plug-in that is used by several institutions to personalise the experience of the audience based on algorithmic calculations.

The CHI professionals we discuss are designated as such in the understanding that they are employed within the CHIs as opposed to being staff that are employed elsewhere and engage with CHIs on an outsourcing basis. This is important because, as Not and Petrelli (2019) note, 'the creation of an exhibition is a collaborative effort often partially outsourced.... Even large museums tend to create mixed teams with the more content-related roles covered by the institution and the more practical side (architecture and graphics) outsourced to contracted partners.' (74) Hence in their study Not and Petrelli talk of 'cultural heritage professionals' or CHPs where questions of institutional affiliation are then somewhat obscured by the fact that it remains unclear who is employed within a CHI and who is employed as part of outsourced work. In this article, we concentrate on professionals actually employed within CHIs. Their details are discussed in the research design and methods section.

Most importantly, we note that CHI professionals, CHIs, heritage collections and their materiality, as well as the possibilities new technologies such as AI and ML provide are intertwined and imbricated in the professional process of implementation. Digitization and digitalization depend significantly on CHI professionals and their context/s, including policy-making, and not solely on the materiality of the collections, as well as the AI/ML methods and tools available. In what follows, we first provide a concise literature review on AI/ML implementation for CHIs from a professional perspective, and then move on to our methodology and the three case studies. In the results and discussion sections, we summarise and organize our analysis in terms of

three overarching themes in our scientific inquiry: we focus on CHI professionals' knowledge about AI and personnel issues; CHI collection types and associated digitization and digitalization issues; and resource issues in operationalizing AI/ML. Ultimately, we show that the implementation of AI/ML in our Swedish CHI case studies is at a nascent state; thus challenges and opportunities that arise with AI/ML implementation within CHIs are at a critical point. These—unless addressed—risk, rather than support, sustainable professional praxis in cultural heritage. To remedy this we conclude that a national Swedish CHI strategy for AI/ML implementation is needed, and we provide suggestions on what such a national strategy could be comprised of.

2 Purpose and literature review

The purpose of this article is to investigate the possibilities and challenges of implementing AI/ML in Swedish CHIs. In order to do so, we undertook a qualitative study of how CHI professionals, from their perspective, deal with the implementation of AI/ML in their collections. This involves thinking about the professionals in relation to the materiality of their collections. Previous theoretical perspectives on human-material networks, as developed by Latour (actor-network theory, 1993, 2005), Law (a material-semiotic method, 2004), and Bennett and Macdonald (assemblage, 2009 and 2009), point to an intertwined relationship of objects, ideas, and practitioners. This 'focuses our attention on the ways in which things and people are involved in complex, interconnected webs of relationships across time and space, rather than seeing objects and ideas about them as somehow separate from one another' (Harrison 2015, p 306). The issue of the materiality of collections has been extensively covered (e.g., Garozzo et al. 2020; Hardman et al. 2009; Su et al. 2019; Talamo et al. 2020) whilst the question of the professionals dealing with the digitalization of these collections is largely under-researched. The lack of literature that focuses on CHI institutions and their professionals is what this article seeks to remedy.

Our research is situated within the context of Swedish CHI professionals and AI/ML implementation. Other contexts such as the USA at one end of AI/ML implementation development in CHIs (where digitization of heritage collections is relatively high) and a country like Tunisia on the other (where digitization of heritage collections is low) might, of course, yield other results from the ones we found, and this constitutes a limitation of our research. This means that we want to emphasize the importance of context here.

When doing the relevant literature search, it became clear very quickly that the existing literature is only in a nascent state. Expectations are high regarding new technologies such as AI, more precisely ML technologies but these are

only just beginning to be explored by museums and heritage institutions, including internationally (Tzouganatou 2018, pp 377–383, 2021). Very little is written about CHI professionals, that is the professionals actually employed by CHIs as in-house staff, and their relation to AI/ML implementation. Instead, as we shall show, articles relevant to the topic often employ the term 'user' by which they may mean CHI professionals, or collection visitors and audiences, or indeed external 'users' who may be professionals (e.g., tech specialists) to whom certain CHI work is outsourced. There is therefore some confusion in the literature regarding who exactly is referred to. However, since it is CHI professionals who make the decisions regarding CHIs' digitization and digitalization processes and practices, it is this group that our article focuses on. The lack of literature that focuses on CHI institutions and professionals is the gap that this study aims at filling, starting with a small yet indicative study of the Swedish CHI landscape.

There does exist a fast-growing body of work where different kinds of practitioners discuss empirical research on AI/ML tools and processes for specific cultural heritage datasets. This is often what we term a 'show-and-tell literature', designed to show to other researchers and CHI professionals what exists by way of useful AI/ML tools or practices. Demetrescu et al. (2020, p 125), for example, discuss the AI/ML 'tools used to obtain a digital replica of a Roman city deepening the integration between photogrammetry and computer graphics.' In this they, and others writing similar articles, respond to Zan and Baraldi's (2013, p 217) call for future research to be 'micro-focused ... on practices... at the level of the individual case study'. Similar perspectives can be found in Liu et al. (2020), Tullio et al. (2020), and in Fiorucci et al. (2020). This literature is extremely important as it constitutes one source of peer learning for CHI professionals. But it is also a literature that arises from the atomization of efforts, and individual case studies that do not necessarily translate to other CHI sites either because the collections within them require different kinds of tools or practices because of the specificities of those collections, or because the articles showcase bespoke tools and practices that cannot necessarily be readily imported elsewhere.

The types of AI/ML tools and practices addressed in these kinds of case studies include computer vision and natural language processing, and also processes and tools for personalizing visitor experiences. Computer vision (CV) acts through auto-generating a description or tags to make images more discoverable (Fontanella 2020, pp 23–29). Several museums have experimented with CV approaches. The National Gallery of Denmark, for example, has used off-the-shelf CV software to categorise every single work in its online collection, containing approximately 40,000 digitised works (<https://www.smk.dk/en/article/artificial-intelligence-helps-organise-denmarks-largest-art-collection/>). This

enables online visitors to search for works in new ways, such as by motifs such as people, flowers, or chairs; or to search for works done in specific colour schemes or that resemble each other. Similarly, Harvard Art Museums uses CV to categorize artwork, making their collections more widely accessible. What the articles cited above have in common is that in so far as they focus on ‘users’, these are the visitors who attend the CHI rather than their staff who are supposed to implement CV. Giugliano and Laudante (2020) argue that technological design offers a key opportunity for the cultural heritage sector to connect technology and context in ways that transcend physical boundaries. While Giugliano and Laudante’s study is focused on users, they argue for an expanded consideration of different stakeholders. Not only could this promote “an increasingly wide and diversified public”, they write, but technology affords opportunities to materialize a common meeting ground, a space that allows for interchange around what is shareable, accessible and consultable (2020, p 7). This has to include prominently CHI professionals. Note, however, that the term ‘stakeholder’, like the word ‘user’, covers a wide array of interested parties, so to speak, rather than focussing on CHI professionals specifically as we do here.

