

**Implementing the International Image Interoperability Framework  
(IIIF) for accessibility and reuse of cultural heritage resources on the web  
– Challenges and Advantages**

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**Dissertação de Mestrado em Gestão e Curadoria da Informação**

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# **Implementing the International Image Interoperability Framework (IIIF) for accessibility and reuse of cultural heritage resources on the web – Challenges and Advantages**

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“There is no enjoying the possession of anything valuable  
unless one has someone to share it with”  
- Seneca

*This work is dedicated to my sister, Ana Paula.*

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## Abstract

The accessibility of images-based resources is important for the practice of research, teaching and knowledge transfer in the Social Sciences and the Humanities. In the past twenty-five years, Cultural Heritage Institutions (CHIs) have been digitizing and providing millions of digital surrogates of their artefacts, paintings, books, maps, manuscripts and other objects in digital repositories and web platforms.

However, most of those digital resources are still locked up in silos which means they lack interoperability and reusability. To address this issue, the International Image Interoperability Framework (IIIF) was created in 2011 by technologists from Stanford University, The British Library and The Bodleian Library, The National Library of Norway and The National Library of France (BnF).

This study will address the challenges and advantages of the IIIF's implementation in digital repositories of CHIs and how the IIIF can enhance research, teaching and knowledge transfer in the social sciences and humanities. This study will also look at the IIIF implementation scenario in Europe and in Portugal through qualitative analysis of professionals' responses to a questionnaire.

**Keywords:** International Image Interoperability Framework, Interoperability, Digital Humanities, Interactive Interfaces, Cultural Heritage Institutions.

## Resumo

A acessibilidade de recursos baseados em imagens é importante para a prática da investigação, ensino e transferência de conhecimentos nas Ciências Sociais e Humanas. Nos últimos vinte e cinco anos, as Instituições de Património Cultural (CHIs) têm vindo a digitalizar e a fornecer milhões de substitutos digitais dos seus artefactos, pinturas, livros, mapas, manuscritos e outros objetos em repositórios digitais e plataformas web.

No entanto, a maioria desses recursos digitais ainda se encontram encerrados em silos, o que significa que lhes falta interoperabilidade e reutilização. Para abordar esta questão, o International Image Interoperability Framework (IIIF) foi criado em 2011 por tecnólogos da Universidade de Stanford, The British Library e The Bodleian Library, The National Library of Norway e The National Library of France (BnF).

Este estudo abordará os desafios e vantagens da implementação do IIIF em repositórios digitais de instituições culturais e universidades e como o IIIF pode melhorar a investigação, o ensino e a transferência de conhecimento nas ciências sociais e humanas. Este estudo analisará também o cenário de implementação da IIIF em Portugal através da análise qualitativa das respostas dos profissionais a um questionário.

Palavras-chave: Quadro Internacional de Interoperabilidade da Imagem, Interoperabilidade, Humanidades Digitais, Interfaces interativas, Instituições do Património Cultural.

## List of Acronyms and Abbreviations

API(s)	Application Programming Interface(s)
ARKs	Archival Resource Keys
BnF	The National Library of France
CHI(s)	Cultural Heritage Institutions
COAR	Confederation of Open Access Repositories
CORS	Cross-origin Resource Sharing
DAMS	Digital Asset Management systems
DCL	Digital Cicognara Library
EDM	Europeana Data Model
GLAMS	Galleries, Libraries, Archives and Museums
IIIF	International Interoperability Image Framework
IMS	Image Management Systems
JSON-LD	JSON-Linked Data
KMSKA	Royal Museums of Fine Arts Antwerp
MEI	Music Encoding Initiative
NGA	The National Gallery of Art
NLW	National Library of Wales
OAI-PMH	Open Archives Initiative Protocol for Metadata Harvesting
OCR	Optical character recognition

OPAC	Online Public Access Catalog
PIDs	Persistent Identifiers
PoC	Proof of Concept
RDF	Resource Description Framework
TNC	Towards a National Collection
UCD	University College Dublin
URI	Uniform Resource Identifier
UV	Universal Viewer
V&A	Victoria & Albert Museum
VRRs	Virtual Reading Rooms
YCBA	Yale Center for British Art



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## 1. Introduction

Cultural heritage institutions (CHIs) like galleries, libraries, archives and museums (also known as GLAMS) have traditionally provided ready access to their resources and services (Candela *et al*, 2020, p.1). Although “GLAM organisations provide access to digital collections in several ways, they are built upon traditional systems that are not suitable for new environments based on computational usage” (Candela *et al*, 2020, p.2).

The goals for digitization and the representation on the web of GLAM resources are: (1) generally to increase remote access of the institution’s resources (Terras, 2008, p.103; Prescott and Hughes, 2018, p.3), (2) to facilitate detailed analysis and research of objects, documents and artefacts (Terras, 2008b, p.244; Terras, 2015; Raemy, 2020, p.1), (3) to attract new audiences (Raemy, 2020, p.1), (4) to promote (Babcock & Di Cresce, 2019, p.181) and to preserve (Emanuel, 2017, p.2; Babcock & Di Cresce, 2019, p.181) the collections through their digital surrogates.

The World Wide Web led GLAM institutions to increase their digitization efforts and has transformed users’ expectations and demands for easy and rapid access to information resources (Terras, 2008a, pp 113-114). However, the way in which this has been accomplished has been intrinsically tied to the technologies and resources available at one time or another, which tend to become obsolete (Crane, 2017).

In addition, significant challenges come associated with digitization efforts, such as the capture, discoverability, copyrights, curation and management of digital images, and accessibility policies (Ying & Shulman, 2015). Although for the last 25 years the phenomenon of mass digitization and reproduction “of hundreds of millions of cultural and historical artefacts as high-quality images” has been a reality, their delivery has been *too complex* whereas their accessibility has been *too slow* and *too disjointed* (Snydman, Sanderson, & Cramer, 2015). The origin of these problems is rooted in the institutions’ virtual silos and duplication of images (Snydman, Sanderson, & Cramer, 2015).

Typically, different CHI digital repositories use different digital asset management systems, frameworks and servers to handle the storage, management, and delivery of digital material (Emanuel *et al*, 2016, p.2; Emanuel, 2017, p.14), which make

it difficult for content to be shared across institutions (Emanuel et al, 2016, p.2). Despite these differences, these institutions all share similar challenges of managing and publishing large sizes of image information (Politou et al, 2004, p.293) and the siloed environment of their repository platforms imposes limitations for image-based research (Babcock & Di Cresce, 2019, p.181).

Moreover, these systems are usually not free of charge and “the lack of technical skills especially [...] makes basic data manipulation and conversion hard to achieve” (Dragoni et al., 2017, p.15:1). From the researchers’ perspective, resources from such institutions must also be searched for in different digital repository platforms one at time, which is time consuming (Babcock & Di Cresce, 2019, p.181 and 182).

Historically, academic libraries have been seen as buildings which house collections and as organizations “vertically integrated around the management of those collections” (Dempsey, 2012, p.204). For Lorcan Dempsey, however, “changes in research and learning behaviours and expectations are more important for the academic library than any library technology changes per se.” (Dempsey, 2012, p.203).

Providing a way in which information resources can be usable, interpreted and researched is becoming essential to institutions. As Melissa Terras put it: “providing large digitized collections of raw material, and some fairly simple access tools, is not enough to allow users to get the most out of digitized collections” (Terras, 2008, p. 124). Users of Digital Images collections are, in addition, looking for:

*[...] fast retrieval, image and text versions (to conduct full text searches of documents), completeness and legibility of images without scrolling down the page, multiple sizes of images to support differing research needs, consistency across image databases, tools (such as zoom and pan) to deal with large images, simple user interfaces, hypertextual links between structural and intellectual content and the ability to manipulate digital images (such as zoom, being able to examine images side by side, save searches, results and annotations). Users also need [...] cross-database searching and, more importantly, a standardized interface and query language across different systems [...] collections* (Terras, 2008, p. 123-124).

The change in research and learning behaviours identified by Dempsey can be related to the change to how information and information systems are perceived by domain researchers (Engerer, 2021, p.44). According to Engerer, the shift to digital humanities led to the transformation of the domain researcher’s relationship to information as researchers have moved from information gap motivation behavior to an exploratory and experimental approach to the information system which is coined *exploratory minds* (Engerer, 2021, p.47).

In the same manner, this shift is also related to another dimension of the digital humanities, which is the *acknowledgement of digital structure* by the users (Engerer, 2021, p.47). In other words, this means that users are interested in the digital item per se and not in making obvious assumptions as to its original physical object (Engerer, 2021, p.47). This shift brought domain researchers closer to the information sciences in terms of both methodology and epistemology (Engerer, 2021, p.49). Engerer noted the similarity between information science and digital humanities by enumerating the common concepts of user-researcher, information system and digital object and the relationships between them (Engerer, 2021, p.45):

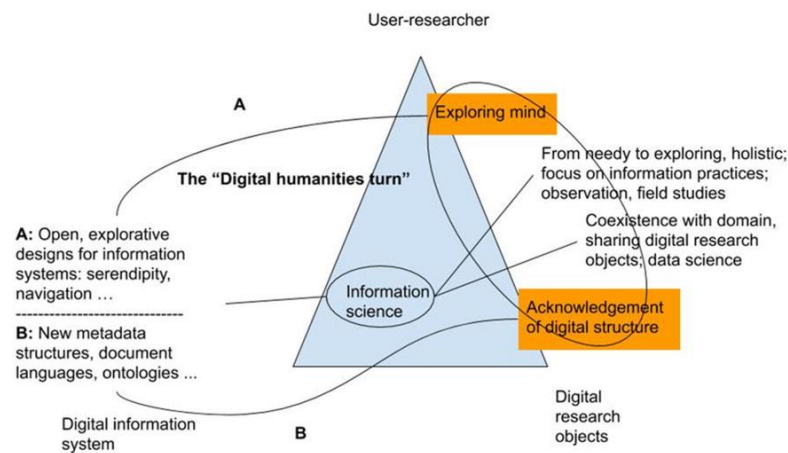


Figure 1 - The tasks of information science given the shift to digital humanities (Engerer, 2021, p.48)

Likewise, information science has been impacted by this concept of *exploring minds*, a concept related to a shift from searchability to exploratory paradigms of information, which has, indirectly, led to the *radical reorientation* of information systems (Engerer, 2021, p.52). Faced with these changes, the challenge for Information Science is to adapt to new users’ attitudes towards the study of digital object structure, their

research focus on digital objects per se and need for information system navigation designs that support this exploratory mind (Enreger, 2021, p.49).

The International Image Interoperability Framework (IIIF, pronounced “Triple-Eye-Eff”) was conceived in 2011 by technologists from Stanford University, The British Library, The Bodleian Library, The National Library of Norway and The National Library of France (BnF). Its aim is the implementing of a simpler solution for exchanging structural data from digitized resources and new image manipulation mechanisms from CHIs (Snydman, Sanderson & Cramer, 2015; Ying & Shulman, 2015) through images visualization software like Mirador and Universal Viewer (UV).

The fact that individual institutions were “making individual technology decisions about data stores and presentation applications” as their digital collections were growing was frustrating for the library technologists who ended up developing the IIIF to tackle this problem (Ying & Shulman, 2015). For the first time, an innovative solution has been implemented that “provides for images and uniform methods of presentation and coding” of digitized and digital-born images between different institutions and repositories, eliminating the creation of single infrastructures for each institution (Long, 2018, p.572) and “transcending the silos created by digital asset management systems and institutional websites” (Card *et al*, 2019, p.161).

More specifically, the IIIF stands out for distributing images through HTTP or HTTPs servers and displaying heterogeneous resources in a consistent manner and oriented towards a good end-user experience. In fact, the IIIF APIs enable images and other associated data to be delivered “consistently across platforms—from one repository, web viewer, or image tool to another—without imposing specific platforms or tools on a library or individual making use of the images” (Babcock & Di Cresce, 2019, p.182).

Overall, the three main goals of the IIIF are: (1) to give scholars an unprecedented level of uniform and rich access to image-based resources hosted around the world; (2) to define a set of common application programming interfaces (APIs) that support interoperability between image repositories and (3) to develop, cultivate and document shared technologies, such as image servers and web clients that provide a world-class user experience in viewing, comparing, manipulating and annotating images (Cramer, 2015).

In addition, the IIF is considered to be a sustainable standard as “most of the technologies used for IIF and the standards on which IIF is based are available in open source” (ARMA Consortium, 2022, p. 5 and 6) and they are maintained and continue to be developed by a community (ARMA Consortium, 2022, p. 5 and 6).

Despite the development of the IIF and increasing knowledge of how digital resources are used, digital images are still viewed rather to support remote access (Prescott and Hughes, 2018, p.3). In fact, the main reason for digitization cited by CHIs is to increase access (Terras, 2008, p.101). Providing images on the web is a very complex process and IIF implementation is seen as a means of addressing these challenges. Nonetheless, the challenges involved in its implementation and wider knowledge of the IIF’s potential advantages (beyond the need to increase access) are still to be addressed in the literature. It is widely acknowledged that digital images of artefacts and documents are essential to research and knowledge transfer in the social sciences and humanities. Moreover, the development of tools that lead to new research methods and new ways of exhibiting cultural heritage resources on the internet can contribute to the preservation of a common heritage. Yet the IIF’s technology has been little studied at a postgraduate level: there is only one master’s thesis (Raemy, 2019) and one postgraduate diploma thesis (Porena, 2019).

As of 2022, the IIF Consortium is made up of 63 members, including not only libraries, but also museums, archives and software companies, across the world (IIF, n. d.). In addition, the wider IIF community consists of more than 130 cultural heritage institutions, universities, open-source software companies and project initiatives (most situated in the northern hemisphere) “committed to sharing and displaying image resources across repositories and the web” (IIF, 2020a). Besides, the IIF has extended its scope to audio-visual, 3D and STEM resources and has cultivated new types of audiences and users (Babcock & Di Cresce, 2019, p.191 and 192).

There is now an opportunity to analyse the implementation (and potential) of the IIF in Portugal as its implementation starts to unfold. In other countries IIF implementation has followed a path that has been studied in other postgraduate work. One of the goals of this study is to elaborate upon how IIF implementation has to date

progressed with further case studies. It therefore follows the following scheme: (1) elaborate an updated state-of-the-art of the development and implementation of the IIF and its tools, (2) elaborate a qualitative analysis of IIF implementation best practices, (3) enumerate the advantages and challenges of the IIF's implementation for CHIs, (4) research the reach of the IIF in Portuguese institutions.

Having its focus on cultural heritage information resources,<sup>1</sup> this study will consider institutions that hold, store, provide, preserve and/or disseminate the mentioned resources while making them accessible and usable for research, teaching/studying or leisure on the internet. The study sample will include GLAMs institutions (Galleries, Libraries, Archives and Museums), university libraries and research institutions or academic projects that may or may not own cultural heritage resources but make use of cultural heritage information resources and display them online. Although it is acknowledged here that these institutions have different digitization and accessibility strategies and that their collections vary in size and nature, each has a common goal of providing digital cultural heritage resources online for public access, thus making their issues and needs regarding this area very similar. This study adopts the definition of accessibility made by Peacock whereby accessible means *usable and valuable as knowledge* (Terras, 2008, p.124). Also, only the delivery and accessibility of digital images will be considered.

This study aims to contribute to the development of Information Science as it proposes to research new ways of managing content, disseminating information on the web and consequently the migration of information systems based on a new paradigm of user and e-research<sup>2</sup> infrastructures that enable new research methodologies to be developed.

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<sup>1</sup> According to Lor and Britz Cultural Heritage Information resources or digital cultural heritage are tangible or intangible material that has been digitised (Chowdbury & Ruthven, 2015, p.1).

<sup>2</sup> The term e-research means enhanced research and its infrastructure provides distributed access to instruments, computational resources, and digital libraries of data (Borgman, 2000, pp.655 and 798).



Thus, the present research aims to understand the implementation of the IIF in the broader context of the need for a technological transformation of how CHI digital repositories are managed, while improving accessibility to and providing new tools for making cultural heritage digital resources available for reuse in research, teaching, and for knowledge transfer. In order to do that, the following question is asked *What are the advantages and the challenges of IIF implementation by CHIs for the accessibility and reuse of cultural heritage resources on the web?*

To address these questions, this study is divided into the following chapters:

In chapter 2, the methodology for this study is described. The methodology will be based on a combination of studying best practices through a literature review, reports and recorded presentations in conferences and IIF community calls and interviews with professionals working with the IIF in CHIs and university libraries and research units. This approach will involve collecting information about institutions' digitalization practices for delivery on the internet, the reasons behind the implementation of the IIF, its benefits and challenges, and the transformation/migration of their information systems approach that occurred as a result.

In chapter 3, in order to further understand IIF implementation, the literature review discusses different aspects of IIF implementation, which include the technicalities of working with the IIF and what it is capable of. This chapter highlights the challenges and requirements of the IIF through the lens of the institutions that already made IIF implementation while pointing out its benefits and advantages. In addition, the IIF in the Portuguese context is summarised.

In addition, in chapter 3, trends in library infrastructures and services are discussed such as migration from a monolithic architectural model to a microservices architectural model and the adoption of an inside-out library approach that supports research outputs, a phenomenon that is unfolding between institutions. The aim of this section is to understand how the IIF is aligned with these initiatives and can be beneficial in supporting these transformations. In addition, to further understand the challenges, and as a practical demonstration, a part of this chapter will be dedicated to the creation and publication of an IIF-compliant image as an example of how a small project might

benefit. Another part of this chapter presents a general view of the IIIF workflow, and the challenges associated with its integration in the already existing workflows at the institutions

In chapter 4, the data of the interviews is presented. The information was thematically analysed (see below), while in chapter 5, the interview results are compared with the results of the literature review.

In sum, the contributions of the present study aim to be: (1) an updated state-of-the-art document on the IIIF, (2) a reference work for institutions and researchers that plan to implement the IIIF and (3) a comprehensive analysis of the digitization and accessibility of cultural heritage resources on the web for research, teaching and knowledge transfer in the social sciences and humanities.

## 2. Methodology & Methods

The aim of the present study is to understand the reasons for IIIF implementation by cultural heritage institutions who provide digital images on the web, its challenges, and outcomes. It therefore seeks to elucidate not only the development and spread of the IIIF, but to comprehend the motivations that lead institutions to adopt it, the setbacks they encountered and their satisfaction (or lack of satisfaction) with the achieved results.

The problems faced by CHIs or other institutions that provide such resources, like university libraries and research units, relate to digital image management since they need to elaborate capture, curation, copyright validation, accessibility and discoverability policies or practices, which is challenging. Those institutions that are providing digital cultural heritage resources also deal with their internal or external silos, which pose challenges for the accessibility of those resources. Moreover, among institutions there are no common standard for digital image delivery and accessibility, which is also an obstacle for sharing content among peer institutions.

In addition, some institutions face funding challenges, infrastructure problems, and a lack of dedicated resources to implement some of the more sophisticated solutions available. These include front-end functionalities that are demanded by the new

information-seeking behaviors in research and learning of users from Humanities and Social Sciences institutions.

With these problems in perspective, the present study aims to research how IIF implementation can help these types of institutions to minimize obstacles towards the accessibility of their digital resources on the internet and their consequent re-use by users.

To address the research question, an *interpretive qualitative methodology* approach was chosen. Qualitative research is defined by G. E. Gorman and Peter Clayton as a:

*[...] process of enquiry that draws data from the context in which events occur, in attempt to describe these occurrences, as a means of determining the process in which events are embedded and the perspectives of those participating in the events, using induction to drive possible explanations based on observed phenomena (Gorman & Clayton, 1997, p.23).*

In other words, qualitative research collects *verbal data* from the context where a certain phenomenon occurs and it attempts to describe and understand the process in which that phenomenon came about while seeking to understand the perspectives and feelings of those participating directly in the described events or activities (Gorman & Clayton, 1997, pp.24-26). The collected data is then used as the basis for a ‘ground-theory’ that attempts to explain the observed phenomenon (Gorman & Clayton, 1997, p.27).

Overall, the purpose of a qualitative approach is the contextualization, description and understanding of an event and its participants’ points of view of that same event “by collecting, observing and studying as widely as possible” (Gorman & Clayton, 1997, p.24 & 26). The goal is “to help understand emerging concerns or to offer specific analysis of those concerns” (Gorman & Clayton, 1997, p.26).

Therefore, this study adopts an explanatory approach which consists of attempting to explain an emerging phenomenon - the adoption of the IIF by institutions or individual researchers - through the gathering of data by the following methods: (1) attending

conferences<sup>3</sup> and watching video recordings of IIF working groups; (2) reviewing the literature on the topic; (3) following practical tutorials/workshops and asking IIF experts questions and (4) conducting in-depth e-mail interviews with information professionals, IT specialists from CHIs or university libraries and domain researchers.

### 2.1 Review of the literature and documentary search

The literature review was conducted to achieve the following goals: (1) to understand what the IIF is in terms of technology and development; (2) understand the main perspectives from adopters and experts, (3) understand the application of the IIF in the context of library information systems, (4) identify the reasons for, challenges and benefits behind IIF implementation, (5) identify potential interviewees and (6) to formulate interview questions.

In analyzing the information available from the literature and from documents such recorded videos from IIF community calls and conferences, blogs and online forums, the goal was to identify the needs of institutions and researchers and what led them to IIF adoption. Also, challenges and benefits from this adoption were identified.

The literature was at first searched using the B-on and Academic Google search engines using the keywords “International Image Interoperability Framework” and “International Image Interoperability Framework” AND “IIF”. The date frame was limited from 2015 to the present. The results obtained were filtered to include those referring to cultural heritage institutions by reading titles and abstracts. Articles mainly referring to 3D and audio & video<sup>4</sup> were not considered as this study focuses mainly on the dissemination of digital images. Academia.edu and ResearchGate were also accessed in order to ask authors for copies of their work otherwise not available to me, which some of them kindly agreed to. Also, Google searches were done using the keyword “International Image Interoperability Framework” AND “IIF”. Google was used to find institutional websites or blogs posts. Other sources were the IIF discuss list, IIF

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<sup>3</sup> In June 2022, I received a travel and accommodation scholarship to attend the IIF annual conference at the MIT and Harvard University (Boston, MA; USA).

<sup>4</sup> The IIF also supports Audio & Video and 3D contents which will not be covered in this study.

community calls or other conferences, slack forums, YouTube and LinkedIn where I was able to ask questions to professionals working with the IIIF.

## 2.2 Interviews and study samples

Considering the novelty of IIIF adoption and its on-going development and growth among institutions and individual researchers at the time of writing, this study has had difficulties in collecting the most up-to-date information. This difficulty may be due to the lack of academic studies on the matter and a reduced experience of the IIIF itself among national institutions, individual researchers, and the general public. On the other hand, the same circumstances can be seen as a considerable opportunity to understand the development of this phenomenon at an early stage and document the perspectives, and expectations of early active participants (information science professionals, IT specialists and researchers) on IIIF implementation.

To better understand institutions' views on the IIIF and implementation approaches by institutional providers and individual researchers, a qualitative method was adopted in the form of *semi-structured e-mail interviews*.

A semi-structured interview is an open-ended-answer interview in which the interviewer has a clear set of themes and questions to be asked but is willing to be flexible, allowing interviewees to elaborate on their answers and prefer topics as much as they like (Denscombe, 2017, p. 203).

The e-mail interview method was chosen against face-to-face or video call interviews because of the limited time available for conducting calls from the researcher side and because the research was conducted partly during the Covid-19 pandemic.