Some scholarship deals with CHI professionals; for example, the digital manager at Brighton Museum (UK), undertook some action research with museum staff regarding AI tagging errors. Such errors, he suggests, serve as a useful starting point for directing the curatorial gaze in new directions. This text is one of the few that actually considers CHI professionals. It is also written by a CHI professional. In this, it contrasts with the work of Brendan Ciecko who is described on his website as ‘the founder and CEO of Cuseum, a platform that helps museums and cultural organizations engage their visitors, members, and patrons. Ciecko has been building technology since the age of 11 and has been recognized by Inc. Magazine as being one of America’s top entrepreneurs under 30.’ (https://www.museweb.net/member/brendanciecko/?_ga=2.136995632.1603281459.1666013346-958801196.1666013346, accessed 15/10/2022). His concern (2020) is with biases in algorithms. Testing various off-the-shelf software solutions, he has found promising results for image classification and object detection (Ciecko 2020). Ciecko acts as an intermediary between technology and cultural institutions, clearly coming at these from a tech angle. This points to an important issue when considering texts on AI/ML, cultural heritage and CHI professionals, namely who is doing the research and constructs the article. That partly determines the extent to which CHI professionals feature. Brenda O’Neill and Larry Stapleton (2022), for example, writing about ‘Digital cultural heritage standards: from silo to semantic web’, are both academics working in the Department of Computing and Mathematics at the Waterford Institute of Technology

in Ireland. This means that they come at the issue of AI/ML and CHIs from a tech angle, not from a curator’s perspective. In their piece on ‘Digital cultural heritage standards: from silo to semantic web’ they state that ‘In the cultural heritage domain... all find themselves at a digital precipice which can be traversed by joining forces with what have been until relatively recently, disparate disciplines...’ (891). They argue that ‘Interdisciplinary teams are required to work in the cultural heritage area—teams consisting of knowledge experts (librarians/curators) and technology experts (developers).’ (893) to ‘break disciplinary silos’ (892). This is an interesting position since it assumes an automatically given binary divide between one kind of knowledge (e.g., curators) and another (technology), and as such reproduces the kind of disciplinary silos that CHIs labour under at present and which prevent them from engaging effectively with AI/ML as our data show. As O’Neill and Stapleton themselves put it: ‘it is no wonder that GLAM institutions find themselves in a position of genuinely wanting to move towards open data but really not quite sure what their new role is or how this metamorphosis is to take place.’ (892) O’Neill and Stapleton do not ask how the interdisciplinary teams they envisage will be constituted or sustained, where the tech staff, for instance, will come from, or for how long they might interact. They advocate participation action research (PAR) as a useful tool to co-evolve ‘processes and technologies’ (896) but do not discuss the feasibility of that way of working for, for example, small collections or museums. The principles they propose are laudable but it is less clear how easy it would be to implement their suggestions.

Elena Not and Daniela Petrelli (2019), also focusing on CHI professionals, begin by pointing out that complex personalization systems designed to enhance visitor experiences of CHIs have not been taken up by CHI professionals because they ‘require technical expertise to operate and therefore end up excluding cultural heritage professionals’ (68). Like O’Neill and Stapleton they thus diagnose a knowledge divide in the sector. To move beyond this, they developed ‘a user-centred design process’ where ‘user’ stands for the CHI professionals (not the visitors) intended to make use of authoring software designed to enable them to create personalized visitor experiences of different kinds. They found that trying to co-design and co-develop ‘an organic platform’ (113) to support CHI professionals in relation to personalization systems was not easy because ‘very different professionals’ were involved ‘at different points of time, with completely different skills sets and roles. This means that those responsible for the content creation were not involved in the technical development, although consultation among the team was frequent.’ (113) They also found that ‘the most advanced personalization techniques (and possibly the most exciting for us as researchers) were not sought by the professionals who instead were interested in simple but

effective ways of designing visiting experiences...’ (114). One might argue that CHI professionals’ ways of overcoming the curation-tech divide were to look for simple ways of generating personalized visitor experiences that they could readily implement. But such personalization systems are of course just one of many ways in which AI/ML might be mobilized in CHIs.

As already indicated, in the literature on the implementation of AI/ML tools in cultural heritage, there is little attention to personnel: CHI professionals and their inter-operative and professional context/s. Apart from ‘users’, ‘stakeholders’ often appear as a category in scholarship around heritage institutions and AI/ML methods and tools, but they tend not to be specified. Lazeretti talks of ‘new ecologies of humans and machines where quality and quantity coexist’ (2020, p 16). Indeed, the collaborative process of curation between humans and machines is increasingly a fact but very little of what is written concerns the co-curation of collections from the perspective of the heritage curator or the digitization officer of a CHI. These ecologies are only just in the making in CHIs in Sweden. In this sense, we advocate for the importance of considering the human curator dimension in such processes of automation/curation as these technologies develop further. Below we turn to our research design and methods.

3 Research design and methods

The research involved semi-structured one-on-one interviews with professionals from three CHIs in Sweden as well as research on their website information, digitalization and digitization plans. Here we first describe the CHIs before detailing the research process. As we have highlighted above, these are institutions that were chosen because of their variability in size and personnel, their diverse material collections, as well as the fact that they are institutions that are governmental and belong to the public sector. Because of these parameters we think that these three CHIs are a microstudy of the larger Swedish national landscape.

3.1 The participating CHIs

The three different types of heritage institutions discussed in this study labelled A, B, and C, are registered government bodies with CH collections. They do not represent the entirety of the Swedish heritage landscape but are representative of the size and type of public sector CHI typical for the Swedish landscape as well as for different collections of tangible heritage, textual, pictorial and material. They are all regulated by government and/or university guidelines.

Organisation A is a public-sector institution that comes formally under the Swedish government and the Ministry of Culture. Defined as an information management organisation, it is regulated by the Archives Act and by annual priorities from the government. Its labour force is the largest in this present study; as of 2020 it had an annual labour force of 401. Its core activities include managing, interpreting and making available information, both for research and public access. It is funded by the government, foundations and corporate sponsors. B is also a public-sector government entity under the Swedish Ministry of Culture, governed by government guidelines. It is a medium-sized enterprise with 129 people, with activities including managing, procuring, interpreting and making available collections to wider audiences, promoting interdisciplinary knowledge and conducting inter/national outreach. B’s staff support research and public access. C is the smallest CHI in this study, with a total of only 16 staff. It is a public sector heritage institution, a unit within a university. It is governed by university regulations in supporting research and education by managing facilities and procuring, interpreting and making available collections and managing resources for teaching and research inter/nationally. It is funded by the government, university teaching departments, and research and education foundations.

The three CHIs involved in this study all have complex collections in terms of varieties of artefacts but with different emphases regarding the latter. Institution A deals primarily with physical archives such as government records, archives of private individuals and non-public organizations, i.e. businesses. These hold predominantly handwritten and printed materials of variable quality. However, sometimes one finds texts (handwritten or printed) and images (sketches, photographs) in the same collection or item. This CHI holds and continues to acquire large amounts of documents and images as every government agency, sooner or later, delivers their archives to A, for future safekeeping. At the time of the interviews, Institution A had more than 200 million archival documents digitized.

Institution B curates objects, images, books, journals, and other archival materials that combine text and image. Their strategy covers digitalization and digitization, not as an ad hoc approach, but an approach whereby B simply attempts to digitize everything, collection by collection, and bring it into their content management system. Institution C is similar to B as it contains objects, artifacts, images and human remains, as well as maps and archival materials, art collections and a vast coin collection. Each collection contains many smaller collections.

Overall, all institutions offer interesting case studies for Sweden. Their size and aims differ to some extent, but they share one purpose: providing access to their collections. Here A and B address a general public whilst C focuses on

supporting researchers. All three CHIs' collections are to some extent similar in that they are complex, comprising digital, textual, pictorial and material objects, though to different degrees. Institution A mainly deals with government materials, with a predominantly textual collection whilst C has much more object-centred holdings. This means that their respective AI/ML requirements and opportunities are different as the digitalization of their collections involves different considerations. The CHIs also have sensitive material, such as human remains or ritual objects, or collections that are embargoed for particular lengths of time for a diversity of reasons. All CHIs are concerned with inter/national users and audiences, a fact that is augmented by the affordances of digitization since it extends their audience reach.

3.2 Research and data analysis process

The study involved six semi-structured one-on-one interviews with professionals from each CHI. The interviewees were purposely selected in terms of their specific responsibilities within the CHIs to oversee AI/ML implementation for their collections. The key criterion for the selection of these professionals was therefore that they were identified within the CHI and self-identify as the ones assigned the professional responsibility to engage with and to support the implementation of new technologies within their CHI. These CHI professionals were therefore largely or wholly responsible for decisions regarding AI/ML implementation. The interviews were conducted in June 2021 by a co-author. The interview schedule focused on the CHI professionals' work situation, the use of AI/ML in their institution and related policies, the professionals' experience and views of AI, and their experiences of implementing AI/ML. Given the then prevailing COVID situation, the majority of the interviews were conducted on Zoom, but one was conducted in person. The interviews were done in English. Co-author interviewed two women and four men, with a mean age of 55. In institution A the interviewee was one man, in B two men and one woman, and in C one woman and one man. All interviewees had worked for the CHIs for several years; in

four cases this was for about ten years. In other words, these were established professionals in permanent posts of some duration, with responsibility for AI/ML implementation. They described their jobs as follows (Table 1):

The interviews lasted on average 38 min. They were transcribed by the interviewer and jointly analysed by the research team using thematic analysis or TA (Braun and Clarke 2006, 2021a, b). TA 'is best thought of as an umbrella term for... approaches that share some characteristics in common (analysis through coding and theme development; some degree of theoretical and research design flexibility; a focus on semantic and latent meaning) but can differ significantly in both underlying paradigmatic and epistemological values, and procedures.' (Braun and Clarke 2021b, p 335) Hence Braun and Clarke (2021b, p 335) advocate making explicit which TA approach we use, even as they manifest variation beyond the typologies Braun and Clarke proffer (2021a, p 39). In our case, we opted for reflexive TA. This involved repeated, close readings of the interview transcripts whilst listening to the actual interviews, and coding the transcripts individually first, thus using multiple coders. Here we were concerned with the 'reliability and accuracy' of our coding (Braun and Clarke 2021a, p 39) but we do not regard this process as taking a 'codebook approach' as Braun and Clarke describe it (2021a, p 39). Rather, we view the discussing of our individual and mutual understandings of the transcripts as expressed through our codes, and then the themes we agreed upon, as an expression of a reflexive approach to our data. We discussed our codes and grouped them under certain headings, effectively our themes. This process enabled us to see 'patterns of shared meaning' (Braun and Clarke 2021a, p 39) in the data and to systematize these. For instance, 'personnel issues' which included codes such as 'knowledge of AI/ML', 'skills requirements', 'skills deficits', 'understaffing' and 'tech-curation gap' became one such theme. 'Personnel issues' was here the 'central concept or idea' drawing 'together data that on the surface appear rather disparate.' (Braun and Clarke 2021b, p 341) In generating these themes we made some distinctions that we thought reflected certain meaning differentiations

Table 1 Job descriptions according to interviewees

Institution	Job description in interviewees' own words	Interviewee by sex (m/f/o) and pseudonym
A	Manager of digital experiences with focus on application of AI and ML on the archives	Interviewee 3 (m) Per
B	Chief of staff responsible for admin + strategic develop. of B; acting director for dept of collections; responsible for digital strategy	Interviewee 1 (m) Sven
	Digitalization coordinator	Interviewee 5 (m) Olof
	Responsible for digital development	Interviewee 6 (f) Malin
C	Curator, responsible for digitizing collections	Interviewee 2 (m) Jan
	Lead curator, responsible for digitalisation of collections	Interviewee 4 (f) Sofia

but which can seem hard to understand. For instance, we initially discussed personnel issues both as a theme in its own right and under the heading or theme ‘resources’. This was because in our material at times questions of personnel were treated as a resource issue (not having enough or the wrong kind of personnel) and at others as a knowledge issue (not knowing about AI/ML). These differentiations were made for analytical purposes, and we recognize that other researchers might have done them differently. But our joint discussions about our data gave us confidence in the distinctions we decided to make.

The analysis of the data was both deductive and inductive, in that the interview schedule set up the content direction each interview would take but the interviewees then of course provided their own view of what they were asked about. This process and repeated discussions among the researchers about the interviews generated the three main themes discussed here: (a) knowledge among CHI staff about AI/ML and its impact, and personnel issues; (b) the relation between CHI collections and actual digitalization; (c) resource issues. We discuss each of these main themes in turn.