The study sample was chosen by selecting a *purposive sample*. A purposive sample is a sample in which different kinds of representatives from different groups (Gorman & Clayton, 1997, p.127) are selected as interviewees, which for this study were IT technicians, information and library professionals, and domain researchers dealing with the IIIF. The IIIF can be implemented by large or small institutions, while information professionals or individual domain researchers in Information Science and Information Systems disciplines have different levels of knowledge and skill in its implementation. Hence, in this type of interview, the participants do not necessarily need

to have a high degree of awareness of the subject or be familiarized with certain issues (Kallio *et al*, 2016, p.2959). In this sense, the interview can focus on the matters more important to them (Kallio *et al*, 2016, p.2959).

The development of this method was made following the *Framework for the development of a qualitative semi-structured interview guide* (Kallio *et al*, 2016). The steps of this framework are: (1) Identify if the research question is suitable to this method; (2) Gain in-depth knowledge of the study topic through a literature review and gain more empirical knowledge by attending workshops or conferences in order to then write interview questions; (3) Formulate the preliminary semi-structured interview guide segmented into different themes; (4) Test the interview guide with internal evaluation and (5) Present the complete semi-structured interview guide.

The interview guide was built into seven different topics: (1) Personal Information of the interviewee, (2) Institution information, (3) IIIIF implementation background, (4) Reasons behind IIIIF implementation, (5) IIIIF adoptions challenges, (6) IIIIF benefits and (7) Feedback & Improvement:

*Table 1 - Interview Guide*

<b>Question themes</b>	<b>Questions</b>
Personal information	Q1: Interviewee’s job title
Institution information	Q2: Institution type Q3: Country Q4: Users characteristics Q5: Digital services offered
IIIIF implementation background	Q6: In what context was the IIIIF implemented? Q6.1: When and how did the idea of adopting IIIIF come about in your institution?

	<p>Q6.2: how did your digitization and digital services plans develop before you adopted the IIF?</p> <p>Q7: In which stage is your implementation?</p> <p>Q8: What is the amount and type of material available in IIF?</p> <p>Q9: What are the IIF functionalities/services that are implemented?</p> <p>Q10: The implementation of IIF is for external or internal use?</p> <p>Q11: What are the departments or partners involved in the implementation?</p> <p>Q12: Before the implementation, did a testbed take place?</p>
Reasons behind IIF adoption	<p>Q13: What were the issues or needs that led to the IIF implementation?</p> <p>Q14: What were the goals and expectations related to the implementation of the IIF?</p> <p>Q15: How is the IIF complaint with your institution's digitization and online accessibility strategy?</p>
IIF adoption challenges	<p>Q16: What were the expected risks in the context of the implementation?</p> <p>Q17: What were the main challenges of the implementation?</p> <p>Q18: What were the identified risks from the implementation?</p>
IIF Benefits	<p>Q19: What are the main internal and external benefits of IIF?</p> <p>Q20: What kind of feedback staff and users report about the IIF?</p> <p>Q21: Did the institution conduct surveys or interviews to measure the satisfaction of staff and users?</p>
Feedback and improvement	<p>Q22: What goals or expectations were met?</p>

	<p>Q23: What kind of feedback staff and users report about the IIIF?</p> <p>Q24: In which way IIIF can be improved?</p>
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Through the literature review, Portuguese projects and institutions that mentioned the IIIF as a potential tool were first identified. After realizing that the study sample would be insufficient, it was decided to expand the sample to include projects in other countries, mostly European. Although, a national perspective is lost, including other European countries has the advantage of setting this study in a border perspective not only of European implementation but also of placing Portuguese national institutions onto the IIIF global map.

Institutions or representatives of the institutions were contacted via e-mail to establish a first contact and were invited to participate in the study. In total 11 institutions from Portugal (5), Spain (1), Italy (1), UK (1), Poland (1), Brazil (1) and Germany (1) were approached.

The following table lists the institutions/representants that agreed to take part in the study and indicates the group categories they belong to. The interview guide that were sent to them via e-mail (Appendix I)



Table 2 - Interview respondents and their categorizations

	<b>Institution category</b>	<b>Country</b>	<b>Type/Type/Number of resources</b>	<b>IIIF APIs.</b>	<b>Interviewee(s) role(s)</b>
<b>Respondent 1</b>	National library	Not disclosed <sup>5</sup>	1,8-1,9 million IIIF manifests of publications	Presentation and Image	Not disclosed
<b>Respondent 2</b>	University library	UK	300,000 own IIIF images + 30,000 not owned images in the main LUNA repository. Plus, 500 in the Cantaloupe server for other websites.	Presentation and Image	Not disclosed
<b>Respondent 3</b>	University library	Portugal	Books, manuscripts, letters, maps, photography, publications, among others.	Presentation and Image	Not disclosed
<b>Respondent 4</b>	University research unit	Germany	100 digital surrogates of XIX manuscripts in TIFF.	Image	Not disclosed
<b>Respondent 5</b>	University research unit	Portugal	300,000 images in JPEG	Image	Not disclosed

<sup>5</sup> To maintain anonymity of the national library, its country will not be disclosed.

### **2.2.1 Ethics and limitations**

The interview data and interviewees are anonymized. The intention of this study is not to compare institutions but to give a general overview of IIF implementation by the different types of organization. Also, some parts of the interviews were anonymized so as to preserve the anonymity of both interviewee and institution.

In addition, the interviews were conducted both in English and Portuguese. Only selected passages of the Portuguese interviews are translated into English for the purpose of presenting the findings. The data from the interviews in Portuguese is not fully translated because of the potential risks of losing or changing the initial meaning (Mckenna, 2022 p.2) of the answers.

### **2.2.2 Thematic analysis**

The method chosen for analysing the interview data was thematic analysis (TA), which “is a method for identifying, analysing and reporting patterns (themes) within data” (Braun and Clarke, 2006, p.79).

This method was chosen for its flexibility as it is autonomous of a theory (Braun and Clarke, 2006, p.79). Furthermore, as TA “does not require the detailed theoretical and technological knowledge of approaches, such as grounded theory and DA [discourse analysis], it can offer a more accessible form of analysis, particularly for those early in a qualitative research career” (Braun and Clarke, 2006, p.80).

Moreover, for Braun and Clarke, the researcher cannot just passively give voice for their data nor conduct their research based on “one ideal theoretical framework” (2006, p.80). Rather, they continue, “what is important is that the theoretical framework and methods match what the researcher wants to know, and that they acknowledge these decisions, and recognize them as decisions” (Braun and Clarke, 2006, p.80).

Also, Braun and Clarke argue that thematic analysis should be “the first qualitative method of analysis that researchers should learn, as it provides core skills that will be useful for conducting many other forms of qualitative analysis” (2006, p.78). Qualitative research methods can vary widely but thematic analysis process can be found among different approaches in qualitative research (Braun and Clarke, 2006, p.78).

Braun and Clarke (2006) identified a set of decisions to be made by the researcher before carrying out a TA approach as a qualitative research method.

First, the researcher must define what counts as a theme as themes must “capture something important in relation to the overall research question and represents some level of patterned response or meaning within the data set” (Braun and Clarke, 2006, p.82). For instance, a theme does not have to be quantifiable to be regarded as a theme (Braun and Clarke, 2006, p.82).

Thus, the question of the prevalence of a theme can be considered in different ways: by counting where the topic appears in the entire data set, whether it comes across from different speakers or even if it comes out in each individual data item (each interview, for example) (Braun and Clarke, 2006, p.82).

The second step is to choose the type of analysis that is going to be done: a rich thematic analysis of the entire data set or “a more detailed and nuanced account of one particular theme, or group of themes, within the data” (Braun and Clarke, 2006, p.83). Choosing one or another depends on the type of research being conducted. For example, for topics under researched or when interviewees’ views are yet not well known, an overall analysis is recommended (Braun and Clarke, 2006, p.83), whereas for studies focused on a specific question (or questions) a detailed analysis of certain themes can be more effective (Braun and Clarke, 2006, p.83).

The next step is defining an approach to identifying a theme. How a theme is defined has consequences for the way the data is coded, and why it is being coded in that way (Braun and Clarke, 2006, p.84).

Thus, according to Braun and Clarke, a theme can be defined either inductively or deductively (2006, p.83). An inductive approach for identifying a theme is data-driven, which means that the research question can develop from the data itself and is not based on any previous coding framework or analytical notions held by the researcher (Braun and Clarke, 2006, p.83 and 84). In contrast, the deductive way is linked to the analytic interest of the researcher, which means that the coding process is made with a specific research question in mind (Braun and Clarke, 2006, p.84 and 89).

Also in the TA, the level at which a theme is identified must be defined, either semantic or latent. The first level identifies a theme by its explicit meaning while the latter scrutinises

“the underlying ideas, assumptions, and conceptualizations - and ideologies - that are theorized as shaping or informing the semantic content of the data” (Braun and Clarke, 2006, p.84).

Finally, the TA “can be conducted within both realist/essentialist or constructionist paradigms” (Braun and Clarke, 2006, p. 85). As mentioned before, the TA is not linked to a theoretical framework and, therefore, is more flexible and can be compatible with both paradigms (Braun and Clarke, 2006, p.78).

For this study, a realist paradigm was used when conducting the TA as the data collected is relatively straightforward and the research question aims to describe a phenomenon.

In this study, the six phases of analysis proposed by Braun and Clarke (2006, p. 87) were used. After familiarizing myself with the data (the interviews), the initial coding and thematic framework was made manually in Microsoft Word using the method created by Jaroslaw Kruikow (Kruikow, 2020).

For coding and data analysis, a deductive approach was used as the main research questions served as guidelines to define the main themes in the interviews. Additionally, a detailed analysis of the themes related to the research questions was opted for independently of where or how many times they appear through the data set.

### 3. Literature Review

This review of the literature is divided into three main topics: (1) technical and tools development (where the evolution of the IIF in terms of its functionalities and tools is presented), (2) Perspectives on the IIF (where different professional opinions and views on the IIF from 2011 to the present time are considered), (3) Trends in library infrastructure and services and (4) A summary of the chapter.

#### 3.1 The IIF's technical and tools development

Since its conception in 2011, the IIF has been developed in terms of its functionalities and tools. With the original aim of addressing the limitations of online web applications for hosting digital images from CHI silos, the IIF has been adopted as a solution for institutions that lack more sophisticated tools for image analysis and comparison as well as capacity for updating digital images management systems (Snydman, Sanderson e Cramer, 2015). In 2015,

the IIF was defined by its founders as a set of common APIs for image and metadata delivery as well a supporter of the development of image delivery and comparison software (Snydman, Sanderson and Cramer, 2015).

That said, a community of developers as well as institutions with content repositories started building tools employing the IIF standards (Ying & Shulman, 2015). Early on, the community realized the need to improve the IIF's technicalities and functionalities related to authentication and authorization, search within an object, and open annotation (Ying & Shulman, 2015).

### 3.1.1 The IIF ecosystem

As mentioned before, the problem that the IIF is trying to solve is the way each institution delivers images on the web, each of them having their own image server and viewer. This translates into the creation of institutional silos and conditions the way users view and interact with their digital objects.

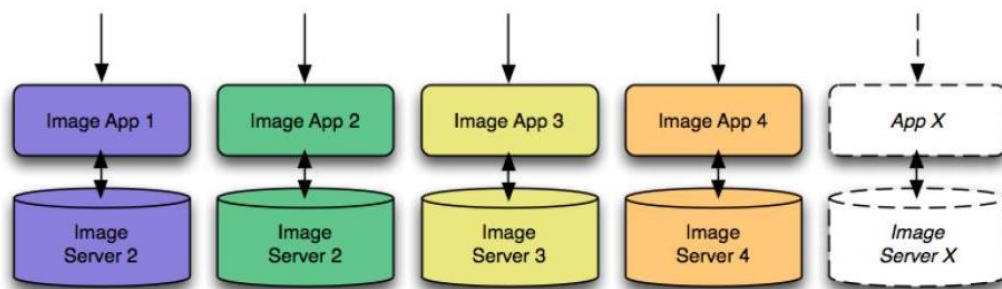


Figure 2 – Individual closed ecosystems consisted in image servers and clients (Snydman, Sanderson & Cramer, 2015).

The IIF ecosystem, however, propose a different approach to the delivery of digital objects in which tackles users' and institutions' needs:

*Table 3 - Users and institutions needs regarding digital image delivery on the web.*

<b>What do users and institutions want and/or need?</b>	<b>What do institutions want and/or need?</b>
<ul style="list-style-type: none"> <li>• Ability to contextualize images from across collections and institutions.</li> <li>• Actively engage with images - deep zoom, pan, annotate.</li> <li>• Combine images from across the world in one space-</li> <li>• Be free to use the image viewer of choice.</li> <li>• Cite and share work - confidence in stable image URLs</li> </ul>	<ul style="list-style-type: none"> <li>• Make images highly available and open but in a standardized and extensible way.</li> <li>• The ability to load/transfer large, high-resolution images easily without server overwork with a view not only to openness and access but data persistence and longevity.</li> <li>• System flexibility.</li> <li>• Publish once, reuse often.</li> </ul>

(Reed, 2018. Source: <https://training.iiif.io/iiif-5-day-workshop/day-one/iiif-introduction.html>)

Through IIIF APIs, the incompatibility of image resources can decrease and therefore digital objects and data become sharable and interoperable (Snydman, Sanderson & Cramer, 2015). Additionally, the IIIF Restful APIs work as layers between their data servers and applications allowing the same data and metadata to be used on different applications with different purposes (Snydman, Sanderson & Cramer, 2015).

## APIs -> Framework -> Ecosystem

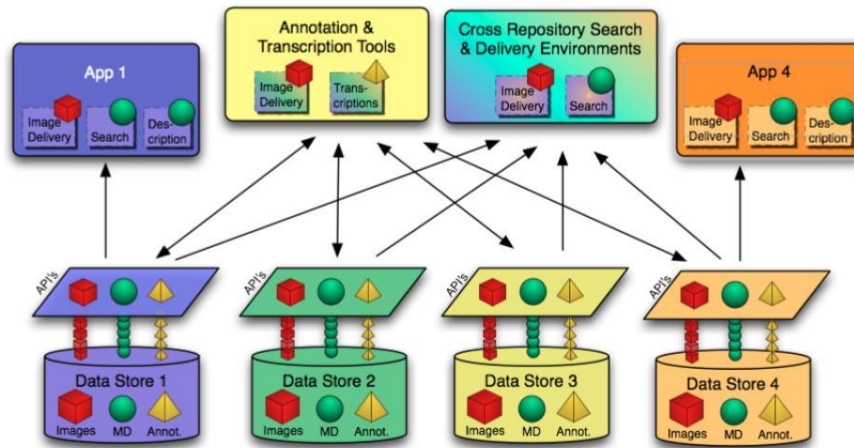


Figure 3 – Multiple servers connecting to different application through common APIs (Snydman, Sanderson & Cramer, 2015).

In addition, the IIIF makes it easier for the providing institution to maintain control over the representation of their content thanks to the interoperability of shared APIs. This is because control of what is being shared with third institutions is granted to the provider institutions (ARMA Consortium, 2022, p.5). It also makes the use of hard disks to distribute the digital resources unnecessary for those institutions that want to contribute to specific digital projects or platforms (ARMA Consortium, 2022, p.5).

Nevertheless, the fact that the IIIF-compliant images can be viewed in any compliant platform can lead to the transformation of the original institution's function of providing access to their resources to become one more platform where their digital objects can be located (Babcock & Di Cresce, 2019, p.189).

### 3.1.1.1 IIIF APIs

The IIIF consists of two main APIs (Raemy, 2020, p.18). These two core IIIF APIs, Image API and the Presentation API, are based on a single data model called Shared Canvas (Frunzeanu, Robineau and MacDonald, 2016, p.127) that “specifies a linked data-based approach for describing digital facsimiles of physical objects” (Sanderson & Albritton, 2013).

Additionally, there are four other APIs in their first versions: Authentication API, Content Search API, Change Discovery API and Content State API (IIIF, 2021a). They are all web-based servers serialized in JSON-LD (JSON-Linked Data) (Raemy, 2020). The Content State API is in the beta version (IIIF, 2021a).

Through the survey called “alternative aggregation mechanisms” conducted for his Master’s thesis, Raemy asked 52 participants about their experience implementing the IIIF APIs, among other questions (Raemy, 2020, p.37). The conclusion reached was that the most-implemented API is the Image API with 21.2% while the Presentation API has a rate of 19.9% implementation (Raemy, 2020, p.37). The IIIF presentation API only works in combination with the Image API, since in order to implement the IIIF presentation API, institutions must implement the Image API (Raemy, 2020, p.37). Raemy confirms this since he found that all the institutions that implemented the IIIF presentation API also had implemented the Image API (Raemy, 2020, p.37).

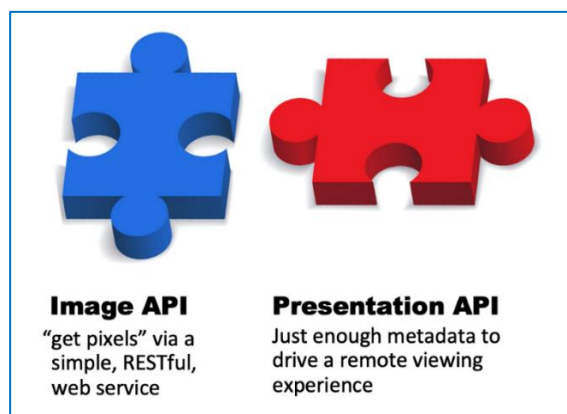


Figure 4 - IIIF core APIs: Image API and Presentation API (Source: <https://training.iiif.io/iiif-5-day-workshop/day-one/presentation-api.html>)

In fact, with the Presentation API only, the images rendered by the Image API become connected to other types of data, adding value to it (Porena, 2019, p.19).



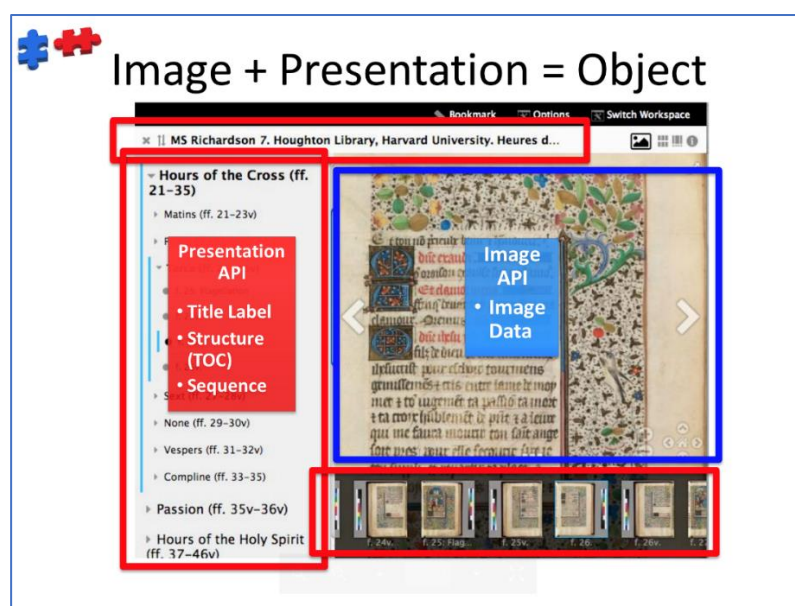


Figure 5 – Representation of the Presentation API elements (red squares) and the Image API elements (blue square) in the viewer (Source:<https://training.iiif.io/iiif-5-day-workshop/day-one/presentation-api.html> ).

### 3.1.1.1.1 Image API

The Image API provides access to the image content (*pixels*) and technical descriptions, allowing the user to ask for images with different sizes, formats, and qualities by specifying a web service that returns an image in response to a standard HTTP or HTTPS<sup>6</sup> request (Snydman, Sanderson and Cramer, 2015). In other words, the Image API allows requests of different versions of a single high-resolution image.

In IIIF-compatible digital collections, images are fetched via the IIIF Image API whose syntax is defined as follows:

*{scheme}://{server}/{prefix}/{identifier}/{region}/{size}/{rotation}/{quality}.{format}*

For example: [https://iiif.archivelab.org/iiif/shere-shah\\_202107/full/512,/0/default.jpg](https://iiif.archivelab.org/iiif/shere-shah_202107/full/512,/0/default.jpg)

However, different hosts have different levels of IIIF Image API compliance. In total, there are three level of compliance: 0, 1 and 2. The level of compliance sets the parameters and

<sup>6</sup> Placing server resources on https prevents images and manifests being requested with mixed content issues. A mixed content issue is described as “a scenario when a user visits a site hosted over HTTPS and that page then requests content hosted over HTTP” (Reed, 2017). Other benefits of hosting the content on https are: (1) the assurance that only requested content will be delivery to the user, (2) the assurance of privacy for the users, making traffic data between user and the server private, (3) the optimization of search engines in which https websites and content are identified as high-quality material (Reed, 2017).

features implemented. Level 0 is the minimum required to implement IIIF standard services while level 1 is the recommended level. In the example below, the image is stored at Internet Archive, which is IIIF level 2 compliant, allowing images to be rotated 360 degrees:

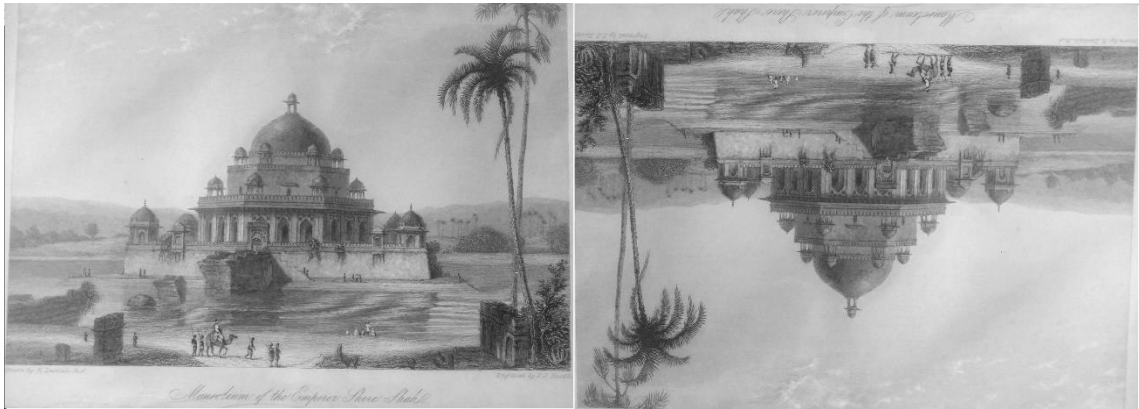


Figure 6. On the left, the Image rotated at 0 degrees: [https://iiif.archivelab.org/iiif/shere-shah\\_202107/full/3212/0/default.jpg](https://iiif.archivelab.org/iiif/shere-shah_202107/full/3212/0/default.jpg) and at right, the same image is rotated at 180 degrees: [https://iiif.archivelab.org/iiif/shere-shah\\_202107/full/3212/180/default.jpg](https://iiif.archivelab.org/iiif/shere-shah_202107/full/3212/180/default.jpg) (©Cecília Pitta).