3.3 Ethical considerations

In conducting this research we followed the guidelines of the Swedish Ethics Approval Board. We sought, in the first instance, direct written approval from the cultural heritage institutions for their collaboration in this research. This was already part of the grant application process we undertook. We then anonymized the cultural heritage institutions in which we conducted the research by designating them as A, B, and C. Further, all interviewees had the purpose of the interview explained to them, were given an information sheet about this and asked to sign a consent form to allow the recording of the interviews and the pseudonymized publication of their data. Hence all participants were given pseudonyms, used throughout this article. This was both an ethical requirement and necessary because the number of participants was small. We also stripped away, as far as possible, any identifying markers such as specific job designations, in depicting what our interviewees said. The data were stored in password-protected university computers in line with Uppsala University and Swedish Ethics Approval Board requirements, and were accessed only by the researchers (the authors) who also conducted their analysis.

4 Results and discussion

The information collected in the interviews resulted in the three overarching themes mentioned above, concerning the use of AI/ML for CHI collections in Sweden. For analytical

reasons we disaggregate them and discuss them separately below, but it was clear in the interviews that these topics inter-relate strongly.

4.1 CHIs’ knowledge about AI/ML and personnel issues

The use of AI/ML is in its infancy in the Swedish CHIs researched, and in the interviews this was confirmed by the explicitly stated, generally low level of knowledge about AI/ML that emerged. In our research, it is important to note that the CHI professionals we interviewed did not talk in detail about the ML methods they implemented. Instead, we found a similar and understandable conservatism in their views on AI/ML as Not and Petrelli (2019) diagnosed. Per, who was responsible for digital experiences in one CHI, said, for example: ‘We have really only been experimenting and built prototypes, and so it is not something that is part of our standard operational procedure.’ When asked ‘Do you use any AI or ML methods for your collections currently...?’ Sven, director of staff of another CHI, replied: ‘No, I don’t think so. Maybe some small experimental things, but not generally. No.’ And Malin, responsible for digital development at one CHI, said: ‘... where I am, people talk about AI and my impression, as not very skilled myself, is that it is a kind of dream cap over all things cool and exciting, and that many people talking about AI don’t really know what they are talking about...’ This sense of limited knowledge about AI and ML had its counterpart in the fact that the CHIs in question had only recently developed a digital strategy for their organization, i.e. within the past twelve months prior to the interviews. They were thus learning organizations, still in the process of developing their strategies and competencies. The plans themselves were over-arching and often not comprehensive. Although Sven, for example, maintained that their one-year-old strategy ‘covers everything—from collections to work with exhibitions, try[ing] to digitize certain processes of administration and so on...’, it did not, for instance, deal with staff development. Instead, discussions on topics of staff development were included in annual staff reviews, indicating different administrative processes. Continuing professional development (CPD), as it is sometimes known, was not envisaged but seemed clearly necessary in light of what our interviewees told us about the state of their knowledge regarding AI/ML. The interviewees’ and hence the institutions’ knowledge of AI/ML depended largely on specific staff appointments. One interviewee, for example, during the interview repeatedly referred to another member of staff convinced that this person would be better able to answer our questions. The interviewees’ knowledge of AI/ML also depended on what they had heard or come across online. Sven, for example, told us: ‘It was interesting to hear this presentation from a Danish museum of art,’ sharing

those efforts in making digitization more efficient with AI was inspiring. It also indicated how knowledge transfer between CHIs might happen through information-sharing events. We return to this issue in the conclusion. Malin similarly knew of developments elsewhere, saying: ‘We are not there yet... I know that the state museum for art in Copenhagen have used some Microsoft platform to deal with their collection, though theirs is very much different from ours... but they found it very useful.’ Unsurprisingly, CHI professionals learnt most from peers, often internationally, staff in other CHIs ahead of them in AI/ML implementation.

One major reason why AI/ML implementation appears nascent in the aforementioned case studies has to do with certain personnel issues. Staff in these institutions tend to stay permanently or at least long-term and do not receive any continuing professional development training (CPD) or additional skills training. Most of our interviewees had been at their CHI for 10 years or more. They had thus been socialized into the institution before AI/ML arrived on the scene. Most had ‘grown up with’ card catalogue systems. Digitization, therefore, involved a completely new skill set for them. Some interviewees clearly recognized that digitizing their collections was an enormous task and they did not have or had only limited, skills to undertake that work. Even the CHI that had digitized two million images had only dealt with about two percent of its collections according to one interviewee. There was serious understaffing of the CHIs concerning digitization tasks. As Per, for example, said: ‘I really want to stress the staffing and competency raising issue because that is so important if you want to start to use AI now... most Swedish museums do not have a single person on staff who is a programmer.’ Per said that ‘typically, when it comes to AI’, staff development would give you ‘a generalist’s skill level. But it cannot typically turn someone into someone who can actually program AI solutions.’ Lack of relevant qualifications, skills and relevant competence was thus a serious problem. This is on par with a recent Swedish government report of the Swedish Higher Education Authority (UKÄ see Heintz et al. 2022) where the need for digital skills and competence training, especially concerning AI/ML, is becoming greater and more important. In order for Sweden to continue to be a country at the forefront, with innovative companies and well-functioning welfare for all, an education system that is one step ahead is required.

Gefen et al. (2021) suggest that AI is ‘an essential working tool ... that marks the beginning of a new discipline per chance, cultural analytics’ (2021, p 194). Still, they too recognize the emergence of ‘a paradox...[of] more verifiable methods so complex and computationally demanding that only a handful of researchers and institutions can afford to use them’. Moreover, ‘the machine only works with data that it receives, making AI approaches deeply dependent

upon theoretical and interpretive choices and frameworks’ (2021, pp 195–196). However, lack of human resources and relevant skills meant that the implementation of technology for CHIs, as described by our interviewees, was characterized by fragmentation of efforts, including at the level of the work of individual researchers and research projects, a familiar issue also evident within university initiatives on digital methods and tools (Golub et al. 2020). Internationally, the direction is toward cooperative efforts that improve content management and make it multivocal and interoperable beyond individual projects and well-established traditional disciplines. However, as our interviews showed the CHIs in question were not only understaffed but also largely under-skilled, often not having any training or knowledge in digital methods or tools and also no experience in implementing them themselves. In consequence, specific competences were outsourced to external personnel that might have specific technical knowledge but not necessarily be acquainted with the exigencies of critical CH studies.