In order to know which parameters of the image can be rendered by the server, the json file with information on the image can be requested through the following syntax:

*{scheme}://{server}/{prefix}/{identifier}/{info.json}*

For the image shown in Figure 6 it will return the following json file:

```

{
  "@context": "http://iiif.io/api/image/2/context.json",
  "@id": "https://iiif.archivelab.org/iiif/shere-shah_202107",
  "height": 2298,
  "profile": [
    "http://iiif.io/api/image/2/level2.json"
  ],
  "protocol": "http://iiif.io/api/image",
  "tiles": [
    {
      "scaleFactors": [
        1,
        2,
        4,
        8,
        16
      ],
      "width": 256
    }
  ],
  "width": 3212
}

```

Figure 7. An `info.json` file at [https://iiif.archivelab.org/iiif/shere-shah\\_202107/info.json](https://iiif.archivelab.org/iiif/shere-shah_202107/info.json). The profile line (highlighted) specifies the API version (2) and the compliance level (level 2). The tiles are also highlighted (see below (© Cecília Pitta).

The `info.json` file also determines how the Manifest is going to respond to a certain zoom request. This means that it will return smalls regions, known as tiles, according to the available dimensions. For the image shown above, the scale factors set are 1, 2, 4, 8 and 16:



Figure 8. Scale factor 16 (© Cecília Pitta).

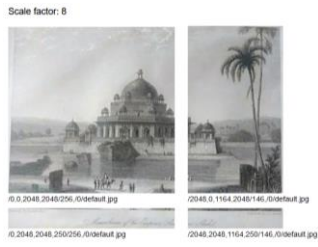


Figure 9. Scale factor 8 (© Cecília Pitta).

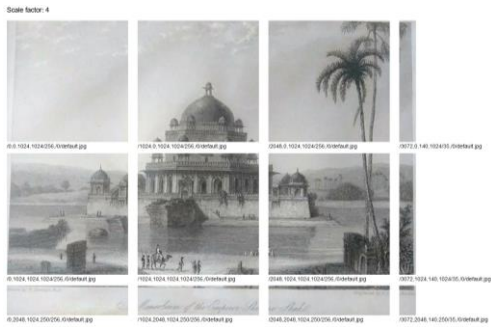


Figure 10. Scale factor 4 (© Cecília Pitta).



Figure 11. Scale factor 2 (© Cecília Pitta).

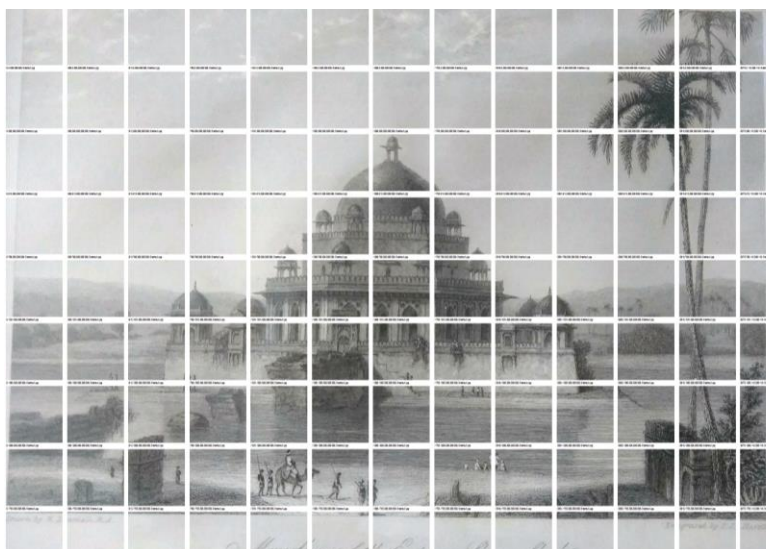


Figure 12. Scale factor 1 (© Cecília Pitta).

#### 3.1.1.1.2 Presentation API

Presentation API provides structural and descriptive metadata about images such as image sequence, display labels, licensing, attribution, and links to “more information” (Syndman, Sanderson and Cramer, 2015). In other words, the Presentation API enables the interoperability of metadata by providing in a standard way a “description of the structure and properties of the digital representation of an object [...] needed for the viewer to present the digitized content to the user” (Witt, 2018). This description is known as an IIIF Manifest, which may also be thought of as a representation (or layout) of an object with its structure and properties (Babcock & Di Cresce, 2019, p.186).

The Presentation API is based on the Shared Canvas Data Model whose goal is to provide a standardized description of the digital resource (Sanderson & Albritton, 2013). This model is based on a single structure which can render the digital object and its basic metadata in a logical sequence to any repository (Sanderson & Albritton, 2013).

Moreover, this model is built on the idea that any repository can have information about an object, not just the one that holds it (Sanderson & Albritton, 2013). This means that the model makes room for further digitization or better description by allowing, for example, the insertion of descriptive metadata through annotation or the insertion of a lost page of a manuscript (Sanderson & Albritton, 2013). This is possible because it is based on Linked Open Data dynamics that allow layers of information to be included through annotations.

However, a person annotating a Manifest owned by another entity cannot do this directly because the Manifest cannot be edited (Crane, 2017). Instead annotations are created “using the identity and coordinate system you have established for your canvas by your act of publishing it in a manifest”(Crane, 2017) make annotations for their private use without publishing them while combining them with the Manifest and its canvas in their presentation (Crane, 2017). Institutions may, if they like, incorporate those annotations into the Manifest (Crane, 2017) as “the Canvas and all the annotations of content onto it, are interoperable, and part of the web of linked data” (Crane, 2017).

More specifically, the Presentation API is built on the W3C Web Annotation Data Model which puts resources together in the abstract canvas (Crane, 2017). The definition of the Web Annotation Data Model is as follows:

*An annotation is considered to be a set of connected resources, typically including a body and target, and conveys that the body is related to the target. The exact nature of this relationship changes according to the intention of the annotation, but the body is most frequently somehow "about" the target. This perspective results in a basic model with three parts, depicted below. The full model supports additional functionality, enabling content to be embedded within the annotation, selecting arbitrary segments of resources, choosing the appropriate representation of a resource and providing styling hints to help clients render the annotation appropriately. (Source: <https://www.w3.org/TR/annotation-model/>).*

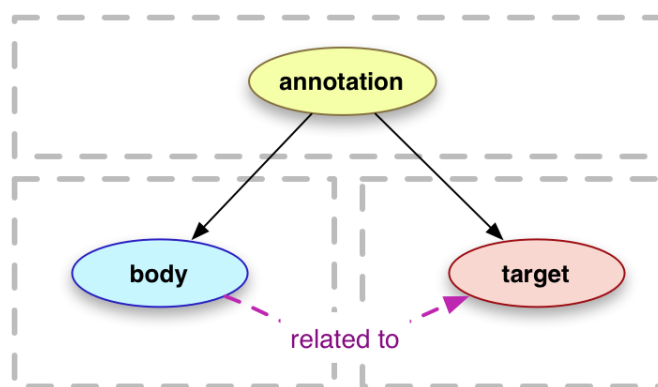


Figure 13 - Web Annotation Data Model by the W3C (Source: <https://www.w3.org/TR/annotation-model/>).

Frequently, the shared canvas is compared to a PowerPoint where images and texts can be juxtaposed on a slide:

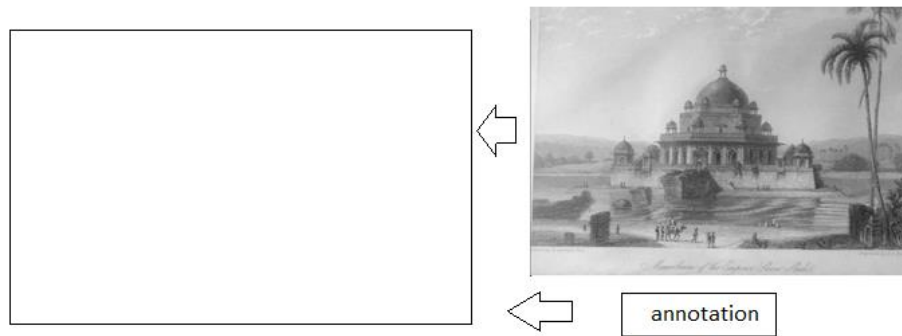


Figure 14. Image and annotation (right) can be painted onto a canvas (left) (© Cecilia Pitta).

Nevertheless, annotation is any content annotated onto the canvas, including the image (Crane, 2017). In other words, any content that the “user ever sees rendered by a viewer - images, text and other content - is associated with the virtual space of the canvas via the mechanism of annotation” (Crane, 2017).

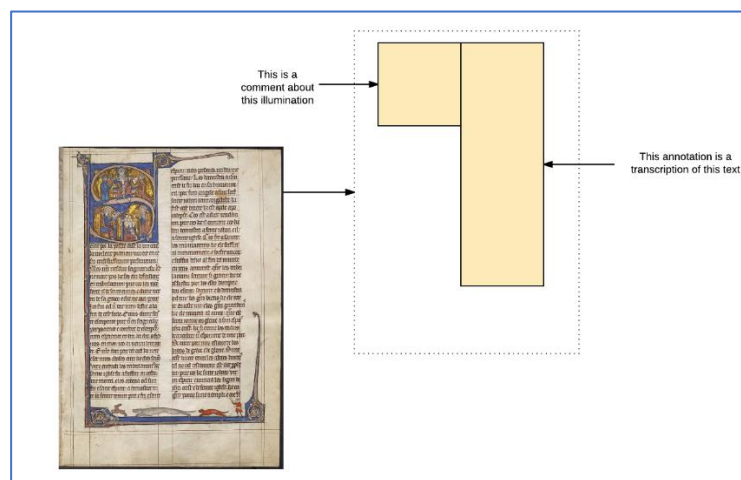


Figure 15 – A shared canvas and annotations (Crane, 2017).

A manuscript or a book is a Manifest with different canvases (representing a page) that usually have one image annotated each (Crane, 2017). This means that, as mentioned before, a lost page of a manuscript or a book may be incorporated through the model (Sanderson & Albritton, 2013).

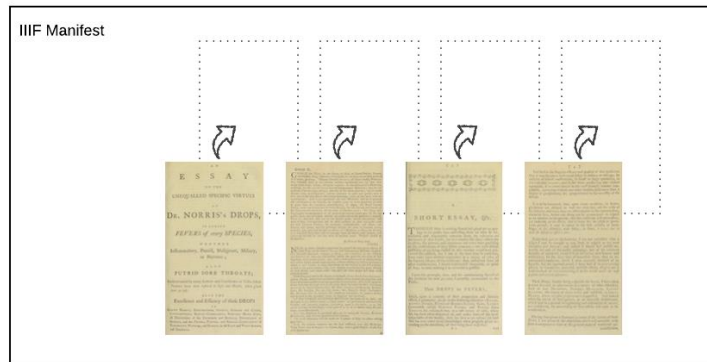


Figure 16 – An IIF Manifest with four canvases, each with one annotation (a page) (Crane, 2017)

However, different parts of the same page can be dispersed, or a folio can be missing a section. Therefore, in the same canvas, it is possible to reunite the parts that are known and create an annotation for the missing piece.

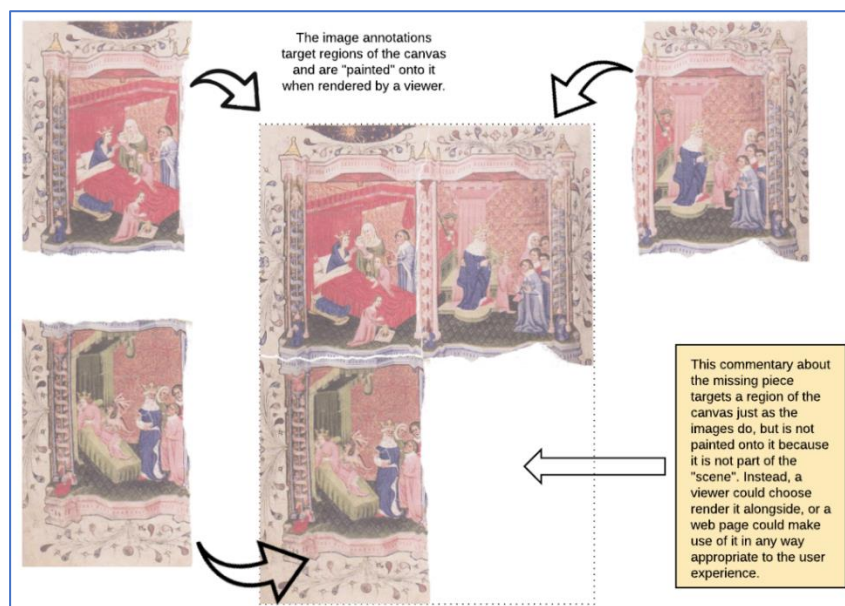


Figure 17 - A canvas with different annotations (Crane, 2017).

Although “this approach might work well to help represent provenance for collections that have been broken up across multiple institutions” (Magnuson, 2016) inserting resources “from other collections might skew the authentic representation of some collections, even if the objects are directly related to each other” (Magnuson, 2016). Nevertheless, in this way, researchers do not need “to visit and keep track of multiple repositories that contain similar collections or associated objects” (Magnuson, 2016).



The Presentation API is a model that enables the transmission of the digital object and each digital object is interpreted by the model through its different features (Porena, 2019, p.19 and 20) or resource types. The main element in the Presentation API is the Manifest (Porena, 2019, p.20).

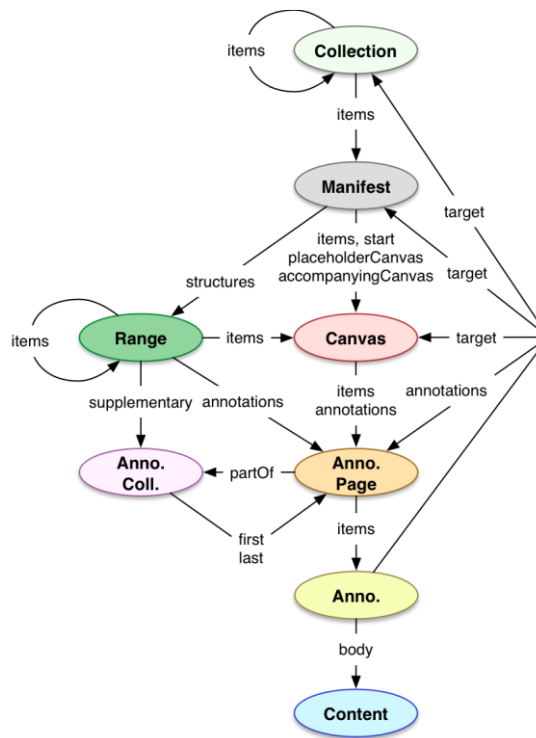


Figure 18 – The Presentation API model consists of the different resource types for the digital object (IIIF, Presentation API 3.0).

Although it is recommended that institutions present their resources in a common way, “an object described by the Presentation API could be rendered by a conventional bookreader style viewer, loaded into a scholarly workbench application for annotation, displayed as an explosion of thumbnails, projected into a virtual space, rendered as minimalist web pages, remixed into multimedia presentations, worked into online exhibitions [...]” (Crane, 2017) and other forms of display.

However, the IIIF makes images interoperable and available for different users to classify and annotate them in their own way. The metadata associated with an IIIF-compliant image is readable by humans only (Hiltmann & Schneider, 2020). Thus, it is not semantically readable by machines and *discovery is not directly supported* (IIIF, 2021b).

### 3.1.1.1.3 IIIF Manifest

Technically, an IIIF Manifest is a lightweight text file in JSON-LD (Roddis, 2020) that is “loaded by a viewing software rendering the content to humans” (Crane, 2018). It provides the structure and description of the digital representation and presentation of the digital object.

The structure of a Manifest is made up of items,<sup>7</sup> a canvas, range and content resource (IIIF Presentation API 3.0, 2021). These elements may be defined as follows:

- Sequences: Sequences or items are related to the order in which an object is viewed;
- Canvas: an abstract space in which different content resources are associated through annotations;
- Range: An ordered list of Canvases;
- Content resource: images or texts associated through annotations

The Manifests can also be assembled into a Collection. A Collection is used either as a list of manifests available for viewing or to navigate the hierarchies of manifests (IIIF, Presentation API 3.0). It can also be provided to the user as a set of search results (IIIF, Presentation API 3.0).

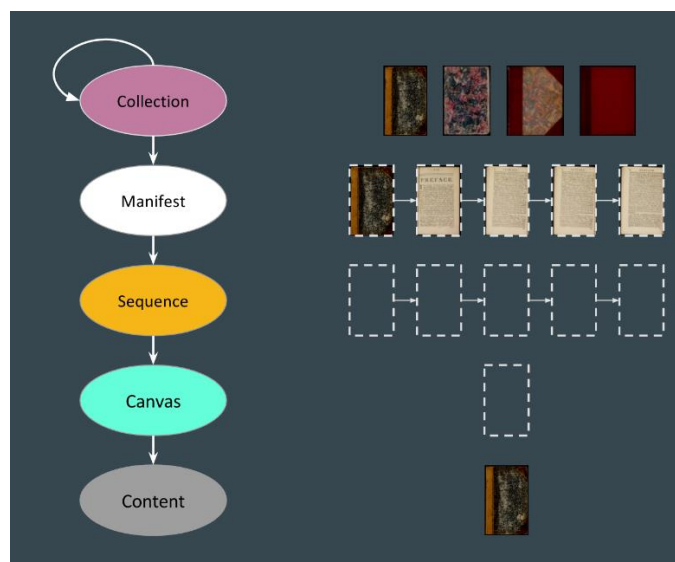


Figure 19 – A diagram illustrating a collection of manifests and a manifest and its properties (Ronallo..., n.d.).

<sup>7</sup> In previous Presentation API versions, items were called sequences (IIIF Presentation API 2.1).

Moreover, a JSON-LD is a JavaScript file in which there is a *context* to be used in RDF systems<sup>8</sup> (Santarém Segundo *et al*, 2019, p.80). In the JSON-LD file, the linked data “gateway” is located on the first code line:

```

@context: "http://iiif.io/api/presentation/2/context.json"
  @id: "https://cpitta.github.io/testone/manifests/shere_manifest.json"
  @type: "sc:Manifest"
  label: "William Daniell RA, 1769-1837, Mausoleum of the Emperor Shere Shah"
  service:
    profile: "http://iiif.io/api/search/0/search"
    @id: "http://sas.gdmrdigital.com/search-api/4be18d7c616fc5c2a22c6c3a28eb13e2/search"
    @context: "http://iiif.io/api/search/0/context.json"
  metadata: []
  description:
    @:
      @value: "Drawing of Mausoleum of the Emperor Shere Shah by W. Daniell RA. Engraved by E. J. Harris"
      @language: "en"
  license: "https://creativecommons.org/licenses/by/3.0/"
  attribution: "W. Daniell RA"
  sequences:
    @:
      @id: "http://4fce4665-9624-4c0e-be20-2c494c2521ed"
      @type: "sc:Sequence"
      label:
        @:
          @value: "Normal Sequence"
          @language: "en"
      canvases:
        @:
          @id: "http://1c901edd-8bfa-4e68-bdb7-43bcc84a1b99"
          @type: "sc:Canvas"
          label: "19th century print by W. Daniell RA"
          height: 2298
          width: 3212
          images:
            @:
              @context: "http://iiif.io/api/presentation/2/context.json"
              @id: "http://ffe343c8-f632-4f84-8cb1-55edee945a97"

```

Figure 20 JSON-LD file. Context value highlighted (©Cecilia Pitta).

### 3.1.1.1.4 Other APIs

The IIIF has four more APIs that can be implemented:

- Search API: allows annotations such transcriptions, commentaries, or OCR to be searched within the manifest or collection. The annotations are integrated as a layer into the manifest they are related to (see 4.1 below: “Creating and publishing an IIIF Manifest”). The search API does not search for metadata.
- Authentication API:<sup>9</sup> offers restriction over access to specific aspects of the displayed object. The access can be given to the end-users by a term agreement,

<sup>8</sup> “JSON-LD is primarily intended to be a way to use Linked Data in Web-based programming environments, to build interoperable Web services, and to store Linked Data in JSON-based storage engines” (W3C, 2020).

<sup>9</sup> The IIIF was built on the understanding that institutions have their limitations regarding sharing content (copyrights, internal policy, etc.) (Padiefield, 2021). Therefore, institutions can limit who can access their content

cookies, login credentials or IP address (Crane, 2016). The choice of control system is the choice of the provider, and does not have to be known to the IIIF client (Crane, 2016).

- Change Discovery API: it provides information needed to discover IIIF resources and the location of the system to crawl and harvest (Appleby et al, 2021). It allows providers to signalize changes in the resource that are read by the systems that leverage it.
- Content State API: it provides a description of the Presentation API resources (a Collection or a Manifest), or part of a resource (part of a Manifest), that can be readable or shared by any viewer client or application (Appleby et al, 2021). This API is currently in development.

#### 3.1.1.1.5 IIIF API challenges

Though the IIIF APIs' strengths reside in the form of presentation for the end-users, they are not designed to support metadata aggregation (Freire, 2017, p.239). However, studies on how digital resources can be aggregated by web technologies are being conducted (Freire *et al*, 2017; Freire *et al*, 2020). They have responded to the rejection of aggregation technologies such the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH), which is expensive and was conceived before the principles of the semantic web had been established (Raemy, 2020, p.1; Freire *et al*, 2017, p.237).

Moreover, the IIIF resources (images) and resource types (manifests, sequences, canvases, annotations, annotation lists and content resources) have their unique URIs, which means they can be either a subject or an object in the Linked data context (Loh, 2017, p.53). However, the IIIF Presentation API does not directly support semantic tagging (Loh, 2017, p.53). According to Loh (2017), "the Presentation API could also benefit from stricter adherence to Semantic Web standards and ontological models like RDFS and OWL to promote even greater interoperability and server-side adoption" (Loh, 2017, p. 55).

Furthermore, the Presentation API lacks a specification of rules or definitions regarding the metadata associated with an object (Manoni, 2022, p.314). Although, the

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and make certain versions of the content available (e.g. with a particular size, color, resolution, etc.). This also allows the institutions to know where and how their resources are being used (Padiefield, 2021).

information/description is readable by humans, a client application cannot understand what the manifest is exactly (Meeus *et al*, 2021, p.13). Thus, the discoverability of manifests using domain-specific metadata can be a challenge. One way to tackle this problem is using the `seeAlso` property within the Manifest (Meeus *et al*, 2021, p.13) which is machine-readable. (ARMA Consortium, 2022, p.31).

Bruges Public Library, Ghent University Library, Major Seminary Ten Duinen in Bruges and Ghent Diocese are collaborating in the Mmmonk project to provide access to 820 extant medieval manuscripts (About, n.d). The Mmmonk project uses the IIIF to gather and present images and metadata from those manuscripts in a custom collection-building effort (KRB, 2022; About, n.d.).

As part of the project, they developed a proof-of-concept experiment that consists in aggregating IIIF metadata through the IIIF manifests with the goal of understanding if it is possible to browse and to search metadata from IIIF manifests in their platform the same way as they do with images (KRB, 2022).

As is already known, the IIIF is not commonly used to share metadata (KRB, 2022). In fact, metadata in the IIIF manifests provides context and it is not meant to be aggregated (KRB, 2022). As mentioned before, institutions are free to define the IIIF manifest labels as they see fit, which causes a variation in labelling and metadata enrichment (KRB, 2022). In addition, a standardization of metadata is lacking, and most institutions insert minimal metadata, which can create ambiguity and affects metadata search and search filters (KRB, 2022).

For their experiment, the Mmmonk project built an ingest module into their craft CSM that enables the insertion of IIIF manifests, which follow a set of rules for metadata mapping, of 800 manuscripts owned by the project partners (KRB, 2022). However, 120 manuscripts come from other institutions that do not follow the same rules and, consequently, the metadata within the IIIF manifests varies (KRB, 2022). Specifically, in this case, date and provenance metadata have a high degree of variation (KRB, 2022).

As result, the metadata from the 120 IIIF manifests was manually validated, and extra rules had to be deployed in the ingest process, which for a small experiment was doable (KRB, 2022).

Through surveys with users, they realised that providing IIIF metadata displayed alongside images, among other items, is an advantage (KRB, 2022). However, metadata is still a “background thought” within the IIIF community and it is important to make metadata a tool for research and not only for contextualization (KRB, 2022). The SeeAlso reference link, a suggestion by the IIIF cookbook for non-IIIF machine structure metadata files, is not yet used by small institutions (KRB, 2022). One recommendation to tackle the problem of the discoverability of items is to “invest in SEO as Google remains the main entry point for searches” (ARMA Consortium, 2022, p. 20).

Nevertheless, at this moment, the experiment by the Mmmonk does not aggregate metadata automatically. Only through manual checking and validation are they able to do so (KRB, 2022).

Another challenge regarding the nature of the IIIF APIs is the permission of users to insert new elements into IIIF manifests without the consent of the provider (Kitamoto, 2019; Regimbal et al., 2020, p.17). To tackle this problem, the IIIF Curation Platform was created with the goal of allowing researchers to create their own image collections. This is accomplished by building “a new structure from the outside of the manifest, which is the root node in the IIIF Presentation API, and create an inbound link to an appropriate element within the manifest” (Kitamoto, 2019). Likewise, the team responsible for an online square-notation music editor, Neon (based on the International Image Interoperability Framework (IIIF) and the Music Encoding Initiative (MEI) file format) (Regimbal et al., 2020, p.15), created a similar mechanism called “Neon Manifests” (Regimbal *et al.*, 2020, p.16).

### **3.1.2 Image Viewers**

Regarding image viewers, many feature IIIF compatibility, including the Universal Viewer (previously known as Wellcome Player), Mirador, Leaflet, OpenSeaDragon, Internet Archive, BookReader, IIPMOOViewer, OpenLayers and Omeka (Snydman, Sanderson and Cramer, 2015; Emanuel, 2017, p.5). In this section I will focus on Mirador and Universal Viewer as the teams behind these image viewers collaborate regularly (Raemy, 2017, p. 30).

Mirador is an open-source, web-based, image viewer based on pre-existing library software (Van Zundert, 2018, p.5) created by a group of developers, mainly from Harvard and Stanford universities (Van Zundert, 2018, p.5; Frunzeanu, Robineau and MacDonald, 2016,

p.127; Emanuel, 2017, p.5) to tackle “the needs of Art History and Manuscripts scholars at Stanford University” (Raemy, 2017, p.34 citing Reed, 2017). Considered as “one of the leading image viewing applications that implements the IIIF protocols” (Frunzeanu, Robineau and MacDonald, 2016, p.127), Mirador is usually described as a multi-window workspace where image-based resources from different repositories can be zoomed, compared, annotated and shared (Frunzeanu, Robineau and MacDonald, 2016, p.127; Carvalho, 2019, p.45; Emanuel, 2017, p.5).

Similarly, the Universal Viewer (UV) was built originally for the Wellcome Library’s Digital Delivery System and it supports Open Seadragon, DZI, PDF and audio-visual assets (Raemy, 2017, p.30 & 33). It enables zooming; single, two-up page view, or gallery; downloading, sharing and embedding, thumbnails, indexing, and other features (Raemy, 2017, p.32). Unlike Mirador, however, it lacks annotation and image manipulation tools (Raemy, 2017, pp.32 &35).

In 2017, usability tests were conducted with members of the Swiss national platform for scientific editions. The conclusion was that both Universal Viewer and Mirador are excellent tools on the usability scale and from a user-experience perspective (Raemy, 2017, pp.60-61), even though refinements are needed (Raemy, 2017, pp.64-66).

Since an IIIF-compliant viewer connects directly to the IIIF manifest to render an image from an institution’s digital repository, they have great advantages: (1) the digital objects from other institutions do not need to be stored and managed by the receiver institution, (2) institutions that share digital objects do not need to make low resolution copies, instead they can access high-resolution files with IIIF manifests, (3) the IIIF-compliant viewer makes it possible to view multiple images from the same or different repositories at the same time, (4) downloads for the sharing or customization of the objects are no longer needed since they can be done directly in the viewer and (5) users can make annotations that can be saved and shared (ARMA Consortium, 2022, p.9).

However, “embedding IIIF viewer capabilities into existing [proprietary] applications” is a difficult task (Magnuson, 2016).

### 3.1.3 The IIF and Displaying Research and Educational Tools

In 2016, the University of Toronto created the Digital Tool for Manuscript Study project with the goal of simplifying digital manuscripts research (Di Cresce, 2020). As part of this project, the IIF Toolkit was developed to be used as a plugin to Omeka Classic<sup>10</sup> that ingests IIF content, allows metadata addition and embeds Mirador viewing, among other functionalities. Omeka Classic is widely used by researchers, professors, and students at the University of Toronto as a research and teaching tool (Di Cresce, 2020). The IIF Toolkit is also potentially usable by small institutions that already use Omeka to showcase their collections or create exhibitions with outside resources without financial constraints (Di Cresce, 2020).

Likewise, the University of St. Andrews (UK) created the Exhibit tool that enables the creation of digital exhibitions using IIF Manifests (Towards a National Collection, 2021a). This project unfolded during the Covid-19 pandemic, which led to the closure of universities and classes and their move to the online environment (Towards a National Collection, 2021a). The goal was to provide an experience of handling old books similar to that found in the classroom. To that end, a scrolling tool was created (Towards a National Collection, 2021a).

Also, at the University of Ghent, students were taught about Digital Humanities through the creation of exhibitions with Omeka S and IIF manifests with the support of the IIF server module from Omeka S and with the Madoc annotation and crowdsourcing platform for enrichment of the collections (Foket et al., 2022).

Likewise, at Leiden University Libraries (UBL) IIF viewers are used in classrooms by both students and teachers who can access high-quality images and metadata (ARMA Consortium, 2022, p.21).

As part of a project to restore the Raphael Cartoons, marking 500 years since the painter's death (2019), all seven cartoons displayed at the Victoria & Albert Museum (V&A) were digitalized (Towards a National Collection, 2021b). The images and associated data were

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<sup>10</sup> "Omeka Classic is a web publishing platform for sharing digital collections and creating media-rich online exhibits" (<https://omeka.org/classic/>).



catalogued in a structured way with the aim of preservation and to support “inward collaborative research” efforts (Towards a National Collection, 2021b).

The cartoons were digitized in high-resolution color, infrared and 3D surface scans which led to the design of a new interpretative approach for access to the images in person and online (Towards a National Collection, 2021b). To this end, the V&A built specialized interactable viewers based on IIIF for image study (Towards a National Collection, 2021b).

These viewers enable the exploration of images through IIIF manifests that carry and display annotations, links and structured data (Towards a National Collection, 2021b). One of the viewers enables the different types of resolution layers to be compared while a second viewer enables comparison of similar images made with different techniques using a different layering tool (Towards a National Collection, 2021b). The V&A is using IIIF Image API to align images on the fly,<sup>11</sup> and in doing so, is eliminating images derivatives (Towards a National Collection, 2021c).

These cartoons, now available as IIIF manifests, can also be viewed on other IIIF-compliant viewers like Mirador (Towards a National Collection, 2021b). Also, the cartoons can be compared to the tapestries they were created for as the Vatican Museum (that owns them) also provides IIIF manifests (Towards a National Collection, 2021b).

To address the process by which researchers in the humanities create digital collections, the Central Library in Zurich created a tool for collecting and sharing digital resources (Keller & Kreyenbühl, 2022). Usually, researchers in this area collect different files formats, including pictures of analogue objects, that are stored and managed with different tools like google docs, excel, pdf, pen drives, and others (Keller & Kreyenbühl, 2022).

To improve the user experience, the Central Library developed a prototype for collecting and sharing IIIF manifests through `detektIIIF` plugin, which detects IIIF resources on any website (Keller & Kreyenbühl, 2022). Through the plugin, the user can open their manifests in a Mirador viewer workspace (Keller & Kreyenbühl, 2022).

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<sup>11</sup>. The capture and alignment of different spectral bands of a single image is called image registration. For more on image registration and IIIF discussion, see <https://tanc-ahrc.github.io/IIIF-TNC/seminar01.html> .

In addition, other IIIF-compliant tools for educational/research and exhibition purposes have been developed:

Table 4 - IIIF-compliant tools for educational and exhibition purposes

<b>Annona Storyboard viewer</b>	Developed by Niqui O’Neill, Annona allows the creation of stories from annotations.	<a href="https://training.iiif.io/iiif-online-workshop/day-four/annotations-annona.html">https://training.iiif.io/iiif-online-workshop/day-four/annotations-annona.html</a>
<b>Exhibit</b>	Developed by the University of St Andrews, the Exhibit tool allows the creation of exhibitions and storytelling with IIIF-compliant images	<a href="https://www.exhibit.so/">https://www.exhibit.so/</a>
<b>FromThePage</b>	FromThePage is a crowdsourcing platform that supports IIIF Presentation API and web annotation.	<a href="https://github.com/benwbrum/fromthepage/wiki/FromThePage-Support-for-the-IIIF-Presentation-API-and-Web-Annotations">https://github.com/benwbrum/fromthepage/wiki/FromThePage-Support-for-the-IIIF-Presentation-API-and-Web-Annotations</a>
<b>Omeka</b>	Omeka is an Open-source web publishing platforms that allows the creation and sharing of media-based online exhibitions and digital collections. Omeka has integrated an IIIF plugin.	<a href="https://omeka.org/">https://omeka.org/</a>
<b>Recogito</b>	Recogito is an open-source software, developed with aim of supporting collaborative semantic annotations of text and images including IIIF-compliant resources.	<a href="https://recogito.pelagios.org/">https://recogito.pelagios.org/</a>

<b>Storiis</b>	Created in 2017 for the IIF conference at the Vatican Library, Storiis is a digital storytelling tool developed by cogapp.	<a href="https://storiies.cogapp.com/">https://storiies.cogapp.com/</a>
<b>Transkribus</b>	The Transkribus platform automatically reads and transcribes handwritten and printed documents.	<a href="https://readcoop.eu/transkribus">https://readcoop.eu/transkribus</a>
<b>Wax</b>	Wax is a project that was designed to create scholarly exhibitions with a minimum computing principles.	<a href="https://minicomp.github.io/wiki/wax/">https://minicomp.github.io/wiki/wax/</a>

The IIF is also used for Wikimedia Commons (Wikimedia’s image server) (Paulter, 2018). Since November 2018, IIF manifests started being linked to Wikimedia or other Wikipedia resources (Paulter, 2018) through the Wikidata property “IIF Manifest” P6108 (Baskauf, 2022).

### 3.1.4 Other Tools compliant to the IIF

In terms of performance evaluation, researchers from Kyoto University Library and the University of Tokyo developed an application that measures and visualizes which IIF image regions (pixels) are most accessed by users, to enable platform administrators *to understand the detailed image usage* (Nishioka & Nagasaki, 2019, pp.308-310). This application functionality can enable others to know which areas of an image have been studied before and to analyse patterns of interactivity with the content (Nishioka & Nagasaki, 2019, p.311).

On the other hand, Fudan University Library’s digital collection Seal Stamping Catalogues is expecting that the Mirador annotation feature will help in their image recognition of seals in subsequent developments of their database (Xue et al., 2020, p.548).

### **3.1.5 IIF and Persistent Identifiers (PIDs).**

Some discussion around the IIF's sustainability has been taking place within the community. Although IIF technology addresses some of the sustainability issues around websites and projects through the digital surrogates (Toner et al., 2022, p.19), one of the concerns of those implementing the IIF concerns Persistent Identifiers (PIDs).

The assurance users need that digital objects will not disappear was discussed during the webinar "Persistent identifiers in IIF" (on 26 October 2021) as a part of the Towards a National Collection (TANC) project in the UK (Towards A National Collection, 2021e). One of the topics discussed was that it is arguable that responsibility for content created by users (either transcriptions or annotations) lies with the image providers. The panel for this webinar reached the conclusion that providing a way for users to keep their work while not demanding that institutions manage and provide objects outside of their scope is vital.

As explained before, IIF-compliant images and manifests follow a URI syntax. Some institutions have decided to incorporate a Digital Object Identifier (DOI) at the manifest level which safeguards the sustainability of individual IIF-compliant resources. Nevertheless, it fails to be granular enough (Raemy and Schneider, 2019, p.35).

Instead, Archival Resource Keys (ARKs) such as PIDs are being deployed as a better solution. They have been implemented with the IIF by the National Library of France (BnF) and Durham University Library, for example (Raemy and Schneider, 2019, p.35). ARKs are persistent links, 8 billion of which have been created by over one thousand institutions (including GLAMS) (Home, n.d.). An ARK's URL identification is designed to support long-term access and it follows a hierarchical identification of the object (About ARKs, n.d.).

### **3.1.6. IIF APIs Implementation Workflow**

In 2017, Jason Ronallo and Sara and Ben Brumfield elaborated a questionnaire that can be used as an initial guide to institutions thinking of implementing the IIF. This questionnaire includes questions on institutions' goals, the systems they have deployed, their public access and images policies, their dedicated resources and other IIF-specific questions.

In summary. for implementing the IIF. the following resources and skills sets are needed: (1) "someone capable of installing and configuring a compatible server" with the Image

API or a system administrator “who can set up and configure a normal web server” and (2), “someone who understands JSON, and can read and understand” the Presentation API “specifications to generate manifests for your collection objects” (Roddis, 2017).

Also, Raemy and Scheiner (2019) have elaborated a diagram, based on the IIIF recommendations and the IIIF Implementation guide by the Brumfield Lab (2017), that outlines the approach institutions might take when first planning on implementing the IIIF. This diagram identifies different steps towards IIIF implementation, from gathering information to site integration of IIIF content.

The implementation of IIIF specifications may vary according of the scale of a collection and/or institutions’ IT infrastructures (Roddis et al, 2020). Through the available literature, different approaches to IIIF implementation can be identified. However, the following description of an IIIF API implementation workflow is intended to be a general outline of the process.

Typically, CHIs use Digital Asset Management Systems (DAMS) or Image Management Systems (IMS) to capture, ingest/upload, store their digital surrogates, born digital objects and their associated metadata files (Terras, p.171, 2008a). Additionally, DAMS can also enable transformation/conversion of data, data management, search and loading/retrieval requests by authorised users (Terras, p.171, 2008a).

Moreover, within IIIF implementation, DAMS are still considered “very useful in the pipeline to prepare images. E.g. bulk-exporting in JPEG2000 format, or in other high-res versions suitable for conversion and upload to your own servers” (Roddis, 2017). Another option is to use a “small library that transparently intercepts an API, changing the parameters passed, handling the operation itself, or redirecting the operation elsewhere” (Awesome IIIF, n.d.). This option is also known as ‘shims’ and can be used to enable images to be retrieved directly from DAMS that do not yet “support Image API URL syntax” (Roddis, 2017)

Also, to deliver content on the web, organizations usually have one or more web servers that work by responding to HTTP requests (Roddis, 2021). However, those delivered contents are usually static. In the same manner, they are usually low in resolution or are too big, taking time when uploading them on the web, and thus time consuming (Porena, 2019, p.14). To be

able to deliver interactable content, organizations must therefore have an Image Server which will transform those contents into medium or high-resolution images.

As mentioned before, the IIIF has two main APIs: Image API and Presentation API. The Image API requests and delivers images to the web while the Presentation API presents images and metadata in a standardized and interoperable way.

For images to be suitable for an IIIF Image API they must be converted to JPEG2000<sup>12</sup> or PTIFF which are “‘pyramidal’ formats that store derivatives at multiple resolutions within a single file” (Roddis et al, 2020). An Image Server that can understand those URL requests and convert the source images into the appropriate format is therefore also required (Roddis, 2020). Furthermore, an Image Server must be implemented if institutions wish to deliver dynamic images that users can interact with in accordance with IIIF goals. Pyramidal file formats are essential for an Image Server to work efficiently in this manner, and it is a *strongly recommended step for using the IIIF Image API* (Roddis, 2020).

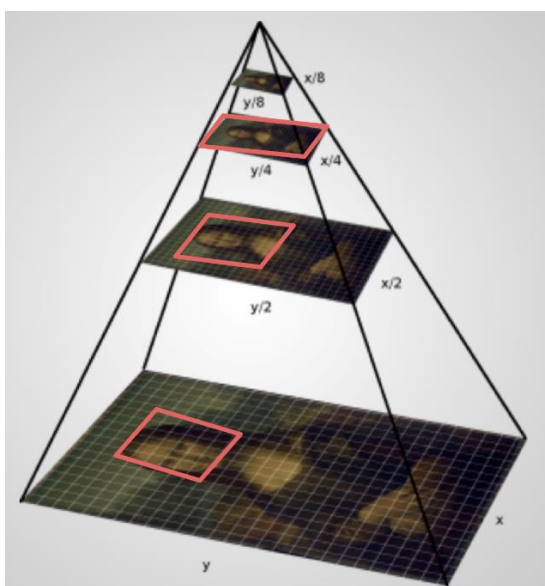


Figure 21 - Tiling of an image in pyramidal format in which red squares represent the area of tiles that are visible when one zooms into the image (Source: <https://training.iiif.io/iiif-online-workshop/day-two/fileformats.html>)

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<sup>12</sup> JPEG2000 became a standard format for image compression in the year 2000. This format fulfilled the requirements of the cultural sector early on since it enabled “storage, data manipulation and handling, rights management, progressive and error resilient transmission with support for region of interest coding [...] while providing with better compression and image quality” and transmission over the internet (Politou et al., 2004, p.293 and 294).

Steve Baskauf explained in detail what an IIIF server does when he received a request for an image:

*When a client application requests an image from the IIIF server, the server looks through the images in the pyramid to find the smallest one that will fill up the viewer and sends that. If the viewer zooms in on the image, requiring greater resolution, the server will not send all of the next larger image. Since the images in the stack are tiled, it will only send the particular tiles from the larger, higher resolution image that will actually be seen in the viewer. The end result is that the tiled pyramidal TIFFs load much faster because the IIIF server is smart and doesn't send any more information than is necessary to display what the user wants to see (Baskauf, 2022).*

In addition, in order for these images to be integrated into third-party open-source viewers like Mirador or Universal Viewer they must be provided as JavaScript Object Notation (JSON) files (called IIIF Manifests). However, institutions may choose to implement an image viewer or a manifest presentation viewer only. This means that institutions looking only for deep zoom functionality can implement image viewers like OpenSeadragon and Leaflet-III, which will therefore require only the use of Image API (Babcock & Di Cresce, 2019, p.184).

On the other hand, to display the metadata alongside the image, institutions need to choose a manifest presentation viewer like Mirador or UV. In this case, a Manifest server compliant with the Presentation API must be implemented. Some Image servers support both core IIIF APIs. Manifests can be created manually or through open-source software libraries. Once the manifests are created, they can be presented in a viewer inside a website. For the purpose of this study, an IIIF Manifest was created using a web server and a Manifest builder, which is described below.

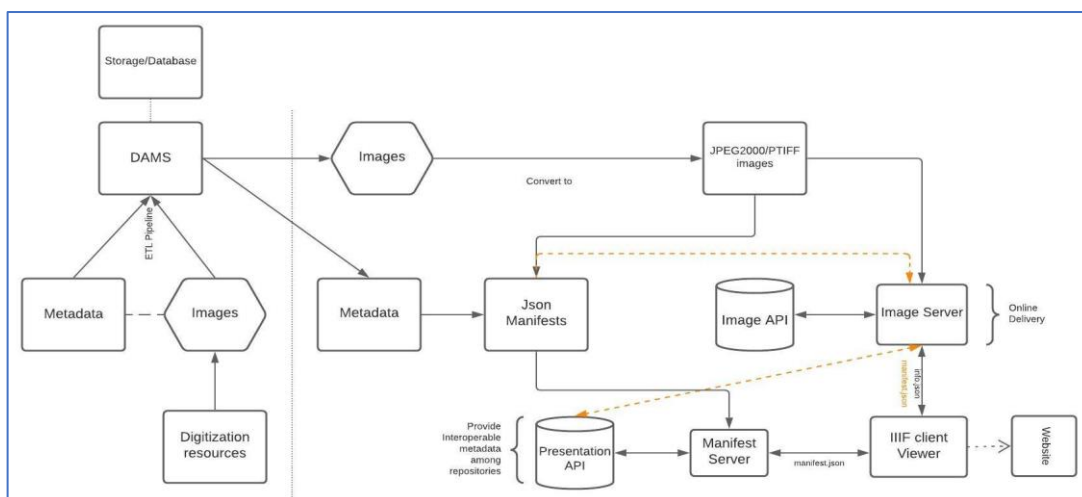


Figure 22 Simplified diagram of IIIF API's implementation workflow (© Cecília Pitta)

Figure 22<sup>13</sup> outlines a general view of the how images and metadata are delivered and presented to a website:

1. The process begins with the digitisation of physical objects that are, then, uploaded to a DAMS. The metadata associated with those digital surrogates are also uploaded to the system. This process is known as ETL Pipeline.<sup>14</sup>
2. The Images must be converted to JPEG2000<sup>15</sup> or PTIFF. This can be done with the open-source software ImageMagick (Porena, 2019, p. 76).
3. Converted images are integrated into an IIIF Image API compliant server (Image Server<sup>16</sup>) which will deliver an *info.json* file<sup>17</sup> and the associated image to the Web.
4. Images and metadata are merged in a Json text file known as an IIIF Manifest.

<sup>13</sup> The diagram was created by me and then validated through a series of exchange messages shared with the IIIF experts in the IIIF Google discuss group (<https://groups.google.com/g/iiif-discuss/c/fVmftZvEJ-0/m/bvDLXyvvAQAJ?hl=en>).

<sup>14</sup> ETL stands for Extraction, Transformation and Leverage.

<sup>15</sup> When choosing JPEG2000 (or JP2K), an institution has also to decide if the format of the derivatives is going to be either lossy or lossless as “the lossy JP2K ... [gives] ... users high quality images without enabling reconstruction of an image that is very near to the original lossless format” (Gomez *et al*, 2020).

<sup>16</sup> An Image Server “must run specialist software such as IIPImage or Cantaloupe to convert the source pyramidal images into regular JPEGs for delivery over HTTP” (Roddis, 2021). which differs from the Manifest server “that can serve JSON files over HTTP” (Roddis, 2021).

<sup>17</sup> “The info.json is created by the IIIF image server and the data contained in it can all be extracted from the image that is loaded to the image server” (Robson, 2021).



5. The Manifest (manifest.json) is integrated in an IIIF Presentation API-compliant server (Manifest Server) that will provide interoperability to both image and metadata (Some image servers also support Presentation API specifications)<sup>18</sup>.
6. An IIIF client server sends requests to both the Image Server and Manifest Server.