Institution A, with its primarily textual collections, focused on transcription. In doing so it made use of open-source tools such as Transcreva for the type of archival materials that can be made available to the public. HTR is about scale. It has the benefit of being usable by someone who is not a programmer. As one interviewee from that organisation put it: ‘a reason why we chose to use Transcreva is that it provides you with a type of user interface that means that a non-specialist, in terms of technology, can actually set up a training model in AI and not know anything about programming at all... you can actually handle it in a two-day competency day for your staff.’ This CHI worked with its own staff or with volunteers or a combination of the two to transcribe enough handwritten text to be able to create an AI model that could then translate the rest. But they had only two and a half full-time employees for this, where the 0.5 FTE’s work primarily focused on engaging with volunteers who help to transcribe and thus prepare the material to create enough training materials to generate an HTR AI model. There was also an additional non-permanent contractor, so three and a half FTEs in total, with one and a half not permanently employed in the organisation. Given the vastness of the task of digitizing their collections, this is a very small team. Further, these staff, as the relevant interviewee said, were not all recruited for their AI skills; only one ‘was recruited specifically for data science and AI applications.’ AI competence thus operated largely outside of the CHI.

Institution B is a CHI that generally focuses on areas that are quite interactive and explorative for visitors, including online courses and extensive materials for teachers and schools, but also the general public. It has three main departments: collections; content and learning which works with programming; and audience experience (organizes front-of-house staff). Institution C has a coordinator and a project

leader for digitalization. At the time of the interviews, a project leader position for digital content had been newly appointed. Organisation C, a research university institution, had, at the time of the interviews, three full-time curators, and one full-time conservator.

One thing was very clear: apart from understaffing and a lack of in-house skills, there was also an issue regarding the right skills mix. As Olof put it: ‘We are lacking a lot of the technical skills. There is a gap between those that knows [*sic*] the technology and to create code and models and the techniques behind all this, and the museum staff that knows about the collections and what is important there.’ Such division between tech-competent staff and content-competent staff has been noted elsewhere (e.g., Griffin 2019). Olof continued to say: ‘There is a gap there... there are just a few people that are in the middle there.’ Given that staff in museums tend to stay rather than move around his view was: ‘As in general, people in museums, they work there a long time, so it takes some time before you make, you get new people with that new knowledge. So we really have to focus on the current staff to develop competence, we really have to develop our competence, and in digital in general.’ Quite how realistic this view is, is unclear, not least because staff training in Olof’s CHI was ad hoc and bottom-up individual-driven rather than systematic. This clearly needs to change. Outsourcing digitization processes to technical staff and off-the-peg software offer limited solutions to the problem of understaffing and under-skilledness. The skills mix that is ideally required is at present not readily available. Those with the right skills mix can find themselves over-demanded upon by under-resourced institutions.

4.2 CHI collection types and associated digitization and digitalization issues

The digitization of the CHIs’ collections, to the extent that it had occurred at the time of the interviews, was driven by three factors: first, by administrative processes and the desire to create internal information systems about the CHIs’ actual holdings; second, by requests from the public i.e. researchers or citizens wanting particular datasets; third, by contingencies, guarding against losses, loan requests, etc., for instance the need to deal with perishing materials such as fragile papers that need to be preserved in digital form. Above all, there was the over-arching strategy, intended to give direction regarding what to select for digitization. We discuss each of these briefly in turn.

As has been common when digital systems are newly introduced into organizations (Martinez 2019), internal usage in the form of achieving systematic housekeeping or ‘process excellence’ was the initial driver for the CHIs to engage digital tools. As Sven put it: ‘we need to get our

collections in order.’ He also told us: ‘it has been, up to some years ago, more of a process where we start from zero and went through the old catalogues and cards, and just step by step moved forward. And no, we did not have a strategic selection where we decided that this is an important collection... [it was more] like a general flow of just getting through the old catalogue and transcribe the cards.’ A similar digitization path was described by the other interviewees. Magnus said: ‘at that time it was very much an inside tool for the people inside the museum.’ However, as Malin who was quite digitization-savvy, suggested:

‘One thing to be wary of is that... the catalogues or the information that we have about our collections is in no ways neutral, so there is a built-in bias... if you put on top of that the bias that [is] maybe built into the algorithm and AI analytical programs, you may end up with something you really do not like, so that is something to be wary of.’

Malin here rightly diagnoses a core issue about how digitization was introduced into at least some CHIs, that is to digitize already existing catalogues, many of which were established decades or even over a century ago, with the biases that were common then. Digitization potentially offers the opportunity to rectify this but if cards from old cataloguing systems are merely transcribed rather than critically reworked, such rectification does not occur. Sven argued that ‘it is of course very interesting then if we can make machine learning more adjusted to the kinds of collections that we cater for with regard to indigenous populations and so on, and other aspects. But it is hard to see how it will work.’ Such difficulty in seeing how this might work could be rectified by staff development opportunities, and by peer exchanges with other CHIs.

As indicated above, the second driver for digitization is requests from external users—researchers, citizens, other organizations—for specific items. Olof interestingly described this as ‘it has really moved from being for us to the outsiders.’ Indeed, in several instances users were the key driver for which collections were actually digitized. In one instance, for example, a researcher had gained a large grant and this had meant that the CHI then focused prominently on servicing this work. Jan, a curator at one of the CHIs, described this as follows:

I have official bosses and unofficial bosses. The first curator, our first conservator, and museum hierarchy... are the ones who are my official bosses. However, in every meaningful way... [external grant holder’s name] and the archaeologists... are my unofficial bosses... [When the external researcher] got research money,... that rather forcefully focused my attention on [their material and needs].

Sven similarly said: ‘We have some specific projects with external stakeholders, for instance with indigenous peoples in [...], that we work with in digital repatriation... when we work with collections connected to these projects, then we digitize them at the same time, so I would say it has shifted a little bit our strategy.’ The implication of this is that digitization processes are partly done in reactive or responsive mode, answering user and stakeholder needs. Hence CHIs can have something of a dual-track approach to digitization: one driven by their over-arching digitization strategy which may be strategic and proactive, the other user- and/or stakeholder-driven and hence responsive. Because of resource issues, as we will discuss below, user- and stakeholder demand could come to dominate CHIs’ digitization efforts. As Jan put it: ‘It is like in a battle. You make this wonderful big battle plan but as soon as the first shot is fired, it goes right to hell, and what’s important is the small commanders and on that field that make decisions. Same way here. If you have someone that comes in and want [sic] a particular object, or whatever, then deal with that object while you can... so we have a plan, but it’s very flexible...’.

A third driver structuring the digitization of CHIs collections were a variety of events and processes, expected and unexpected, e.g., loan requests, emergencies, or the fragility of some materials in their collections where digital preservation was considered conservation. Olof described it thus:

Even if we have a plan that we would like to digitize what is most requested, what is...sensitive, that is going to be destroyed if we do not do anything, like old photos and so on, even if there are these ideas... we can’t follow that plan because this happens. Now they want to loan those objects. We have to digitize them before they can loan them... [then] suddenly there is flooding at the storage, everything has to be moved... so there is a mix of all those things.

This driver also generated a largely responsive way of digitizing, based on the view that records of holdings are essential. As Jan rather poetically put it: ‘an uninventoried collection is a collection that is... living on borrowed time.’ Hence classification and categorisation emerged indirectly as the most desired outcome of AI implementation for all three organisations, as it would significantly strengthen the central mission of all three organisations.

When it came to what AI/ML might be able to do for the CHIs we researched, views among our interviewees were mixed. When Sophia, a curator, was asked ‘if you could envision a future development where AI could hold some meaning for digitizing collections, what do you think it could be good for?’ she answered: ‘I don’t know really. I know too little about that.’ Others saw more possibilities but had not necessarily tried them out yet or to any extent. Olof thought that ‘imagine recognition, like Google Vision

interpreting photos... is something we would like to integrate into our current system’. But this was all for the future.

More AI/ML-savvy staff discussed potentially training AI models. Several interviewees commented on the problem of having to train models for small collections where the training data are not vast. An associated issue was that off-the-peg AI models were not necessarily trained on historical data and might therefore misattribute or misclassify data. Malin gave the entertaining and worrying example of an AI pilot study done on older portraits in Sweden where ‘the algorithms detected mostly all men in the eighteenth century *as women* because they were so faintly dressed, they had coloured coats and long hair, and so all this must be ladies as they have jewellery on.’ Her solution was to suggest ‘build[ing] our own models to work better on our own kinds of material.’ This, however, creates its own problems in that such a distributed approach to creating AI models raises questions of interconnectivity and interoperability. Between using off-the-peg solutions that had been trained on ‘modern data’ as one interviewee called it, and building customized models that might not be linkable to other databases, staff could be stuck concerning how best to serve their collections and users.

4.3 Resource issues: operationalizing affordances

The resource issues the CHI interviewees reported came in three guises: as issues of personnel, as issues of funding, and as systems issues. We shall discuss these here in turn. We have already discussed personnel concerns in terms of understaffing and lack of know-how above. Below we focus on what our interviewees thought their CHIs needed. Sophia, for instance, said:

what we need to have is a data steward, like a coordinating role, preferably with knowledge of Arches [a relevant software tool that operates on cidoc-crm standards and supports linked data], of course, and that this person will have an overview of active and future research projects in the field... just like a coordinating role, make it easy for scholars to find what is already available in terms of resources and databases... and that this person also have [sic] a close collaboration with curators, and a digital curator also...that will be responsible for handling and mapping data from local databases to Arches... I would like that person to have a background perhaps in archaeology or history.

But such people with their feet in both AI/ML and in a relevant academic field are not that easy to find. Thus Per said:

A major limitation...for our organization and also for many other cultural heritage organizations... is recruit-

ing staff. Specifically, staff who know both the material. People with hybrid skills... They are of course very rare, but especially in R&D there is an immediacy with having someone who both understands the subject field, the material and the technology, and can experiment with it.

The rarity of such hybrid staff points to the need to reform education curricula to embrace both substantive subject matter and technology simultaneously. But it will take a generation or so to see such staff coming through the education system, even if such curricular reform was on its way immediately. In the absence of such staff CHIs rely on outsourcing their digital needs. Olof, for instance, said: ‘we have not any inside staff, that are: “Now we need this tool, can you create one?” And then someone sits here and creates it. We have to order it from outside. We have to buy this new tool.’ Off-the-peg solutions could thus be(come) the answer to digitization needs. But since each organization appeared to do its own thing, this raises questions of sustainability and interoperability. Concerning the latter, linked open data were almost nowhere mentioned in the interviews.

These concerns are particularly acute in the case of small CHIs with limited collections and budgets. Although one interviewee told us that for his CHI procuring a system ‘is never a problem’ and that he was ... ‘happy to, spoiled actually, to be able to say, we have the resources, we are given the resources that we need, there is almost no other museum... who can say that.’, this was not confirmed by our other interviewees, including the second one from the same CHI who said of their need for staff with digital skills: ‘The limits are that we need funding for these persons, and I think [the funder] at large needs to acknowledge the need, not only for [our museum] but different museums...’.

Not only staff but also the ability to acquire, access and make use of new digital systems relevant to CHIs was related to funding issues. As Jan, for example, put it: ‘those who have larger collections ... use a barcode system and we were considering that but it was a sizeable investment, and we did not see that there was a need for us, we came up with some other manual things that function...’ Jan also fancied ‘an almost Amazon storage type of environment’ to facilitate dealing with changes in humidity, etc. in the collections but, as he said, ‘again, anything like this would be outside the realm of economic possibility for any museum that I have ever heard of’.

The resource needs of acquiring and implementing AI/ML solutions were one financial concern. The other was that ad hoc funding, by which we mean project-limited funding acquired through research funding applications by CHI-external researchers, could come to dictate what CHIs would digitize, simply because the research funding included money for that purpose. Here conflicts might arise

between the funded researcher’s priorities and the CHI’s planned collection digitization, as already indicated under Sect. 4.2. The result of these funding issues was that digital resources, to the extent that they existed, were set up and operated in a fragmented, ad hoc manner. Jan talked about the British Museum’s integrated databases allowing to ‘digitalize things on a curator’s level, the internal database. They have another system that works for the internet, that extracts certain information and puts it out on the internet. I can see that having a system like that would be very useful... because at the moment I have to enter things into two different databases. And it would be nice not to have to do that.’ Given the under-staffing in the Swedish CHIs, especially around digitality, it is obvious that labour-intensive, multiplicative processes in cataloguing information are undesirable. In the ‘Conclusions’ we discuss some of the ways in which this might be mitigated.

The final discussion here concerns systems issues. These centred on questions of building one’s own digitization solutions vs. getting off-the-peg solutions, the associated concern regarding interoperability and the potential for information exchange between CHIs inter/nationally, and issues of future-proofing collections. One interviewee talked about local databases which were gradually being superseded by other databases. She said, for example: ‘We have one database called [name]... and this [name] will not be used anymore, eventually, because we have a new project... we’ll use Arches, and take the material that is available now in [name] and include that in the new [name 2], we can call it, database Arches.’ The fact that this interviewee called the new, differently named database ‘[name 2]’, in other words, referred to it with the name of the previous database, indicates the difficulty this curator had in adjusting to the new database.