In more detail, the diagram below describes the typical IIIF request response cycle:

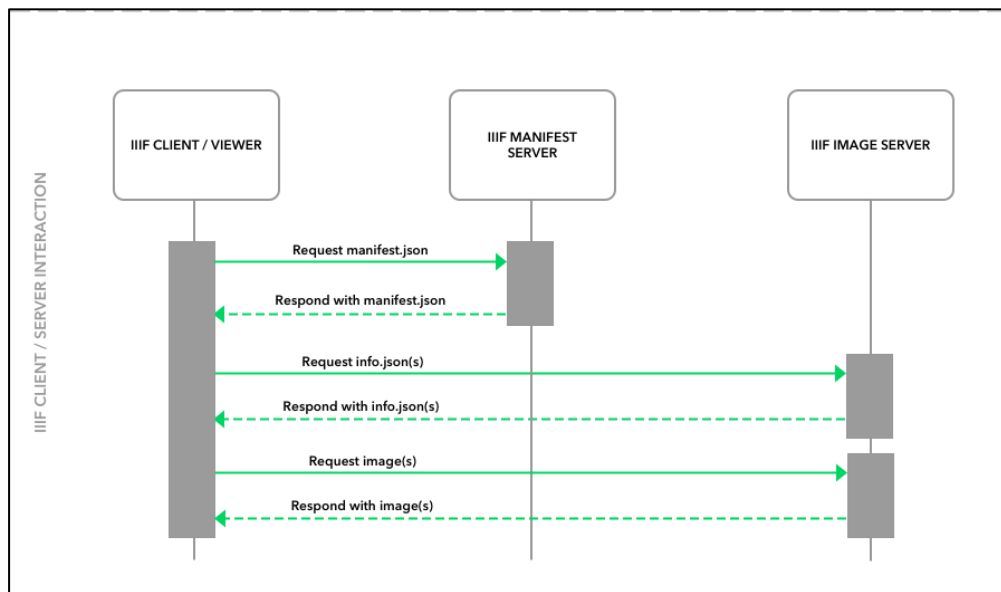


Figure 23 -IIIF Client/ Server interaction (Reed, 2017)

The diagram above describes an IIIF client’s requests for a digital object. First, it asks the IIIF Manifest Server for the manifest, which returns the manifest.json file (Ronallo, , n.d.). Through the manifest.json file, the image needed to display the resource is found (Ronallo, n.d.). Then, the IIIF-client will require the info.json file related to that image for the IIIF image server (Ronallo., n.d.). Only after receiving information about image size and tiles, it will cause the actual images to be displayed (Ronallo,..., n.d.).

As said before, this implementation process may differ from institution to institution. Roddis *et al* (2017) explain how IIIF APIs are implemented according to the repository scalability operation (availability, volume, and traffic). They outline how Image API,

<sup>18</sup> The orange line in the diagram (Figure 1) represents the manifest.json being created by such an Image Server.

Presentation API and images preparation can be implemented and handled by different sized collection repositories. Different solutions can range from implementing open-source software or digital asset management systems sold by vendors that are compliant with the IIIF APIs.

Through the documentation available online, the Royal Museums of Fine Arts Antwerp (KMSKA) outlined their method while testing the IIIF as a solution to tackle the issue of a high number of duplications of their images in different internal servers and folders (Vanderperren, 2017). Due to finances reasons, the institutions could not afford to implement a DAM system, so a Google form was created so that employees could request images (Vanderperren, 2017). These requests were handled by the two employees responsible to the image collection (Vanderperren, 2017). The IIIF testbed was designed so that staff at KMSKA could: (1) find images according to an inventory number, name of artist and/or title; (2) interpret the images from identifying metadata; (3) see the images without having to open them manually; (4) not be obliged to save images to their folders via the application; (5) zoom images in the application and (6) compare images in the application (Vanderperren, 2017).

Following the IIIF Quick Start guide for providers, the institutions decided to install the open-source IIImage server (Vanderperren, 2017). A script was created using ImageMagick and installed inside this server to convert every image entering the server to the PTIFF format automatically (Vanderperren, 2017).

Next, different viewers that are compliant with the Presentation API were considered (Vanderperren, 2017). Mirador was selected because it enables image comparison in the same web workspace (Vanderperren, 2017). For the creation of manifests, the metadata files in cvs were converted in manifests using Ubuntu server (Vanderperren, 2017).

Motivated by the same need to eliminate duplicates, The National Gallery (UK) uses the IIIF internally to solve the problem of accessibility and use of its own data stored in different departments (Towards a National Collection, 2021c). The accessibility of files in this siloed environment was previously resolved by duplicating files. Also, the IIIF is used to document and connect paints and samples (Towards a National Collection, 2021c).

In the IIIF implementation guide by the Brumfield Lab (2017), the tiling and zoom aspects of the IIIF are mentioned as compelling features for those institutions that lack these functionalities (Brumfield Lab, 2017). However, while interoperability across institutions is

another compelling feature, it is harder to implement (Brumfield Lab, 2017). Instead, they argue that institutions should think about the vertical interoperability advantages that the IIIF can have internally by helping institutions to migrate to solutions that are compliant to the IIIF (Brumfield Lab, 2017).

On the other hand, the implementation of the IIIF APIs by the University of Coimbra is related to adoption of management system by 4Science called DSpace-GLAM that includes the support of IIIF APIs (Silva *et al*, 2019, p.316). With this implementation, the university was able to guarantee the functionality of the IIIF APIs (Silva, 2022). The migration of data from the old system to the new one consisted in the extraction of images and metadata (from PDFs with Table of Content) that were transferred to the IIIF Image server and included as bitstream metadata (Silva *et al*, 2019, p. 317).

In the IIIF Google discussion group, I asked in the name of a colleague implementing a digital project in music manuscripts, how he could convert ten thousand images of manuscripts in jpeg2000 that are stored in an external drive.<sup>19</sup> Additionally, he would need to crop certain regions of the images and sort these manuscripts into folders by copyist. My idea was that the IIIF could help him create on-the-fly derivatives while using a DAM for converting the images.

However, the IIIF community members pointed out important aspects to be considered by the researcher in this case: (1) the budget available for the server, maintenance and development; (2) the technical resources they have available (self, or others) to provide adequate support for this shift in the workflow; (3) whether the time spent in implementing an IIIF workflow would save time in the long run, or only add delay to the project (even if the existing workflow is “inefficient”); (4) whether the project requirements are aligned to IIIF benefits (linkable, sharable images; existing viewers; web-native image delivery) and (5) whether implementing the IIIF could be accomplished in the moment as leaving it for later might cause a distraction from the project’s initial goals.

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<sup>19</sup> The link for the messages exchanged in the forum is the following <https://groups.google.com/g/iiif-discuss/c/Z0IXsHm8-o8/m/M4XFWECjAgAJ?hl=en>

Additionally, one of the forum participants asked if the researcher had difficulties with basic technical problems. If so, he suggested “that IIIF is overkill since getting the IIIF server up and running, creating integrations and customization is beyond basic technical knowledge”. He gave advice for using photoshop for cropping instead, also noting that the goal of batch converting thousands of images would be manageable.

The large-scale IIIF provides an extensive list of image servers, IIIF-compliant viewers, guides and other related-tools and documentation for those looking for IIIF implementation support which is available through the following link: <https://github.com/IIIF/awesome-iiif#image-viewers>. Also, the IIIF-To-Go<sup>20</sup> tool developed by the University of Toronto has the aim of lowering the technical barriers to IIIF implementation by individuals and institutions, since it provides different solutions for implementation according to their particular needs and requirements (Raemy, 2017, p. 18).

### **3.1.6.1 Creating and publishing an IIIF Manifest**

As an exercise, the following illustrates how the creation and publication of a Manifest may be done. It was accomplished following my attendance at an IIIF workshop held in July 2021 by Glen Robson.

First, to make IIIF images available, an IIIF Image API is needed. Following the steps recommended at the workshop, the *Internet Archive* was chosen as the host since it provides IIIF Image servers and IIIF Image API. The Internet Archive is a good solution for individual researchers who are planning to share a few images (Robson, 2021). The Internet Archive is level 2 IIIF compliant.

For the purpose of this exercise, I have chosen a family-owned nineteenth-century engraving of a drawing by W. Daniell RA which depicts a temple in India. After creating a user account at Internet Archive, I uploaded the image.

If uploading more than one image, each image must be uploaded one at a time. Note that images must be rotated to the exact position the provider wants them to be in when first loaded into a viewer. Unwanted rotations can happen especially if one is transferring images from a cell phone. Also, a rotation option in the manifest at level 0 is not available. In my case,

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<sup>20</sup> The IIIF-To-Go website: <https://digitaltoolsmss.library.utoronto.ca/iiif-to-go/>

after realising the image would not always appear at the correct rotation, I used the IIIF Image Manipulator to effectively rotate it to the desired position.

The Internet Archive Image server generates an info.json file from the image just uploaded:

```
{
  "@context": "http://iiif.io/api/image/2/context.json",
  "@id": "https://iiif.archivelab.org/iiif/shere-shah_202107",
  "height": 2298,
  "profile": [
    "http://iiif.io/api/image/2/level2.json"
  ],
  "protocol": "http://iiif.io/api/image",
  "tiles": [
    {
      "scaleFactors": [
        1,
        2,
        4,
        8,
        16
      ],
      "width": 256
    }
  ],
  "width": 3212
}
```

Figure 24 An info.json file generated by the Image Server: [https://iiif.archivelab.org/iiif/shere-shah\\_202107/info.json](https://iiif.archivelab.org/iiif/shere-shah_202107/info.json) (© Cecilia Pitta).

Then, a folder named iiif-manifest was created and the Web Server For Chrome app was downloaded to my personal computer. When the app is launched, the iiif-manifest folder was selected as well as the Set CORS headers option (in advanced options at the bottom):

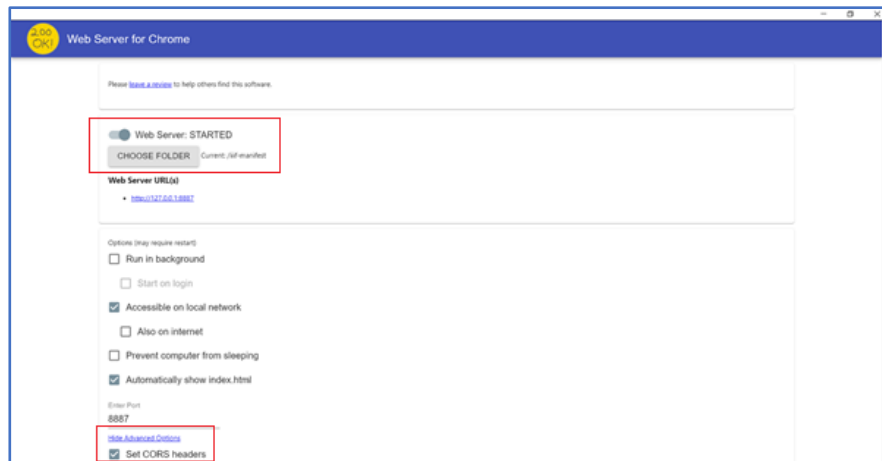


Figure 25. Web Server for Chrome app (© Cecília Pitta).

The next step was to create a Manifest using the IIIF Manifest Builder by the Bodleian Library:

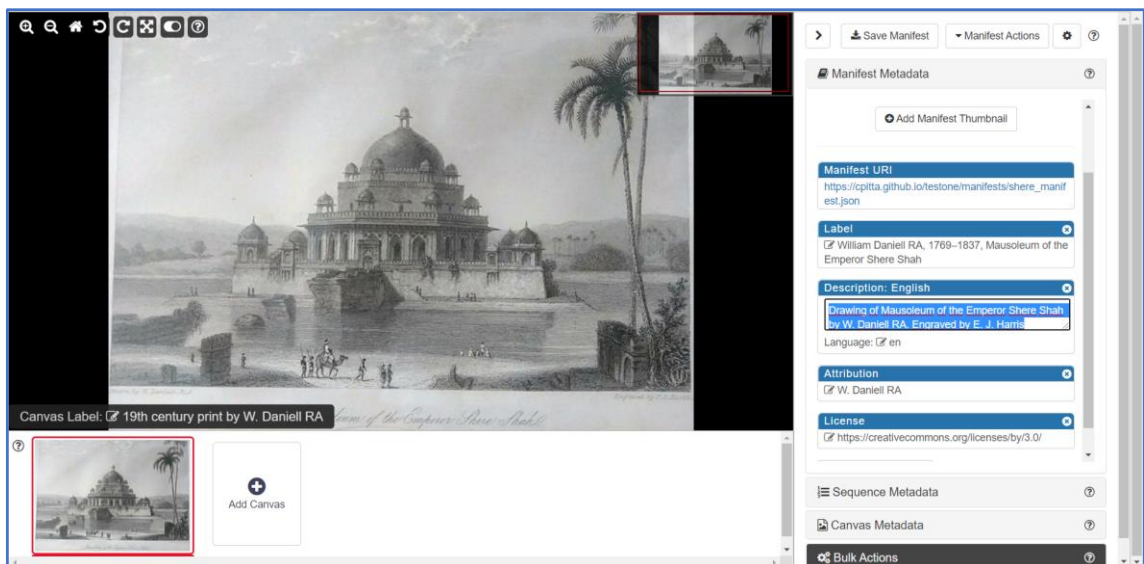


Figure 26. The IIIF Manifest Builder workspace (© Cecília Pitta).

First, a *canvas* was added to the Manifest. Afterwards, the *info.json* file URL was submitted to the *canvas*. Then the metadata were added to the manifest, such as a label and description.

Next, I downloaded the manifest and added it to the *iiif-manifest* folder. Downloading it to a local folder is necessary in order to make changes locally and then upload the changed version to the workbench. Alternatively, changes can be made via github directly.



When all the annotations are completed, the annotation file (also a json file) is downloaded from the “View Annotations” button at the top of the IIIF manifest folder. To see the annotations on the manifest, some code must be included in the json file. The annotation list was added by entering the highlighted code into the manifest file:

```

shere_manifest (2).json — C:\Users\cecil\Downloads — Atom
File Edit View Selection Find Packages Help

shere_manifest (2).json
27
28   "@type": "sc:Canvas",
29   "label": "19th century print by W. Daniell RA",
30   "height": 2298,
31   "width": 3212,
32   "images": [ {
33     "@context": "http://iiif.io/api/presentation/2/context.json",
34     "@id": "http://ffe343c8-f632-4f84-8cb1-55edee945a97",
35     "@type": "oa:Annotation",
36     "motivation": "sc:painting",
37     "resource": {
38       "@id": "https://iiif.archivelab.org/iiif/shere-shah_202107/full/full/0/default.jpg",
39       "@type": "dctypes:Image",
40       "format": "image/jpeg",
41       "service": {
42         "@context": "http://iiif.io/api/image/2/context.json",
43         "@id": "https://iiif.archivelab.org/iiif/shere-shah_202107",
44         "profile": [ "http://iiif.io/api/image/2/level2.json" ]
45       },
46       "height": 2298,
47       "width": 3212
48     },
49     "on": "http://1c901edd-8bfa-4e68-bdb7-43bcc84a1b99"
50   } ],
51   "otherContent": [ {
52     "@id": "https://cpitta.github.io/testone/annotations/annotations_shere.json",
53     "@type": "sc:AnnotationList",
54     "label": "My fantastic annotations"
55   } ],
56   "related": ""
57 } ],
58 "structures": [ ]
59 }
60

```

Figure 5. Annotation list added to the code of the manifest (highlighted) (© Cecília Pitta).

Afterwards, the search service (or search API) was added. This service allows searching for terms in the manifest through Universal viewer:

```

1 {
2   "@context": "http://iiif.io/api/presentation/2/context.json",
3   "@id": "https://cpitta.github.io/testone/manifests/shere_manifest.json",
4   "@type": "sc:Manifest",
5   "label": "William Daniell RA, 1769-1837, Mausoleum of the Emperor Shere Shah",
6   "service": {
7     "profile": "http://iiif.io/api/search/0/search",
8     "@id": "https://iiif.archivelab.org/iiif/shere-shah_202107/full/full/0/default.jpg",
9     "@context": "http://iiif.io/api/search/0/context.json"
10  },
11  "metadata": [ ],
12  "description": [ {
13    "value": "Drawing of Mausoleum of the Emperor Shere Shah by W. Daniell RA. Engraved by E. J. Harris",
14    "language": "en"
15  } ],
16  "license": "https://creativecommons.org/licenses/by/3.0/",
17  "attribution": "W. Daniell RA",
18  "sequences": [ {
19    "id": "http://1c901edd-8bfa-4e68-bdb7-43bcc84a1b99",
20    "@type": "sc:Sequence",
21    "label": [ {
22      "value": "Normal Sequence",
23      "language": "en"
24    } ],
25    "canvases": [ {
26      "@id": "http://1c901edd-8bfa-4e68-bdb7-43bcc84a1b99",
27      "@type": "sc:Canvas",
28      "label": "19th century print by W. Daniell RA",
29      "height": 2298,
30      "width": 3212,
31      "images": [ {
32        "@context": "http://iiif.io/api/presentation/2/context.json",
33        "@id": "http://ffe343c8-f632-4f84-8cb1-55edee945a97",
34        "@type": "oa:Annotation",

```

Figure 6. The search service (API) was added to the code of the manifest (highlighted) (© Cecília Pitta).

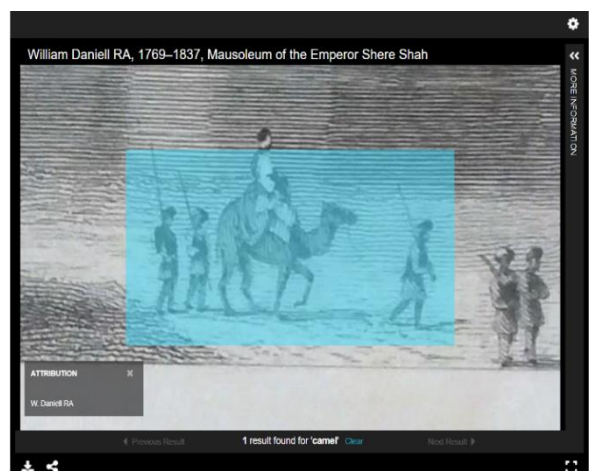


Figure 7. Search result for the word ‘camel’ on the UV (© Cecília Pitta).



Also, the annotations can be viewed on Mirador (but not searched):

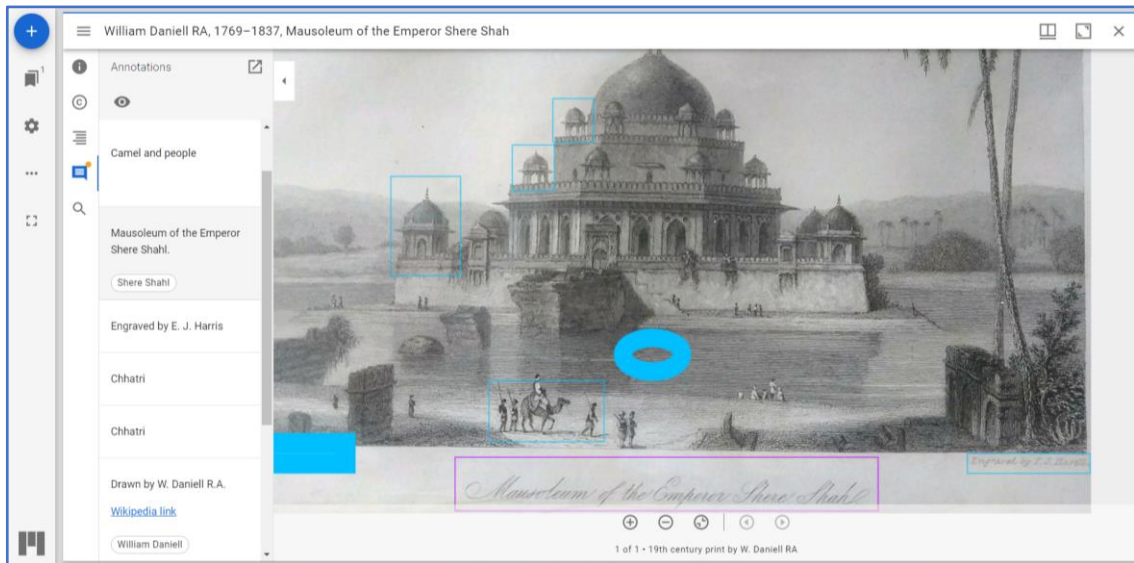


Figure 29. Manifest annotations highlighted on Mirador workspace (© Cecília Pitta).

To publish this manifest, I used the IIF Workbench. Thus, both the manifest file and annotation file were stored to my account on the IIF workbench. The IIF manifest URL for the object is [https://cpitta.github.io/testone/manifests/shere\\_manifest.json](https://cpitta.github.io/testone/manifests/shere_manifest.json)

Here is a print screen of a Mirador workspace where my manifest appears side by side with an IIF manifest of a drawing by the same author owned by the Yale Center for British Art:

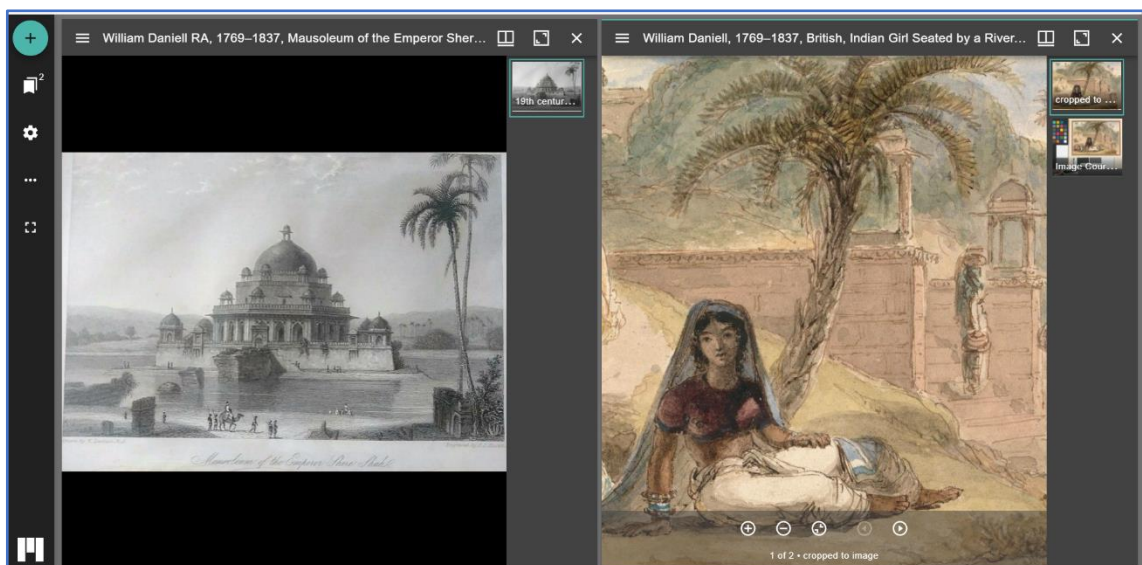


Figure 6. Mirador workplace with two drawings from W. Daniell RA (© Cecília Pitta).