AI/ML implementation changes relatively quickly as technological affordances shift and expand, with the implication of a continuous learning curve for their operators, which the analogue card catalogue systems did not require. Literature on managing change stresses how employees can suffer overload and manifest resistance to the constant need to update and re-learn (e.g. Bock et al. 2010; Schwarzmüller et al. 2018). This is an issue CHIs need to grapple with.

Quite apart from shifts in affordances there was also the issue of a lack of ML affordances in certain key areas. One interviewee who managed digital experiences in a CHI talked of the need to have ML components that would permit entity recognition (i.e., identifying places, names, periods, etc. in texts) but also immediately highlighted that for ‘smaller languages than Swedish’ such as Sami ‘you just have to start from scratch. Basically. There is nothing to start from. Because there is no commercial interest.’ Here the issue of collection size raised its head, coupled with questions of the commercial viability regarding the construction of AI/ML tools. His view of AI tech options was not to

engage with them ‘until they become more mature. Other organizations will have to be the guinea pig.’ He cited chatbots as an example with ‘lots of operational challenges’: ‘they are like talking to an idiot’ and he was not in favour of using them in his CHI.

Overall, what emerged in relation to the resources issues was that the three Swedish CHIs we looked at were, from their professionals’ viewpoint, not well placed to make use and implement the new affordances that AI/ML methods and tools provide. Issues of understaffing, poor knowledge, lack of investment in continuing professional development, lack of finances, small collection sizes and mainly ad hoc, responsive modes in relation to digitization decisions hampered this. As Sven put it: ‘it’s pretty much a question of resources to get the basic work done.’ Hence, we propose the conclusions below.

5 Limitations of the study

One limitation of this study, already indicated, is that what we claim for the Swedish CHI context, cannot be generalized to the situation regarding CHIs and AI/ML implementation in other countries since the state of development of CHIs as such varies from country to country and so does the tech readiness of each country. Secondly, employment conditions will also vary across diverse countries; Sweden is in general characterized by low mobility and low turnover of staff, not only in CHIs, with the implication that renewal of skills sets and staff is also slow, thus retarding the implementation of innovations such as digitization in the CH sector. Third, this study relies on a small number of qualitative interviews. Whilst some may regard this as a limitation, our knowledge of the Swedish CH sector leads us to suggest that what we found is indeed representative of that sector in Sweden. This does not mean that there are no or few cultural workers such as artists for example who are working at the forefront of AI/ML implementation in their field. But our concern here was with a specific set of CHI professionals where we found a clearly defined and particular set of issues regarding AI/ML implementation.

6 Conclusions

The discussions above suggest that the effective and efficient use of AI/ML digitization and digitalization tools in CHIs cannot just be a matter of individual organization solutions. This is partly because individual institutions simply do not have the resources to do so, either in human or in other terms. Further, they frequently lack relevant staff expertise. One way in which this could be remedied is through curriculum reform in relevant professional and

higher education courses to include not only curation-related knowledges and skills but also technical know-how regarding AI/ML. Individualized solutions concerning the effective and efficient use of AI/ML digitization and digitalization tools in CHIs create issues ranging from e.g., the need for additional computational solutions for automated work concerning special and smaller collections (e.g., collections in rare or indigenous languages) to the interoperability of different systems. This has detrimental effects on the collections, as they cannot engage in directly relevant exchanges with other CHIs, which might lead to new insights into an organization’s own collections, the unidentified objects it has, for example, and their provenance. One solution to these problems would be the development of a national strategy for the digitization of CHI collections, and follow-up on its implementation, possibly through fiscal incentives. The Swedish government report of 2021 concerning the Inquiry on the Restart for Arts and Culture (SOU 2021:77, <https://www.regeringen.se/4a941c/contentassets/c96ef2e953fd481ebb68d41b980a1d0a/restarting-the-arts-and-culture-in-sweden---summary-sou-202177.pdf>, accessed 10/2/2022) recognizes this: ‘In the area of cultural heritage, many museums and archives lack the staff and other resources required to digitalise their collections in an effective manner. Our assessment is that a large-scale digitalisation initiative is needed for the whole of the cultural heritage sector’ (2021, p 6). Still, there is nothing about AI/ML resources or implementation, indicating that whoever conducted this report is not up-to-date with resources and possibilities in the sector.

This should be coupled with resource share to create a critical mass of competent staff that knows both the technical and content dimensions of this work. An important aspect of this would be a proactive commitment to relevant staff development for all staff and not on a purely individual basis as is the case now. National workshops where CHI staff get together to get relevant training, to brainstorm and to exchange best practices would be helpful here.

It is clear, given advances in AI/ML, that the long-term transformation of CHIs in relation to the use of AI/ML is required. This, however, happens in the context of foreshortened tech developments, meaning that tech changes occur quite fast while institutions tend to be less ‘agile’. This could be countered by the development of a national group of CHI staff who specialize in AI/ML solutions and work with multiple CHIs, rather than having individual staff who are the only one with certain skills in a single CHI. Much more emphasis needs to be placed, in this context, on the interoperability of systems so that collections can be meaningfully connected. In all, much work remains to be done to facilitate CHIs’ digital development, and this needs national as well as institutional measures.

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Data availability The data are not at present available in an open access database.

Declarations

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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References