Another Mirador workspace with images (both images on the right are owned by the YCBA) depicting the same building by different artists is shown below:

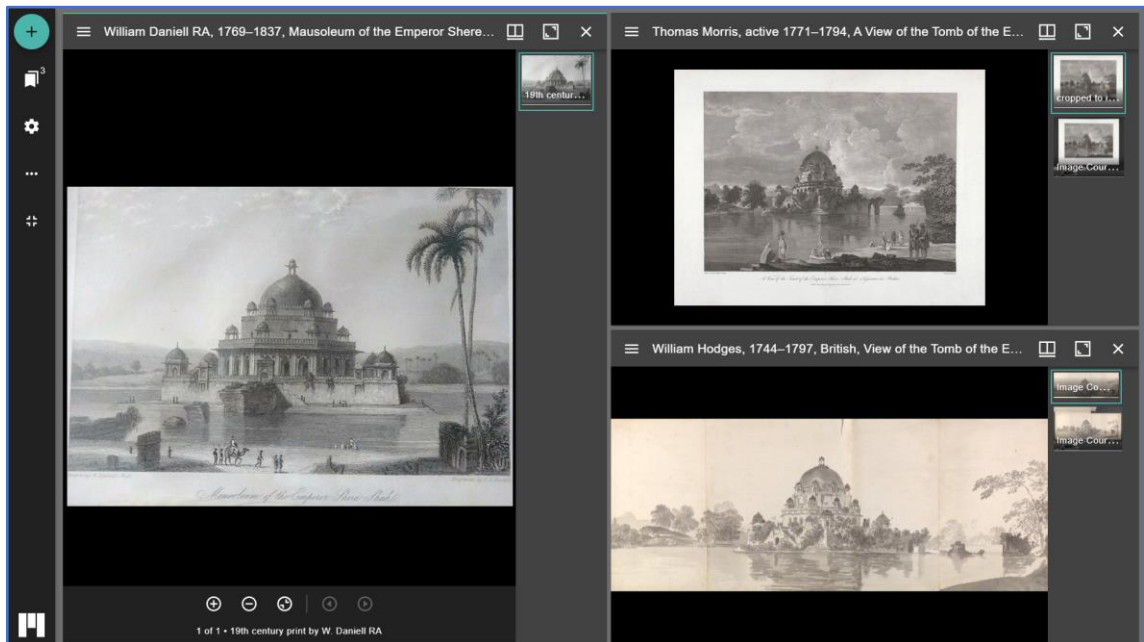


Figure 7. Three drawings of Mausoleum of the Emperor Shere Shah by three different artists on Mirador workspace (© Cecilia Pitta).

Also, a Storiies was created with the above IIF Manifest: <https://storiies.cogapp.com/viewer/5f2gt/Mouseleum-of-the-Emperor-Shere-Shahl-by-W-Daniell-RA>

In addition, other IIF Manifests were created to experiment with the technology:

#### A Pastry shop in Bologna:

- Mirador (with an annotation list): <https://projectmirador.org/embed/?iif-content=https://cpitta.github.io/testone/manifests/shop.json>
- Universal Viewer (with the search option): <http://universalviewer.io/examples/#?c=&m=&s=&cv=&manifest=https%3A%2F%2Fcpitta.github.io%2Ftestone%2Fmanifests%2Fshop.json&xywh=-443%2C-1%2C1335%2C801>

#### A Pastry shop in Bologna v. 2:

- Mirador: (with a annotation list & Image layers):  
[https://projectmirador.org/embed/?iiif-content=https://cpitta.github.io/testone/manifests/pasta\\_manifest0.json](https://projectmirador.org/embed/?iiif-content=https://cpitta.github.io/testone/manifests/pasta_manifest0.json)
- Universal viewer (this version has no search option):  
[http://universalviewer.io/examples/#?c=&m=&s=&cv=2&manifest=https%3A%2F%2Fcpitta.github.io%2Ftestone%2Fmanifests%2Fpasta\\_manifest0.json&xywh=-182%2C-896%2C3626%2C3626](http://universalviewer.io/examples/#?c=&m=&s=&cv=2&manifest=https%3A%2F%2Fcpitta.github.io%2Ftestone%2Fmanifests%2Fpasta_manifest0.json&xywh=-182%2C-896%2C3626%2C3626)

### 3.2 Perspectives and adoption of IIIF

Since the creation of the International Image Interoperability Framework (IIIF) in 2011, professionals in CHIs have been discussing, reviewing and experimenting with it. Discussions were begun at the Stanford Linked Data workshop in 2011, which identified the need “to develop the tools and agreements to support interoperability for scholarly functions across silos of digitized manuscripts in the specific domain of digitized ancient, medieval, and early modern manuscripts” (Burrows, 2018, p.8 citing Keller et al., 2011, p.46). The IIIF was viewed as potentially applicable to manuscripts research (Burrows, 2018, p.8).

When the second set of specifications was realised in 2014, the IIIF’s ability to overcome the lack of interoperability between image silos and deliver images in a more flexible way was much appreciated by those working within the context of CHIs’ digital repositories and scholarship (Ying and Shulman, 2015; Delmas-Glass, 2015).

*e-codices – Virtual Manuscript Library of Switzerland* is the oldest digital library in Switzerland and it provides “access to all medieval and a selection of modern manuscripts” from large and small Swiss collections and institutions since 2008 (Fritschi, 2017, p.245). In the context of the launch of the second version (December 2014), *e-codices* was the first virtual library to become fully IIIF-compliant (Fritschi, 2017, p.246; Raemy, 2017, p.24).

In 2015, the Artstor Digital Library (which since 2016 is part of ITHAKA), which provided at the time “1.9 million high resolution images from archives such as the Museum of Modern Art, Magnum Photos, the Bodleian Library, and over 200 other museums and archives”, implemented the IIIF. It sought to create a network of content from their sources that could flow easily through their systems without the constraints of silos and the need to set a standardized way of delivery and representation of images among digital collections builders

(Ying and Shulman, 2015). Similarly, The Yale Centre for British Art (YCBA) has implemented the IIIF as a solution for collaboration among scholars that have been facing obstacles due to “the lack of interoperability between images silos” (Delmas-Glass, 2015).

The Artstor Digital Library used open access materials in their first IIIF implementations and only after maturing the work with the IIIF did they plan “the delivery of other, access-constrained parts of collections” (Ying and Shulman, 2015). Similarly, the YCBA was “able to leverage its digital resources to the fullest due to its generous implementation of Yale University's Open Access Policy” which allows YCBA to make “high resolution images of works in the public domain freely available without further application, authorization, or fees due to the museum or to Yale, including for commercial purposes” (Delmas-Glass, 2015).

By 2014, the National Library of Wales (NLW) has become involved with the IIIF (Robson, 2016). The motivation behind IIIF adoption was related to the fact that the standard “fitted well with a number of projects the library was involved in” (Robson, 2016).

The Cynefin project was the first in which IIIF images were used (Robson, 2016). This project included a crowdsourcing platform that would allow users to geo-reference more than a thousand maps of different regions of Wales from the mid-19<sup>th</sup> to the mid-20<sup>th</sup> centuries (Robson, 2016). By sharing IIIF images the institution delivers the images on-the-fly to their interface, reducing time and hosting costs (Robson, 2016).

In addition, the Welsh Newspapers online website was launched in 2015 and provided “access to over one million Newspaper images delivered using Open Sea Dragon on top of the IIIF Image API” (Robson, 2016). With this project the NLW became a pioneer in IIIF implementation for newspapers (Raemy and Schineirder, 2019, p.28)

Nonetheless, the main reason for IIIF implementation and development was interoperability (Robson, 2016). Content requests from other IIIF working groups, mainly for manuscripts, made the NLW share “a Guillaume de Machaut Manuscript with Stanford University and two ‘Book of Hours’ manuscripts with Yale” (Robson, 2016).

By providing IIIF images of those manuscripts, researchers will be able “to import the manuscripts into their own tools rather than being restricted by what viewer the NLW has

provided” (Robson, 2016). Moreover, copies of a same manuscript can be imported into Mirador and viewed side by side (Robson, 2016).

For another project transcribing the names of Welsh soldiers who died in World War I listed in The Book of Remembrance, the NWL developed “a Linked Open Data annotation store that is compatible with Mirador” called Simple Annotation Service (Robson, 2016).

In 2016, the IIIF was already becoming the “de facto standard for image delivery and access on the Web” (Frunzeanu, Robineau and MacDonald, 2016, p.127). The National Library of France’s Biblissima<sup>21</sup> is a digital humanities project “which aims to create a federated access point for approximately 40 partner databases dedicated to the history of manuscripts and early printed books, to their circulation and their readers, from the 8<sup>th</sup> to 18th centuries” (Frunzeanu, Robineau and MacDonald, 2016, p.115). In this case, the IIIF was implemented to solve the challenge of providing “a single access point for a large number of digital facsimiles from three different image repositories: Gallica, the BVMM (‘Virtual Library of Medieval Manuscripts’), and the BVH (‘Virtual Humanist Libraries’)”<sup>22</sup> (Frunzeanu, Robineau and MacDonald, 2016, p.127). For the Biblissima team, the solution provided by the IIIF (and its visualization tools) led to the enrichment of digital practices for research purposes (Frunzeanu, Robineau and MacDonald, 2016, p.127).

In the same year the Vatican Library launched the web platform of its digital library for manuscripts from its collection annotated with IIIF technologies<sup>23</sup> (Manoni, 2016, p.266) called *Thematic Pathways on the Web: IIIF Annotations of Manuscripts from the Vatican Collections*. This project was developed with the collaboration of Standard University Libraries and funded by the Mellon Foundation (Manoni, 2016; Ponzi with Manoni, 2020).

The reasons for implementing the IIIF were related to the growing number of adherent institutions but also because the IIIF presented opportunities that matched scholarly needs (Manoni, 2016, p.266). Moreover, the Vatican Library saw an opportunity in “participating in the evolution towards more advanced tools [are] able to offer scholars new perspectives into

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<sup>21</sup> Biblissima Portal: <https://portail.biblissima.fr/>

<sup>22</sup> IIIF collections: <https://iiif.biblissima.fr/collections/>

<sup>23</sup> Thematic Pathways on the Web: IIIF Annotations of Manuscripts from the Vatican Collections: <https://spotlight.vatlib.it>

the world of Medieval manuscripts using IIIF technologies” (Manoni, 2016, p.266-67). The Vatican Library is of the opinion that the IIIF “allows a complete transformation of teaching” (Manoni, 2016, p.268) and even made “erased texts more accessible online than in their physical existence” (Manoni, 2016, p.274).

The Vatican Library started experimenting with the IIIF in 2015 with the design of a small Proof of Concept (PoC)<sup>24</sup> (Ponzi with Manoni, 2020, p.211). This consisted of: (1) evaluating the possibilities of the IIIF by managing ten manuscripts in compliance with the standard as a testbed for the implementation of a digital platform (Ponzi with Manoni, 2020, p.2011) and (2) identify a sample of sheets from those ten manuscripts to annotate and to comment upon in accordance with the functionalities of the IIIF but also to make transcriptions of them and other available information (Ponzi with Manoni, 2020, p.2011).

Harvard University’s IIIF adoption effort involved “Harvard Art Museums and Library, the Faculty of Arts and Sciences (FAS), and the University’s massive open online course provider, HarvardX” and resulted in the digitization of multiple resources through a shared API displayed with Mirador viewer (Emanuel, 2017, p. 7). Also, new tools were created by using IIIF and Mirador, “an image viewer and annotation application for HarvardX courses, a new Harvard Library Viewer, faculty image collections embedded in the Canvas course platform, and walls of images in the Harvard Art Museums” (Emanuel, 2017, p.7).

For the University, the benefits of the IIIF and Mirador adoption were the opening of Harvard resources to reuse on the Internet while enabling access to resources from “peer institutions” (Emanuel, 2017, p.9). Being able to share resources meant that copies of the same work from different institutions could be compared (Emanuel, 2017, p.9).

In 2016, the “Beyond Words: Illuminated Manuscripts in Boston Area Collections” exhibition displayed more than 260 manuscripts and printed books from the Houghton Library (Harvard University), the McMullen Museum (Boston College), and the Isabella Stewart Gardner Museum (Emanuel, 2017, p.9). The physical objects displayed at the exhibition

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<sup>24</sup> A Proof of Concept (PoC) can be defined as a small experiment or test of a certain method, idea, or theory with the aim of demonstrating its feasibility and verify possibilities and potential development.

“were accompanied by tablets running Mirador, thus allowing visitors to appreciate the manuscripts’ materiality” (Emanuel, 2017, p.9).

The specific benefits of the adoption to the Harvard Library were: (1) Provide “a more efficient and standardized way to deliver visual material from the Digital Repository”, (2) enable materials like codices and scrolls to become suitable for viewing without special permission (3) offer “a highly interactive viewing experience for visual material” in a teaching and learning context, while (4) “affording faculty and course staff the opportunity to dynamically access library and museum material, and their own collections, without having to replicate images at every turn” (Emanuel, 2017, p.10).

In addition, for Harvard Art Museums, the outcomes of IIF adoption resulted in: (1) “enhancing the public’s desire to view the physical objects in the museums’ galleries”, (2) “expanding image comparison capability in the museums’ digital tours platform, and (3) “serving as a study in the effort to demonstrate that museum data can be interoperable” (Emanuel, 2017, p.10).

However, the collaborative nature of the IIF and the great number of external and internal partners, as well as the lack of control over IIF and Mirador resources and standards procedures, were identified as potential risks for Harvard University when implementing the IIF (Emanuel, 2017, p.8). Moreover, the number of developers working on the IIF and Mirador was outnumbered by project managers in different departments which created a situation where too many people were involved “in every phase of the project, from requirements gathering, to development, to implementation” (Emanuel, 2017, p.8).

To solve this situation the only developer working on a full-time basis on the IIF and Mirador projects was made product owner and IIF consortium leader, while the project management team focused more on coordination and support (Emanuel, 2017, p.9).

Nevertheless, for Martha Whitehead (vice-president for the Harvard Library) the IIF has helped the university to break down internal silos and it is fundamental for teaching and research at the university (Whitehead, 2022).

In 2016, Europeana started allowing member institutions to distribute their resources through IIF profiles in the European Data Model (EDM), allowing for simpler image sharing and a richer viewing experience (Marjolein de Vos, 2017).

In 2017, in the report “Preparing Europeana for IIIF”, the working group identified two trends in the handling of IIIF technology by Europeana content providers (Task Force on Preparing Europeana for IIIF Involvement, 2017, p.6).

The first was the modernization of digital resource management systems that need to be compatible with the IIIF at low cost while retaining high-quality material<sup>25</sup> (Task Force on Preparing Europeana for IIIF Involvement, 2017, p.6). The second was the development of institutions’ own solutions for long-term distribution and greater reach among partners with refinements and expertise aimed at specific users (Task Force on Preparing Europeana for IIIF Involvement, 2017, p.6). The report also lists the IIIF’s possibilities for the practice of research and teaching, such as, for example, the digital reconstruction of the physical structure of a book, if parts of it are owned by more than one institution (Task Force on Preparing Europeana for IIIF Involvement, 2017, p .7).

The main challenges related to IIIF implementation identified among Europeana providers were: (1) the need for IIIF information and documentation to be mainly in English, (2) low awareness of the IIIF among curatorial staff and senior management, (3) technical capability and time resources, and (4) the need for a great number of technical and publishing infrastructure solutions, including customization alternatives (Task Force on Preparing Europeana for IIIF Involvement, 2017, p .9).

In this context, University College Dublin (UCD) succeed “in delivering new content from UCD and its partner organisations in Ireland” to Europeana by “creating a microservice to delivery EDM metadata via IIIF manifests” (Howard, 2017, p.2). The challenges faced by this institution were related to: (1) The lack of awareness and skills of library staff on web standards, web annotations and data representation with JSON/JSON-LD and (2) Integrating new technologies within an infrastructure “based on older library practices” (Howard, 2017,

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<sup>25</sup> The National Library of Portugal is preparing to implement the IIIF as the institution faces obstacles with the ingestion of heavy pdfs into Europeana, which does not successfully complete and provokes *time out*. The reasons for becoming IIIF-compliant cited by the institution include the migrating of its software to an international standard and the discontinuation of Adobe *Flash*. (I am grateful to the BNP staff for this information; private correspondence, 2021).



p.4). The e-codices project likewise has “its information harvested by Gallica and Europeana through IIIF” (Long, 2018, p. 569).

Also, in 2016, the National Museum of Sweden implemented the IIIF standards as a solution to the institution’s lack of funding to expand its infrastructures to provide access to high-resolution images (Glasemann, 2017). Providing images with different size requirements through the embedding of an URI means that copies of images are no longer needed (Glasemann, 2017). In addition, The IIIF was seen as a fast implementation solution and more sustainable as well (Glasemann, 2017).

However, for small museums this task can be difficult. For example, faced with technical and resources challenges, the Hunt Museum decided it would “publish its collection to Europeana via the national aggregator Digital Repository Ireland (DRI)” (ARMA Consortium, 2022, p. 17).

In fact, IIIF-based aggregation mechanisms are the ones where Europeana sees the most potential for innovating metadata aggregation in the shorter term (Raemy & Schneider, 2019, p.32). In addition, the IIIF is also valued by Europeana as it is believed that it is “enhancing the FAIRness of data” (Isaac & Freire, 2019).

The IIIF APIs supports the interoperability of digital content published on the web while enabling a better interactive experience with the content (Isaac & Freire, 2019). Moreover, the accessibility of APIs to researchers means they can access a large amount of data (Hiltmann & Schneider, 2020, p.8) which IIIF supports.

Furthermore, the adoption of standards like the IIIF enhances interoperability among large number of institutions (Meeus *at al*, 2021, p.10), while the interoperability provided by the IIIF APIs supports the automatic re-use of data by researchers, which saves money and time (Angelaki et al., 2019). Also, their unique URIs make IIIF derivatives findable, accessible and sustainable in the long term.

In 2017, the United States Holocaust Memorial Museum (USHMM) Search Collection integrated the IIIF into their newly launched improved method for providing access to “hierarchically-described archival collections materials” (Levy, 2019, p.27). The IIIF hierarchical organizing concepts of Collections, Manifests, Items, canvas and content is very similar to how archivists organize their material into the levels of “collection, series, or

subseries; file or folder; and item, image, or page” (Levy, 2019, p.27). Thus, the USHMM chose to integrate UV “because it provides an excellent visual user interface combining the hierarchical nature of archival collections” (Levy, 2019, p.27).

In 2017, the Confederation of Open Access Repositories (COAR) Next Generation repositories working group published the “Behaviours and Technical Recommendations of the COAR Next Generation Repositories Working Group” report, which outlines new emerging users’ behaviours and recommends new technologies for the next generation repositories<sup>26</sup> that will support those identified behaviours (Rodrigues & Shearer, 2017). To support the behaviour described as “Interacting with resources (annotation, commentary, and review)”, the report recommends the IIF for enabling interaction with images through annotation, for example (Rodrigues & Shearer, 2017, p. 19). The report also noted that the IIF meets the distributed nature<sup>27</sup> required for a next generation repository (Rodrigues & Shearer, 2017, p.19).

In 2018, The National Gallery of Art (NGA) Library in the USA adopted the IIF because other departments in the Museum had adopted the protocol and because it is a charter member of the Digital Cicognara Library (DCL) which is a digital project that recreates the art library assembled by Count Leopoldo Cicognara in the 19<sup>th</sup> century (Zhou, Y., & Long, Y., 2020, p. 17-18). This project adopted the IIF so that its members can display their contributed resources in a standard way (Zhou, Y., & Long, Y., 2020, p. 18).

By upgrading their imaging equipment and migrating from Ex-libris Voyager to an Ex-Libris cloud-solution with two services, Alma and Primo (Internal and external interfaces, respectively), they became aware that they needed: (1) a suitable method of providing high-quality images to their users and also be able to create on-the-fly directive files; (2) to provide interoperability so they do not end up in silos; (3) to provide resources that can be manipulated and empower users to make most of them in their work, (4) to increase of the scalability of the digital assets and projects (which in the NGA have doubled in number in the last ten years), (5) provide varied ways of access based on existing copyrights and licensing agreements (6) to

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<sup>26</sup> According to the COAR, the next generation repository is a networked resource-focused infrastructure and service that manages and provides access to a variety of resources through HTTPs URIs while supporting technology development and resources update (Rodrigues & Shearer, 2017, p.4).

<sup>27</sup> A distributed network can be described as a network in which different services/resources providers function in a standardized way and interact with each other in the same way (Rodrigues & Shearer, 2017, p.32).

provide an organized different number of digital holdings to single records (7) to maintain the metadata from their MARC records via UV (Zhou, Y., & Long, Y., 2020, p. 17-18). Previously, the NGA Library were presenting their assets through a Java-script viewer that supported low-resolution derivatives of JPEG files which had to be manually created at various dimensions and consequently it was time consuming work for the library staff (Zhou, Y., & Long, Y., 2020, p. 17). Also, the low resolution of these files limited the users' interactions, such as zoom in (Zhou, Y., & Long, Y., 2020, p. 17).

According to the authors, the attraction of the IIIF was also related to the presentation features that enable objects to be embedded directly into an existing online record while providing high-resolution TIFF files that can be deep zoomed (Zhou, Y., & Long, Y., 2020, p. 18). In addition, they found they could also provide and present the metadata from all MARC records through Universal Viewer (Zhou, Y., & Long, Y., 2020, p. 18). The authors also noted that the open-source nature of the IIIF is an advantage in terms of future developments in digital asset leverage (Zhou, Y., & Long, Y., 2020, p. 18).

The prototype of the Digital Library of Artistic Production of the School of Communications and Arts of the University of São Paulo (Brazil) used the IIIF because of its interoperability feature but also because it brought other benefits, such as: (1) the image comparing and cropping functionalities, (2) functionalities for the creation and reuse of images, and for the (3) annotation of images and transcription of texts, (4) its compliance with other open source Image APIs (UV, Mirador, Internet Archive Book Reader, Luna, Diva.js) and Image servers (IIP, Djabatoka, FSI, Loris, ContentDm, LuraTech, Digilib) (5) its image visualisation capacity with deep zoom functionality, (6) its control over the reuse of shared images outside the institution's website, and (7) its access to images via a standard URL scheme (Ferreira, Macambyra & Lima, 2018, p.14-15). The authors believe these are important features of digital libraries which will support the study and research of art in the context of academic production (Ferreira, Macambyra & Lima, 2018, p.15).

In 2019, the IIIF was defined as “an indispensable infrastructure for digital humanities research” (Kitamoto, 2019, p. 1) and had already delivered over a billion images worldwide (Kitamoto, 2019, p. 1, Roddis, 2020; Manoni, p.313, 2022). In fact, in the realm of current tendencies in the management of digital media, Marshall Breeding believes that “the

combination of interoperability via IIF and large-scale shared repositories could significantly decrease the cost of managing images and other types of media for libraries and enable access for researchers to expansive collections while preserving the customized interfaces, branding, and access control inherent to the current environment of standalone repositories” (Breeding, 2018, p.18).

In 2019, the Veneranda Biblioteca Ambrosiana launched its new digital library and joined the IIF community (Cusimiano, 2021). Currently, the library is providing more than 290,000 IIF-compliant images (Cusimiano, 2021).

The main reason to adopt the IIF was to provide access to high-quality images of its manuscripts (Cusimiano, 2021). Adopting an OPAC-centered approach in order to maintain its bibliographical records, users from the library are presented with a Mirador link and can enjoy “an unprecedented viewing experience” (Cusimiano, 2021). This approach means that the Digital library management system deals only with the presentation of the images that are located externally from the OPAC (Cusimiano, 2021). The OPAC, on the other hand, is used exclusively for the description and cataloguing of the manuscripts (Cusimiano, 2021).

Also, in 2019, the digital repository from the National Library of Poland, Polona adopted the IIF as part of its development in technology and user experience (Rosa, 2019, p.27). Launched in 2006, Polona was the first digital library in Poland (Rosa, 2019, p.23). Their aim in delivering IIF Manifests is to deliver data from the National Library of Poland to the international community, promote openness in Poland (Wronkowska, 2018), and participate in an international consortium (Rosa, 2021).

Polona is a national interface with 42 content providers contributing with their resources (Wronkowska, 2018). The goals of Polona are centralization, openness and enhancing user experience by gathering widespread collections from the Polish GLAM sector (including small libraries) on a safe database and delivering images in a common interface in a standard way through the IIF (Wronkowska, 2018). By delivering high-resolution images in a standard way the library aims to allow users to decide how to reuse them (Wronkowska, 2018).