- Bennett T (2009) Museum, field, colony: colonial governmentality and the circulation of reference. *J Cult Econ* 2(1–2):99–116
- Blake J (2000) On defining the cultural heritage. *Int Comp Law Q* 49(1):61–85
- Bock GW, Mahmood M, Sharma S, Kang YJ (2010) The impact of information overload and contribution overload on continued usage of electronic knowledge repositories. *J Organ Comput Electron Commer* 20(3):257–278
- Braun V, Clarke V (2006) Using thematic analysis in psychology. *Qual Res Psychol* 3(2):77–101
- Braun V, Clarke V (2021a) Can I use TA? Should I use TA? Should I not use TA? Comparing reflexive thematic analysis and other pattern-based qualitative analytic approaches. *Couns Psychother Res* 21(1):37–47
- Braun V, Clarke V (2021b) One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qual Res Psychol* 18(3):328–352
- Ciecko B (2020) AI sees what? The good, the bad, and the ugly of machine vision for museum collections. <https://mw20.museweb.net/paper/ai-sees-what-the-good-the-bad-and-the-ugly-of-machine-vision-for-museum-collections/>. Accessed 17 May 2023
- Demestrescu E, d'Annibale E, Daniele Ferdani D, Fanini B (2020) Digital replica of cultural landscapes: an experimental reality-based workflow to create realistic, interactive open world experiences. *J Cult Herit* 41:125–141
- Di Tullio V, Doherty B, Capitani D, Miliani C, Greco E, Ciliberto E, Proietti N (2020) NMR spectroscopy and micro-analytical techniques for studying the constitutive materials and the state of conservation of an ancient Tapa barkcloth from Polynesia Wallis. *J Cult Herit* 45:379–388
- Fontanella F, Colace F, Molinara M, Di Freca AS, Stanco F (2020) Pattern recognition and artificial intelligence techniques for cultural heritage. *Pattern Recognit Lett* 138:23–29
- Fiorucci M, Khoroshiltseva M, Pontil M, Traviglia A, Bue AD, James S (2020) Machine learning for cultural heritage: a survey. *Pattern Recognit Lett* 133(102):108. <https://doi.org/10.1016/j.patrec.2020.02.017>
- Garozzo R, Pino C, Santagati C, Spampinato C (2020) Harnessing the power of artificial intelligence for modelling and understanding cultural heritage data. Impact of Industry 4.0 on architecture and cultural heritage. IGI Global, pp 357–376
- Gefen A, Saint-Raymond L, Venturini T (2021) AI for digital humanities and computational social sciences. In: Braunschweig B, Ghallab M (eds) Reflections on artificial intelligence for humanity. Lecture notes in computer science, vol 12600. Springer International Publishing, Cham, pp 191–202. https://doi.org/10.1007/978-3-030-69128-8_12
- Geismar H (2018) Museum object lessons for the digital age. UCL Press, London
- Giugliano G, Laudante E (2020) Design as collaborative connection between user, technology and cultural context. IOP Conf Ser Mater Sci Eng. <https://doi.org/10.1088/1757-899X/949/1/012010>
- Golub K, Göransson E, Foka A, Huvila I (2020) Digital humanities in Sweden and its infrastructure: *Status quo* and the *sine qua non*. *Dig Scholarsh Humanit* 35(3):547–556. <https://doi.org/10.1093/llc/fqz042>
- Griffin G (2019) Intersectionalized professional identities and gender in the digital humanities in the nordic countries. *Work Employ Soc* 33(6):966–982. <https://doi.org/10.1177/0950017019856821>
- Hardman L, Aroyo L, van Ossenbruggen J, Hyvönen E (2009) Using AI to access and experience cultural heritage. *IEEE Intell Syst* 24(2):23–25
- Harrison R (2015) Heritage and globalisation. In: Waterton E, Watson S (eds) The Palgrave handbook of contemporary heritage research. Palgrave, pp 297–312. <https://doi.org/10.1057/9781137293565.0027>
- Heintz, F., Gulliksen, J., Loufti, A., & Foka, A. (2022). Digital spetskompetens 2035 : Framtidsanalys för kompetensförsörjningen av digital spetskompetens. The Swedish Higher Education Authority, Stockholm. <https://digitalspetskompetens.se/wp-content/uploads/2022/06/Digital-spetskompetens-2035-Framtidsanalys-for-kompetensforsorjningen-av-digital-spetskompetens.pdf>
- Latour B (1993) We have never been modern. Harvard University Press
- Latour B (2005) Reassembling the social: an introduction to actor-network theory. Oxford University Press
- Law J (2004) After method: mess in social science research. Routledge
- Lazzeretti L (2020) What is the role of culture facing the digital revolution challenge Some reflections for a research agenda. *Eur Plan Stud*. <https://doi.org/10.1080/09654313.2020.1836133>
- Liu C, Cao Y, Yang C, Zhou Y, Ai M (2020) Pattern identification and analysis for the traditional village using low altitude UAV-borne remote sensing: Multifeatured geospatial data to support rural landscape investigation, documentation and management. *J Cult Herit* 44:185–195
- Macdonald S (2009) Reassembling Nuremberg, reassembling heritage. *J Cult Econ* 2(1):117–134
- Martinez F (2019) Process excellence the key for digitalisation. *Bus Process Manag J*, 25(7): 1716–1733. <https://doi-org.ezproxy.its.uu.se/https://doi.org/10.1108/BPMJ-08-2018-0237>
- Nauta GJ, van den Heuvel W (2015) Survey report on digitisation in European Cultural Heritage Institutions 2015. https://pro.europeana.eu/files/Europeana_Professional/Projects/Project_list/ENUMERATE/deliverables/ev3-deliverable-d1.2-europeana-version1.1-public.pdf

- Not E, Petrelli D (2019) Empowering cultural heritage professionals with tools for authoring and deploying personalized visitor experiences. *User Model User-Adap Interact* 29:67–120
- O'Neill B, Stapleton L (2022) Digital cultural heritage standards: from silo to semantic web. *AI Soc* 37:891–903
- Risam R (2018) Decolonizing the digital humanities in theory and practice. In: Sayers J (ed) *The Routledge companion to media studies and digital humanities*. Routledge, London, pp 78–86
- Rizzo I, Throsby D (2006) Cultural heritage: economic analysis and public policy. *Handbook of the economics of art and culture*, 1. Elsevier, pp 983–1016
- Schwarz Müller T, Brosi P, Duman D, Welpel IM (2018) How does the digital transformation affect organizations? Key themes of change in work design and leadership. *MREV Manag Rev* 29(2):114–138
- Su X, Sperli G, Moscato V, Picariello A, Esposito C, Choi C (2019) An edge intelligence empowered recommender system enabling cultural heritage applications. *IEEE Trans Ind Inf* 15(7):4266–4275
- Talamo M, Valentini F, Dimitri A, Allegrini I (2020) Innovative technologies for cultural heritage. *Tattoo sensors and AI: the new life of cultural assets*. *Sensors* 20(7):1909. <https://doi.org/10.3390/s20071909>
- Tzouganatou A (2018) Can heritage bots thrive? Toward future engagement in cultural heritage. *Adv Archaeol Pract* 6(4):377–383. <https://doi.org/10.1017/aap.2018.32>
- Tzouganatou A (2021) Openness and privacy in born-digital archives: reflecting the role of AI development. *AI & Soc*. <https://doi.org/10.1007/s00146-021-01361-3>
- Vecco M (2010) A definition of cultural heritage: from the tangible to the intangible. *J Cult Herit* 11(3):321–324
- Zan L, Bonini Baraldi S (2013) The heritage chain management: general issues and a case study China. *J Cult Herit* 14(3):211–218. <https://doi.org/10.1016/j.culher.2012.06.007>

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