As a result of European funding for digitization, small libraries started digitizing their collections. It meant there was a maintenance cost, which Polona proposed to address by offering cloud-based storage for their content and by making it visible at Polona (Rosa, 2021).

Since 2013, Polona have been upgrading and redesigning what has become “a leader in the fields of technology, user experience and quality of provided images” and have switched “from being a simple image and metadata repository [to one] in favour of digital workspace [...] that provides tools for working with digital objects in a convenient web interface” (Rosa, 2019, p.23).

The University of Coimbra’s digital repository for old books (before 1940), AlmaMater (Miguéis, p.37) implemented the IIF Image and Presentation APIs as a result of new developments and it is providing to its users a more *appealing interface* for use (Silva *et al*, 2019, p.317).

Furthermore, since the launch of British Art Studies (a digital open-access journal published by the Paul Mellon Centre for Studies in British Art and the Yale Center for British Art) in 2015, “the evolution of the International Image Interoperability Framework (IIF) has offered the single most significant addition to the art historian’s tool set” (Card *at al*, 2019, p.161) as it allows viewing, zooming, and reassembling of “image resources that can be incorporated within the body of published texts, making both image-based and textual primary documents” (Card *at al*, 2019, p.162).

Since 2019, the Portuguese Early Music database (PEM) has been displaying IIF-complaint images (Ferreira, 2022, p.6n). The images are transformed into the TIFF format through the IIPImage server and displayed via OpenSea Dragon viewer (Ferreira, 2022, p6n).

The International Cultural Heritage Project “A World of Diamond Workers in Belgium, The Netherlands and France, 1895-2000” implemented the IIF in 2020 because they wanted to improve tools for history research (Veramme, 2021, p.6). Their requirements were improved interaction with and dissemination of their digital assets and enhanced accessibility through linked data (Veramme, 2021, p.6). These requirements were related to “extracting a certain region of an image, zooming, annotation, displaying metadata, showing pdf files, establishing strings of images, making the material easily sharable” in the context of their OPAC (Veramme, 2021, p.12). Previously, the library’s platform was limited since it presented only one image per record, lacked a full-text research tool and could not support newspaper presentation (Veramme, 2021, p.13).

Following the YCBA, the largest special collections library at Yale University, the Beinecke, launched its new digital platform in January 2021 to which 1.1 million images were migrated (Hirsch & Appleby, 2021). This new platform was established with the goal of creating manifests and an IIF image viewer (Hirsch & Appleby, 2021). The current navigation of items is smoother than in the older version where each item was opened in a new page (there was no image viewer integrated into the website) and images could only be zoomed (Hirsch & Appleby, 2021). Therefore, the use of UV or Mirador proved to be a great improvement in terms of the image viewing experience (Hirsch and Appleby, 2021) The goal is to unify the different libraries in this platform as museums from the University are also moving in the same direction (Hirsch and Appleby, 2021)

Stanford University libraries launched, in November 2021, a handbook about archival discovery and delivery in the context of a working group meeting of CHIs interested in the development of Virtual Reading Rooms (VRRs)<sup>28</sup> (Matienzo *et al*, 2021). In this report, it is suggested that the IIF has “the potential to set technological precedents and user expectations for digital collection access” (Arroyo-Ramírez *et al.*, 2021, p.166).

In 2020, the Towards a National Collection Initiative (TNC) was launched in the United Kingdom (UK) with the aim of supporting “research that breaks down the barriers that exist between the UK’s outstanding cultural heritage collections, with the aim of opening them up to new research opportunities and encouraging the public to explore them in new ways” (Towards a National Collection, 2020a). In this context, the “Practical Applications of IIF” working group was created to research how “IIF resources can be used as supplementary information to support and enrich online publications or exhibitions” (Towards a National Collection, 2020b) and to highlight opportunities and benefits that IIF standards can offer to a wide audience of institutions and researchers (IIF, 2020b). It also seeks to support smaller institutions with no image service or Information Technology department (IIF, 2020b) and to facilitate the creation of “new aggregated IIF presentations based on existing resources

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<sup>28</sup> A VRRS is “a controlled online research environment in which the discoverability and/or downloading of archival materials is deliberately limited, and/or access is restricted to users who have created a limited-term account and agreed to terms of use similar to those that apply in a physical reading room of an archival repository” (Society of American Archivists 2021).

(overcoming a significant barrier to its adoption)” for non-technical researchers (Towards a National Collection, 2020b).

The TNC has published its findings in the form of a final report that describes the IIF as “a mature, established ecosystem” that “operates beyond a purely presentational layer” (Padfield *et al*, 2022, p.3) and, according to the report, its adoption will reduce delivery costs and provide a shared common user experience (Padfield *et al*, 2022, p.3). Yet, “across the sector, there is some confusion about what ‘using IIF’ actually means, or what benefits it would bring”. The fear is it is creating a digital divide as “most IIF implementation [is] made in large-scale organization[s]” (Padfield *et al*, 2022, p.3)

The ARMA – The Art of Reading in the Middle Ages project by the Europeana Generic Services project and co-funded by the European Union, which ran between 2020 and 2022, had the following goals: (1) “to support European cultural heritage institutions by giving digital access to new medieval objects through Europeana” and (2) To explore “how these digitised items could be used in the classroom to demonstrate how reading culture in the Middle Ages became a fundamental part of European heritage” (Szynkielewska, 2022). In addition, all digitised items from the different partners within the project were required to have an IIF manifest (ARMA Consortium, 2021, p.5).

Overall, the seven cultural-heritage-institution members of the consortium<sup>29</sup> “provided over 34,000 new digital versions of medieval manuscripts, printed books and coins to Europeana and updated and enriched another 31,000 items already available through the Europeana website” (Szynkielewska, 2022).

In a report “Recommendations on the Implementation of IIF” (ARMA Consortium, 2022) each member describes the benefits and challenges of IIF implementation. In the case of the Hunt Museum (which contributed two manuscript fragments to the ARMA project), the benefits of the IIF for “a museum and cultural institution” are “its interoperability, ability to share and the tools and viewers which can be used” (ARMA Consortium, 2022, p.17).

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<sup>29</sup> The National Library of France, Hunt Museum, Manuscriptorium, Narodna in univerzitetna knjižnica (The National and University Library – NUK), Bruges Public Library, Staatsbibliothek zu Berlin (SBB) and Leiden University Libraries.

Bruges Public Library (another member of the ARMA Consortium) conducted surveys with non-technical users prior the development of the Mmmook project and found the following challenges related to the IIIF from a user's perspective: "the impracticality of combining various offline, IIIF-compliant and non-IIIF-compliant materials in research; the 'scary' technical jargon (e.g. 'manifests' and 'json'); the absence of IIIF-infrastructure at the user's institution; the lack of insight into the possibilities beyond basic functionalities (e.g. zoom); fear of investing too much time for too little profit, or of link rot" (ARMA ARMA Consortium, 2022, p. 19). The recommendations set by the report were to "provide basic non-technical education on the reuse of IIIF-data; provide rich metadata; invest in SEO as Google remains the main entry point for searches" (ARMA ARMA Consortium, 2022, p. 19).

In addition, other challenges were addressed by the members of the ARMA Consortium, which led to recommendations for the future implementation and development of the IIIF itself: (1) for institutions with the IIIF already implemented, it is recommended that they enrich the metadata of their items and make use of the *SeeAlso* property in the manifest to link original bibliographical information as the IIIF still lacks a metadata labelling standard (ARMA Consortium, 2022, p. 30); (2) when implementing the annotation feature (which was not implemented in the project because of limited time), institutions must be careful in managing them "to prevent and react to abuse, such as spam, copyright infringement and (other) illegal content" (ARMA Consortium, 2022, p. 31), setting "terms and conditions [for] creating annotations" or "having authentication and authorisation of users who can make annotations" (ARMA Consortium, 2022, p. 31), while having the annotations linked to manifests centralized for controlling what has been annotated (an issue still being investigated by the IIIF community) (ARMA Consortium, 2022, p. 31); (3) for multilingual manifests it is recommended to use both the *SeeAlso* IIIF property to link to structured metadata and to annotate the manifests with different languages that the IIIF supports (ARMA Consortium, 2022, p. 31); and (4) for those institutions ingesting images into Europeana (as was the case with Leiden University Libraries), it is recommended to "limit the size of the image requested from the server with the use of the IIIF link syntax" (ARMA Consortium, 2022, p. 32) to avoid problems with media processing and publication during the Europeana ingest workflow (ARMA Consortium, 2022, p. 31).



For Babcock & Di Cresci (2019), as the IIF community grows and more institutions implement the IIF, they will be more capable of increasing support for smaller institutions wrestling with the IIF requirements and/or those that do not have an information technology infrastructure or “that rely on vendor solutions for their digital repository needs” (Babcock & Di Cresci, 2019, p.193).

Another challenge associated with the IIF is its emphasis on the provider side. According to Joris van Zundert, the potential offered by the IIF is not yet fully exploited by the international scientific community because it is not easy to make scholars (in this case of philology) change their way of working (Pierazzo, 2019, p.14). Researchers from the ROIS-DS Center for Open Data in the Humanities (Japan) also believe that the current IIF specifications design is provider-centric, so it does not allow researchers to fully take advantage of it for their studies (Kitamoto, 2019). To address this problem, they developed a more user-focused functionality for the IIF called the IIF Curation Platform (Kitamoto, 2019,).

However, institutions that would like to pull IIF-compliant-images for their IIF-viewers will need the support of “content experts, such as archivists, historians, digital humanities and/or art scholars, who may be familiar with external repositories and sources of IIF content” as discovering such sources is a challenge (Magnuson, 2016). To address this, institutions usually make the IIF logo visible on their website or adjacent to the items that are compliant or use other forms of referencing (see the Guides for Finding IIF resources by the IIF community: [https://iif.io/guides/finding\\_resources/](https://iif.io/guides/finding_resources/)).

In conclusion, the IIF stands, in the literature, as an alternative to the current paradigm of digital repositories on the web, which proposes a new approach to the management of online image collections and practices for accessibility and reuse of resources on the web. In other words, the IIF is considered “a fundamental and indispensable piece for the creation of a new digital library” (Cusimano, 2019, p.134). Furthermore, “[...] If it were created a real movement to support the growth of IIF as a ‘lingua franca’ in the management of online image collections, we could have in a very short time a real revolution in the way of exploring and enjoying the immense digitized cultural heritages already available via Web” (Salarelli, 2017, p.65).

### 3.3 The IIF in Portuguese CHIs and universities

Through the literature review, Portuguese institutions and projects that had implemented or are planning to implement the IIF technology were identified. Also, an institution was identified through a presentation abstract at a conference and another through a digital humanities workshop.

However, the only Portuguese institution identified as an IIF adopter on the IIF Implementation and Consortium map<sup>30</sup> is the University of Porto.

*Table 5 - Portuguese institutions identified as present or potential IIF adopters.*

<b>Institution/Project</b>	<b>IIF implementation</b>	<b>How was identified</b>
Az Infinitum – Azulejo Referencing and Indexation System	Planning	Literature review
Portuguese Early Music Database (CESEM/FCSH-NOVA)	Implemented	Browsing at the PEM website and Literature review
AlmaMater (University of Coimbra)	Implemented	Literature review
National Library of Portugal (BNP)	Planning to implement the IIF in the context of the Europeana aggregation in which the BNP participates.	Via e-e-mail inquiry
“From Data to Wisdom” (Instituto de Filosofia - Faculdade de Letras, University of Porto)	Implemented	IIF Reader Workshop at DH Lab (NOVA/FCSH)

<sup>30</sup>The IIF implementation and consortium map is available through the following link: [https://www.google.com/maps/d/viewer?mid=1faJRKJpj2Vau\\_RDwt8af040x0GTVozp&ll=30.177259383498008%2C-6.825096623594831&z=3](https://www.google.com/maps/d/viewer?mid=1faJRKJpj2Vau_RDwt8af040x0GTVozp&ll=30.177259383498008%2C-6.825096623594831&z=3)

Casa Sarmento (University of Minho)	Implemented via Omeka S	<i>IV Jornadas de Open-Source</i> conference abstract (2022) and via e-mail inquiry.
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### 3.4 Trends in Library infrastructures and services development

In 2015, an extensive study on the process and rationale for library DAMS migration was conducted (Stein & Thompson, 2015). The main conclusion reached was that libraries were migrating to open-source software, which was linked to a high-score desire for more local control and autonomy of their assets (Stein & Thompson, 2015). Through a survey, the study identified five major reasons for DAMS migration: (1) content management, (2) metadata, (3) Extensibility, (4) Preservation & User Interface customization and (5) Technical support (Stein & Thompson, 2015). The rationale or institutions for this migration was based either on the dissatisfaction of their current system or future needs (Stein & Thompson, 2015).

The desire for more local control and autonomy of assets is apparent from the Extensibility section of the survey where the questions “Institutions can create their own modules/plugins/widgets/etc. for the ‘New DAMS’” and “‘New DAMS’ to have an available API” scored at the top (Stein & Thompson, 2015). At the same time, “The code base is available for everyone to see and use (open source)” question scored high, which led the researchers to conclude that institutions are looking for open software options (Stein & Thompson, 2015).

Within content management, scalability (such as the ability to store large amounts of data without negatively impact system performance) and extensibility were two major features highly desired. The importance attached to extensibility and scalability can be linked to another trend in digital asset management, which is the migration from a monolithic infrastructure to a microservices infrastructure (Stein & Thompson, 2015).

The microservices architectural model “is an approach to developing a single application as a suite of small services, each running in its own process and communicating with lightweight mechanisms, often an HTTP resource API” (Lewis & Fowler, 2014). The word refers not to its small scale but rather emphasises how “each service is fine-grained, [with]

high cohesion to focus on fulfilling a granular responsibility” (Jaramillo et al., 2016). Moreover, “each service should be treated as an independent application with its own source code repository and delivery pipeline” (Jaramillo et al., 2016).

Some of the IIF’s implementation in University Libraries was a direct result of attempts to address the use of a non-appropriate monolithic architecture as a solution for replacing obsolete systems. Instead, for the institutions discussed below, a microservices approach was seen as better suited. Furthermore, the IIF approach can potentially make the accessibility of digital collections more sustainable (Babcock & Di Cresce, 2019, p.190).

In 2016, the University of California, Los Angeles, began a migration from out-of-date and closed software to adopt a microservice around the IIF application that consisted of three independent services: (1) image preparation/transformation, (2) IIF manifest generation and delivery, and (3) IIF image server delivery with the aim to alleviate their open-source digital repository software, Samvera, from handling the load of those tasks (Gomez et al, 2020; McAulay, 2021).

The services selection choice was made based on a tooling approach: for image transformation, they chose Kaduku for JPEG2000 transcoding, Cantaloupe as their image server and Amazon’s AWS (a cloud) to store images and act as a server (Gomez et al, 2020). These microservice suite components can be changed or replaced while not affecting others (McAulay, 2021). Previously, the institution’s system was built locally making it isolated and unable to share code (McAulay,2021).

The benefit of this approach is that the institution has an improved system with nimbler development and maintenance (McAulay,2021). On the other hand, a microservice approach has the downside of are a never-ending series of new implementations (McAulay, 2021).

After failing to identify a monolithic solution, the Boston College Libraries replaced their discontinued repository platform by adopting a microservices architecture approach, which would continue to support “METS in their workflow and maintain the order and relationship among multiple constituent files in a single object” (Mayo et al, 2019). The Boston College Libraries wanted to maintain the same experience in the archives reading room by providing a high level of structural description. To achieve this, they realised they could use

METS in their workflow to generate IIIF manifests, which would be displayed in Mirador along with their structural information (Mayo et al, 2019).

In 2013, the University of Toronto Libraries created a web discovery portal, Collection of U of T, as a direct response to the need of archives and libraries departments, faculty, and outside partners for technological support to make their collection available online (Babcock et al, 2020). In 2016, the IIIF had been implemented and now has become the main images delivery service as every image and collection in the repository has an IIIF manifest (Babcock et al, 2020). The infrastructure of Collections of U of T is made up of “pluggable pieces”, which means every stage of ingest works through different scripts implemented independently throughout, including the creation of IIIF manifests (Babcock et al., 2020).

However, for the UTL, the IIIF still cannot perform every task available in robust repository platforms such as preservation while search and discovery through IIIF-compliant views is yet to be thoroughly researched (Babcock & Di Cresce, 2019, p.190).

Another example of a microservices approach is the one implemented by the Harvard University Libraries which host over 55 million images in their IIIF infrastructure (over 3 million of these are from the museums’ collections) (Amaral, 2022). The microservice approach was chosen because it covers the university’s architectural principles design that consists of *separation of concern*, *single responsibility*<sup>31</sup> and the *principle of least knowledge* (Amaral, 2022). In this case it translated into different services modules: Login, Asset Lookup and Manifest conversion (e.g.) (Amaral,2022).

Moreover, the growing digital and network environments of libraries reflects two other trends: “the reorganization of research work by the digital environment” and “the reorganization of the information space by the network” (Dempsey, 2016, p.339). These new roles for the library are based on a model coined as the inside-out library.

The first trend is related to the increasing role of the library as both a creator and a supporter of learning and production of research outputs by internal users (Dempsey. 2016, p.339) while sharing the research outputs with the world.

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<sup>31</sup> Each module or service has a specific responsibility.

In the inside-out model, the library collections and services are built around users' research and learning needs and workflows. One service of the inside-out library is the support of digital scholarship and digital humanities projects (Dempsey, 2016, p.345). This includes the support of faculty web-based projects and the creation of learning materials (Dempsey, 2016, p.345).

The second trend is related to the shifting of the library's role as a buyer and collector of material for local use towards being a facilitator of services and information available both locally or externally through a network of library collaborations or other third-party partners with the aim of meeting users' needs or expectations (Dempsey, 2016, pp.339, 341 and 350). Reflecting this trend, libraries are increasingly providing access to "network resources they do not own or license" and participating in aggregation efforts to "unite collections and potential users" (Dempsey, 2016, p.350-52).

Other adoption tendencies identified in the Stein & Thompson study (2015) include a trend towards using open-source software by institutions. Open-source software (OSS) or Free and open-source software (FOSS) has now been a reality for the last decade (Wasserman et al., 2017, p.193). Open-source software can be described as follows:

*Open source is a term that originally referred to open source software (OSS). Open source software is code that is designed to be publicly accessible—anyone can see, modify, and distribute the code as they see fit.*

*Open source software is developed in a decentralized and collaborative way, relying on peer review and community production. Open source software is often cheaper, more flexible, and has more longevity than its proprietary peers because it is developed by communities rather than a single author or company.*

*Open source has become a movement and a way of working that reaches beyond software production. The open source movement uses the values and decentralized production model of open source software to find new ways to solve problems in their communities and industries. (Source: <https://www.redhat.com/en/topics/open-source/what-is-open-source>).*

The origins of the IIF are in a group of technologies from libraries that sought to solve issues around the accessibility of resources on the Web. More specifically, the IIF is "a set of

open standards for delivering high-quality, attributed digital objects online at scale” through its public APIs. The nature of open-source code means that the IIF supports other open-source tools, as is the case for many IIF-compliant tools like the IIF Archiver and IIF-compliant viewers such as Mirador. Thus, joining the IIF is a natural step for institutions that already support open-source software, such as the University of British Columbia (UBC) Library (UBC, 2022).

However, incorporating IIF technology “into existing legacy applications that host high resolution images is a challenge” (Magnuson, 2016) as institutions do not “necessarily want to build a separate IIF image server” and may prefer to store their high-resolution images in their current repositories (Magnuson, 2016).

In 2017, the IIF museums group sent a letter to more than 70 DAMS vendors asking them to incorporate native IIF support into their products:

*We are confident that some of the IIF viewer clients would be useful as components of your product, and utilizing IIF could be a cost-reducing effort. IIF integration provides software vendors with a growing market of repositories and their users looking to utilize IIF, a guaranteed web- and standards-friendly framework aligned with existing W3C specifications, and the ability to offer your clients innovative new uses and features from native capabilities. Furthermore, providing IIF-support to your clients will allow them to present more compelling digital interfaces, provide increased interactivity and scholarly research with their images, and publish their images so they can be collocated with other relevant images from other cultural heritage organizations. (Source: <https://iif.io/news/2017/05/01/letter-to-dams/>).*

In the same year, the Online Computer Library Center (OCLC) incorporated the IIF core APIs into proprietary software CONTENTdm which is considered “the most widely implemented digital asset management systems used by libraries” (Breeding, 2017). In the year before, the Luna Imaging incorporated the IIF support into the Luna software (CHDS, 2018). The incorporation of IIF into Luna was driven by their biggest client, David Rumsey collections at Stanford University (Renton, 2017).

However, Lauren Magnuson believes that “it may be some time before legacy digital asset management applications integrate IIF easily and seamlessly” (Magnuson, 2016).

### 3.5 Literature review – summary

The summary of the main findings from the literature review are listed below:

#### The advantages of IIIF implementation

##### **Interoperability**

To become internally and externally interoperable is one of the main reasons institutions implement the IIIF. The interoperability aspect of the IIIF is very attractive as it allows institutions to disseminate their content and metadata for external re-use, making them more openly accessible and FAIR-compliant. Also, IIIF interoperability elements enhance aggregation and centralization efforts with the possibility of providing a single access point for resources of different institutional origins while supporting partnerships among them. In addition, the IIIF model allows parts of the same object be reunited in the browser through its shared canvas.

##### **Modernization of Infrastructure and DAMS**

Most institutions feel the need for a modernization of their TI infrastructures and to create their own solutions for long-term distribution and ingest of content. The IIIF is also considered a suitable solution for those institutions lacking funding for infrastructure expansion and improvement of content management. In addition, the IIIF is a faster and more sustainable option.

Also, institutions wanting to provide new and better services to their users, like access to high-resolution images, led to IIIF implementation.

On the other hand, IIIF-compliant software and DAMS migration have led institutions to re-think their digital image delivery workflows to accommodate IIIF modules. In addition, the migration from a monolith infrastructure to a microservice approach has also been influenced by IIIF implementation.

The nature of the IIIF enables institutions to eliminate duplication of images and create on-the-fly derivatives of them which means internal systems become more scalable and



extensible while delivering content becomes less-time consuming and cheaper. Moreover, institutions look for solutions that will not overload their servers.

Also, providing high-resolution images to users while maintaining control of copyrights and the reuse of images are seen as advantages of the IIIF.

### **New users' behaviors and needs**

The behaviors and demands of users led to the transformation of services and products of information providers. Institutions want now to provide tools that enhance research and teaching, which IIIF supports by enabling user interactivity with resources through deep zooming, panning, cropping, annotating, and sharing. The ability to have different resources in the same viewer for the purposes of comparison is highly beneficial for GLAMs and university libraries that wish to provide resources for researchers and students.

Through the IIIF-compliant tools like Storiis, Exhibit, Omeka S and C (among others), users can disseminate knowledge, share research outputs and improve remote teaching with the possibility to embed IIIF manifests into their websites.

Also, the interoperable nature of the IIIF means institutions can provide a collaborative workspace for researchers. Through the IIIF-viewers, users can have access to multiple images at the same workspace and they not no longer need to download and store the images locally. In addition, the IIIF supports crowdsourcing projects through its annotation feature.

The IIIF can also maintain and present current metadata schemes and formats (MARC, MET, e.g.) and reproduce the experience of a reading room or classroom. For some institutions, the IIIF enhances the quality of damaged documents, and it has the power to reunite dispersed parts of resources into a single viewer. For some institutions, the IIIF's tools have improved research in humanities subjects like Art History and History

Also, the implementation of a basic IIIF project demands a minimum of IT effort, which is beneficial to individual or small digital projects.

### **Outreach and Sector influence**

The implementation of the IIIF is also influenced by the growing number of adopters among the CHIs. As institutions are making their resources more accessible, they want to improve their presence and re-use of their content while reaching new audiences.

More specifically, for a few institutions working in inter-institutional projects, IIIF implementation was the consequence of a successful implementation in a specific department of the institution.

Also, the IIIF supports the creation of online exhibitions that showcase collections at low cost.

### The challenges/risks of IIIF implementation

#### **Managing internal and external resources and staff**

The first challenge institutions must overcome is their internal silos. In bigger institutions with several departments, contents and resources can become isolated. The IIIF demands different types of professionals from different departments to work together which can cause an imbalance within teams. The challenge for institutions is to allocate the right number of resources and expertise while managing the involvement of external partners and vendors in the project.

#### **Institutions' lack of technological and human resources**

One big challenge for institutions is a lack of dedicated resources, either technological or human. The digital skills of staff are also mentioned as a challenge for implementation, since technologies like the IIIF demand a minimum of IT knowledge, specific expertise, and time.

#### **IIIF APIs and IIIF manifests limitations**

The fact that the IIIF does not directly support metadata aggregation is a challenge for institutions. This is due the fact that the metadata inserted in the IIIF manifest is only contextual and is not readable by machines (only humans), which is a challenge for the search and discoverability of resources. Also, the metadata in IIIF manifests are not standardized which means different institutions can use different metadata schemes.

Although some efforts have been made through the development of user-centric tools, the IIF focusses mostly on providers of resources than the user which limits the potential use of the IIF by researchers.

Also, institutions are confronted with the challenge of integrating (and maintaining) the traditional practices of management and delivery of information resources into a new application and software.

Although it complements or improves already existing solutions, the IIF still lacks in its development capacity for the preservation, search, and discovery of images through IIF-compliant viewers. Also, annotations are not yet centralized and institutions cannot easily locate all the annotations that have been made on their items.

#### **Institutions lack IIF resources control**

Institutions do not have a roadmap for IIF implementation and neither control IIF or IIF-compliant viewers, resources and standards procedures.

Also, IIF-compliant images can be viewed outside their institutional repository platforms of origin, which means that they can be viewed in more than one place on the web. Consequently, the original institution loses its main function – to provide accessibility to its own resources.

#### **IIF shortcomings on promotion and universality**

The IIF is not well known among information science, CHI professionals and institutions' top managers. Thus, IIF benefits are still confused or unclear. In addition, the main IIF working language is English, which can be a barrier for implementation for institutions speaking other languages.

Also, the IIF is mainly implemented by large-scale institutions, which may cause a digital divide in the sector.

## 4. Results of the interviews

### **General overview**

This study investigates the following research question: *What are the advantages and the challenges of IIF implementation by CHIs for the accessibility and reuse of cultural heritage resources on the web?*

With these questions in mind, an interview guide was built around the following topics: adoption reasons, challenges, and benefits. In total, five interviews were conducted with professionals from one national library, two research units and two university libraries from different European countries.

This chapter presents the results of a thematic analysis of the interviews conducted manually on Microsoft Word. The final thematic map (see Figure 30 below) is based on the research question, which is divided into two main themes: IIF Implementation advantages and IIF Implementation challenges. The thematic map was created firstly by placing these at the top. From there, each interview was analyzed individually in a separate Word file where a table with two columns was drawn. In the right column appeared the interview text while in the left column the codes. The codes are descriptions or summaries of the data. During the process of coding, the extracted data was highlighted for matching with the related themes in the final report.

The next step consisted in sorting similar codes (or descriptions) into groups. Later, once the subject of each code was identified, sub-themes were created. Afterwards, the identified sub-themes were placed underneath the main pre-defined main themes to create a thematic framework.

The following illustration shows an example of this process. I selected a part of one of the interviews from which I extracted four codes: (1) the need to improve data openness and delivering full-resolution image, (2) data openness goal (3) the support of IIF in the institution policy in accessibility of full-resolution materials that can be made public and (4) the goals achieved were: Promotion of data openness and new developments.

The need to improve data openness and delivering full-resolution image	<p>What were the issues or needs that led to the IIIF implementation?</p> <p>We strived to improve our data openness. Our open API facilitated metadata harvesting but did not provide a mean for downloading images in full resolution, that's where IIIF came in handy.</p>
Data openness goal	<p>What were the goals and expectations related to the implementation of the IIIF?</p> <p>The goal was to improve our data openness. No other reason was needed.</p>
The support of IIIF in the institution policy in accessibility of full-resolution materials that can be made public	<p>How is the IIIF complaint with your institution's digitization and online accessibility strategy?</p> <p>We support full accessibility of full resolution materials that can be made public according to copyrights. That's why we didn't need to hide our manifests and image links inside them.</p>
The goals achieved were: Promotion of data openness and new developments	<p>What goals or expectations were met?</p> <p>I believe that we promoted data openness in our country and were met with enthusiasm during several international events and workshops. IIIF also helped a lot during the development of a new version of [the website] (scheduled to launch next year)</p>

Figure 30 - illustration of a thematic analysis (coding the interview in Word Ms)

The four codes were placed together in the same group related to the issues/needs that led to IIIF implementation.

As Open Access was a common theme, a sub-theme was created called *Alignment to the open access policies* around which the codes were clustered. Also, the need for Interoperability was identified as a common theme in other extracted codes. A subtheme related to interoperability was subsequently created in which all the codes related to it were placed together.

Finally, both sub-themes were placed underneath the pre-defined main theme, *Advantages of IIIF implementation*. The thematic map, created as a result, is as follows:

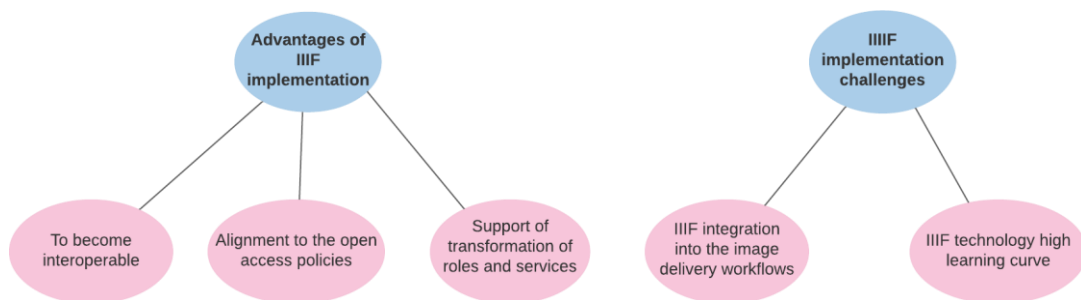


Figure 31 - The thematic map with two main themes and its sub-themes.

The analysis of the framework will be divided into each main theme, followed by its sub-themes. It will focus on the answers given by the different respondents. The aim is not to analyze each interview specifically but to observe similarities and differences between the different interviews in order to understand IIIF implementation from a general point of view.

## **The advantages of IIIF implementation**

The first main topic investigated was the reasons that led institutions to adopt the IIIF. From the literature review it was clear that the reasons ranged from a future need to a problem that needed to be solved. In addition, the potential benefits gained from implementation are seen as motivations towards implementation or the continuing use of the protocol.

Overall, the data revealed that IIIF advantages are as follows: (1) alignment of open data policies, (2) interoperability and (3) a route to the transformation of roles and services provided.

- *To become interoperable & alignment to open access policies*

One of the main advantages for IIIF implementation cited by the institutions interviewed for this study is interoperability. The interoperability aspects of the IIIF supports the institutions that want to make their resources more accessible and available for reuse. Also, it allows them to have their systems linked to other external systems.

For example, one of the reasons that led to IIIF implementation for respondent 2 was that they previously had “no standard for image interoperability”, and even though they “had a good body of content in the image repository, [...] it was not particularly interoperable”. However, they wanted the availability requirements of their images on their websites to improve: “we knew we could take our image provision to supply websites a step further”.

Thus, their goals were “[...] allowing systems to talk to each other better; letting [...] images be used in the outside world more”. In addition, they wanted interoperability between theirs and their partners’ systems: “The great thing about the [aggregation] site is that it actually hosts content ACROSS institutions [...] – it comes STRAIGHT from their systems”.

Similarly, respondent 3’s goals behind IIIF implementation were to improve the presentation and interoperability of their digital heritage resources and therefore to increase the promotion and reuse of them: “To improve presentation and interoperability of the digital heritage [...] of the institution. To increase the promotion and use of digital heritage [...] in the context of research and to promote it to the general public”. When asked what the main benefits of IIIF implementation are, respondent 3 answered that they are the “[...] sharing and interoperability of contents” and the potential given to resources promotion.

Moreover, the development of data openness or access policies in the sector and within the institutions are also seen as advantages of IIF implementation as it supports these practices.

When asked how their involvement with the IIF began, respondent 1 replied: “At that time [joining the IIF consortium in 2017] we were undergoing a full remake of our systems to better fit our data openness policy. In 2017 we also received around 20m euros in funding for digitization of 1m digital publications [...]. One of the requirements of the project was to share those publications in a way that enables mass access to them. IIF seemed to be the way to facilitate that access”.

Although they already provided metadata and images of their resources through their open API, they wanted to improve access to their open data by providing high resolution images for download: “[...] Our open API facilitated metadata harvesting but did not provide a mean for downloading images in full resolution, that’s where IIF came in handy”.

When asked what their goal with IIF implementation was, they replied that “The goal was to improve our data openness. No other reason was needed”. As a result of implementation, they believe they achieved their goal: “I believe we promote open access in our country”.

Also, when asked how the IIF is complaint with their institution’s digitization and online accessibility strategy, they replied that they “support full accessibility of full resolution materials that can be made public according to copyrights”. Their aim in doing this was to ensure that materials are not hidden.

When asked if the IIF is aligned with their digitization and accessibility strategy, respondent 2 replied that the IIF supports their commitment to open source and open access: “We do have a commitment to Open Source, and obviously making as many of our images open as possible, which IIF completely supports”. They also stated that “The whole point of IIF is that our images can be used by external users”.

When asked the same question, respondent 3 expressed the belief that the technical nature of the IIF’s structure is an advantage for the easy promotion and sharing of digital resources on the web: “IIF uses linked data models and web protocols standards that enables and guarantees, in an easy way, the access, promotion, and sharing of digitized resources on the

Web”. In addition, respondent 3 learnt about the IIIF at an open access conference: “We have learnt about IIIF at a conference about open access”.

Furthermore, respondent 5 said that when they implemented the IIIF they already had a fair number of digitized resources but only some were available in open access “[...] At the moment of IIIF implementation, several hundreds of musical manuscripts were already digitized, however we have so far only made a small percentage available in open access on the internet”.

- *The transformation of roles and services*

Throughout the data, the institutions mention front-end features and user accessibility improvements they had in mind when implementing the IIIF.

The need for better visualization of images also appears to be a relevant factor for implementing the IIIF. Respondent 1 said that their open API “did not provide a means of downloading images in full resolution, that’s where IIIF came in handy”, while respondent 2 stated that the IIIF was implemented because, among other reasons, they had “[...] flat websites with no deep zoom [...]”. Furthermore, in adopting the IIIF, their expectation was to have “great user engagement”.

For respondent 3, the IIIF promised to improve navigation and search at the front-end of their digital library: “The idea [of implementing the IIIF] [...] resulted in the necessity of improving navigation and search in the digital library [...]”.

In addition, for respondent 4, one of the main reasons for IIIF implementation was that they “wanted to use the zoom functionality to display digital facsimiles together with [...] transcriptions of texts using TEI Publisher”.

For respondent 5, however, only one issue was mentioned that led to IIIF implementation, namely “because the zoomify module was not working any longer in Drupal 7” and their expectation was that image visualization would be easier and faster. In fact, for respondent 5, the IIIF is aligned with their digitization and online accessibility strategy because it “allows greater speed and ease of image visualization and sharing of annotations [...] about each image”.



On the other hand, the IIF is also being used to develop new tools. Respondent 1 stated that the main benefit of the IIF is using its resources in the process of developing new tools: “The main internal benefit is a possibility of using our resources during development process of new products. Some of our employees also use IIF to develop image recognition and handwriting detection tools”. Likewise, respondent 3 met the goal of developing “some functionalities based in the annotation adoption”.

### **Challenges of IIF implementation**

The challenges to IIF implementation are related to IIF integration into image and metadata delivery workflows. Also, the IIF’s high learning curve is seen as an obstacle for easy implementation.

- ***IIF integration into image delivery workflows***

During IIF implementation some institutions felt frustrated by the need for data conversion and storage of IIF-compliant resources. For instance, the main challenges for respondent 4 were the “Lack of enough storage for big files, difficulty in converting TIFF into Pyramid or creating manifests from existing metadata records”.

Also, the size and formats of the content put the functionality of the image servers at risk and, consequently, access to the images at threat. Regarding this, respondent 5 said that “Since a good resolution for the images [...] is essential to have, this requirement overloaded the website host server, putting the operation of the website at risk”. Equally, respondent 1 had their servers overloaded when they had a large number of people asking for images from their API at the same time: “The only risk [of the implementation] was that image harvesting would overload our servers, and it happened on several occasions when some bigger workshops took place and a large group of people used our API”.

In fact, the biggest challenge for respondent 5 was “[...] the migration of images and its associated data” and the fact that they also still need to “to optimize the link between the site and image server”. The integration of CMS such as Omeka and Drupal were identified between the respondents. Also, for respondent 5, “the configuration of the IIF server and the connection to Drupal” were among the main challenges.

For respondent 2, there is a risk of losing information or of sharing resources that are not public via the IIIF: “There is a danger of putting something out through IIIF which really shouldn't be public, but that should be captured prior to upload”. They gave an example of the integration of their partners’ resources into their workflow via the Image API, which is problematic because of the absence of provenance information: “The use of Cantaloupe (Image API only) for other people's content was contentious: it's just images, so you lose some important provenance/rights information, unless you're working with metadata (you only get that with Presentation API). That simply served a purpose- without the website the information is lost”.

In addition to that, respondent 1 believes that more metadata should be required and mapped onto popular metadata schemes: “There should be more mandatory elements of manifests. Some of the metadata elements should be mandatory and be mapped to a popular metadata standard (based on schema.org or RDF or any other popular schema), for example title and release date”.

Both respondents 1 and 3 think the implementation of annotations can be difficult. Respondent 1 decided not to implement them at all: “[...] The annotation part of IIIF is slightly too complicated and for this reason we decided not to use it”.

- *IIIF technology high learning curve*

For four of the respondents, IIIF implementation is difficult for institutions lacking dedicated resources and knowledgeable staff.

For respondent 1, although the IIIF is well received internally, “it is still challenging often for non-technical staff to understand how to use the APIs”. The lack of dedicated and knowledgeable staff can lead to implementation risks, as noted by respondent 2: “The main risks were the availability of human resources to do the content migration for our new model and its validation”.

Currently, for respondent 5, “there is a lot of necessary technical knowledge for its [IIIF] implementation”. With the same perspective, respondent 4 believes that the IIIF “[...] requires infrastructure and resources that sometimes are not available in small institutions”. Also, respondent 3 agreed that “the learning curve for IIIF implementation is considerably high”.

Respondent 4 likewise described the impact of a lack of expertise and dedicated resources in their partner institutions, such as the Cuban institution they work with: “The problem that we are dealing with is that our partner institution is very small and it is in Cuba, where there are other priorities like preserving physical documents rather than sharing online. So the budget is very small and there is only one person working on digital repositories and access. Plus, this person only just took the online course on IIIF, watched the youtube videos and read the documentation”.

For respondents 4 and 5 the IIIF would be improved by becoming more universal, to be deployed in smaller institutions or /and by non-technical staff. Nevertheless, for respondent 2 one of the challenges for IIIF implementation is convincing people: “Winning people over”.

## 5. Discussion

This discussion chapter will be divided into two sections: (1) *What are the advantages of IIIF implementation by CHIs for the accessibility and reuse of cultural heritage resources on the web?* and (2) *What are the challenges of IIIF implementation by CHIs for the accessibility and reuse of cultural heritage resources on the web?*

*The discussion* will be based on a comparison of the interview findings and the knowledge gathered through the literature review.

### *What are the advantages of IIIF implementation?*

The IIIF can be deployed by institutions for several reasons. In the analysis of the interviews, I reached the conclusion that the advantages relate to the desire of institutions to become more interoperable, to become more accessible and open and to improve their services and products.

From the interviewees’ responses, it is clear that the interoperable nature of the IIIF APIs has motivated institutions to adopt the protocol. Improving the availability of their images and requirements on their websites, or improving accessibility, promotion and re-use through interoperability are all examples of why institutions interviewed implemented the IIIF.

The idea of sharing and exchange information between institutions is possible through the IIIF APIs which also enhance aggregation and centralization of content. One of the goals of respondent 1 was to allow communication between their system and their partners’ so

images can be used anywhere, which is attainable through the IIIF Restful APIs. As noted in the literature review, the IIIF was developed and built to eliminate silos from CHI repositories, which are locked up and isolated (Card *et al*, 2019, p.161) and in this way, the IIIF APIs are employed by institutions so they can “create a network of content” (Ying and Shulman, 2015).

Also, they needed interoperability of content from other institutions participating in their aggregation site. Through the IIIF APIs, the partners’ content “comes STRAIGHT from their systems”. This is also related to the ability to create on-the-fly derivatives of resources, which is mentioned as an advantage of the IIIF throughout the literature as institutions that share digital objects do not need to make low resolution copies (ARMA Consortium, 2022, p.9). Instead, they can access high-resolution files with IIIF manifests (ARMA Consortium, 2022, p.9) which reduces time and hosting costs (Robson, 2016).

From the literature review, similar examples of employing IIIF APIs to help aggregation are found. For example, Biblissima implemented the IIIF to provide “a single access point for a large number of digital facsimiles from three different image repositories” (Frunzeanu, Robineau and MacDonald, 2016, p.127). Also, the NWL implemented the IIIF because they would be become interoperable and answer to the image requests from other IIIF-compliant institutions (Robson, 2016).

In addition, the literature review identified that institutions are implementing IIIF as a result of what is being done within the sector or because the IIIF is set as a requirement for projects they are joining. As examples, the National Gallery of Art Library implemented IIIF because other departments in the museum had already implemented IIIF while IIIF has also been implemented in the project they were participating in. Likewise, the ARMA project for the digitization of medieval manuscripts required that all digitized items be IIIF-compliant. Similarly, Respondent 1 in the interviews implemented the IIIF because the protocol covers the requirements of the project they were involved in.

Although in the literature review this relationship is not obviously visible, in the interviews, some answers pointed to a direct link between the implementation of the IIIF and

the adoption of open access ideals among institutions<sup>32</sup>. However, it suggests that institutions tend to first implement open-access materials with the IIF and then, as they develop their framework, implement restricted resources. Yet, in the interviews, respondent 1, for example, reported having all IIF-compliant images in the public domain. In fact, throughout the interview given by respondent 1, the connection between the goal improving open access and deploying IIF functionalities to achieve that goal is evident. Therefore, becoming open access is not only about providing access to resources in the strict sense of the word but, for respondent 1, was about providing high-quality images that can be downloaded by the users, which IIF supports.

Throughout the Perspectives and adoption of IIF chapter, it was found that institutions wanted to provide access to their resources, to support interoperability between peer-institutions and to develop and provide tools for user engagement and interactivity. All these goals and features are aligned to the open-access movement.

Pursuing this matter in more detail, respondent 1 made this connection clear by noting that improving open access is the reason for IIF implementation, since its funding was conditioned on providing mass access to their publications which IIF endorses.

Moreover, for respondent 5, IIF implementation made their institution put more resources available in open access. Before implementation, only a small number of open-access resource were made available.

In addition, respondent 2 mentioned that they are committed to both open access and open source when asked if the IIF was aligned to their digitization and accessibility strategy. As mentioned in the Trends in Libraries infrastructure and services chapter, the IIF is an open-source framework. The implementation of the IIF by institutions that already deploy open-source software may be linked, as was identified above in the case of University of British Columbia Libraries, but further studies are needed to reach a definitive conclusion on the matter.

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<sup>32</sup> One of the respondents learnt about the IIF at an Open Access conference. The lack of studies on the relationship between the open access initiative and the IIF is an opportunity for research on this topic as it would be beneficial to understand their mutual influence or even understand if they are in effect a joint endeavor.

The demand for resources that enable comparison of high-resolution images from different institutions in the same browser, or the ability to open them in any viewer while being able to deep zoom have been tackled by IIIF (Reed, 2018). Also, as noted in the Perspectives and adoption chapter, these sorts of functionalities of IIIF and IIIF-compliant viewers and tools were mentioned as having the power to enhance academic research production and outputs (Ferreira, Macambyra & Lima, 2018, p.15; Frunzeanu, Robineau and MacDonald, 2016, p.127). Indeed, libraries are adopting the role of a supporter of research production (Dempsey, 2016, p.339) as well as a facilitator for creating aggregated resources (Dempsey, 2016, pp.339, 341 and 350), including for example, the digital reconstruction of the physical structure of a book parts of which are owned by more than one institution (Task Force on Preparing Europeana for IIIF Involvement, 2017, p .7).

The interview respondents were similarly occupied with questions related improvements of user engagement and expected that with the IIIF implementation they would begin to address them. The upgrades they were making were related to a need for better presentation of resources on their front-end of websites with deep-zooming functionalities. Also, improvements to navigation and search on the front-end were likewise reasons for IIIF implementation. Moreover, two respondents mentioned that the IIIF had benefitted them from the point of view of developing of new tools such as image and handwriting detection tools, joint display of images and transcriptions (with TEI Publisher) and in the building of functionalities around the IIIF annotation feature. These initiatives relate to how digital repositories and services as a whole are increasingly linked to the integration and creation of new digital tools for remote learning (Exhibit, e.g.), online exhibitions (Omeka plugins, e.g), image layers analysis (as exemplified by the V&A museum image registration project), crowdsourcing and annotation, image storing (DetekIIIF, e.g.) and others.

#### *Challenges of IIIF implementation*

One of the challenges institutions faced identified in the literature review is to maintain their server stable when transferring and sharing resources, avoiding overloading (Reed, 2018). A microservice approach at the University of California, Los Angeles was seen as one potential solution (Gomez et al, 2020; McAulay, 2021). However, respondent 1 had their servers overloaded when they had many people asking for images from their API at the same time

during a workshop. Also, pyramidal formats files are essential for an Image Server to work efficiently (Roddis, 2020) but according to same respondent “this requirement overloaded the website host server, putting the operation of the website at risk”.

In addition, institutions can decide only to deploy the Image API but the isolated use of this API can be dangerous, according to Respondent 2, as it does not provide important metadata such as information on provenance or copyrights. For respondent 2, embedding images into a website can avoid the loss of information. However, even working with a Presentation API that provides metadata can be a challenge for institutions that are aggregating content as the IIIF does not require a metadata standard (Manoni, 2022, p.314).

For example, the Mmmonk project’s efforts to aggregate 820 medieval manuscripts involved having to manually validate 120 of them (Veramme & Hauwaerts, 2022). However, this is a problem that has been recognized by some institutions as the interview responses showed. For example, respondent 1 believes the IIIF could improve if it established more mandatory metadata elements into the manifests and used a popular metadata scheme.

Deploying CMS like Omeka into IIIF implementation was widely identified throughout the literature review. Although, no challenges associated were mentioned, one interviewee mentioned that the connection to Drupal pointed to a challenge in IIIF implementation. Therefore, in future studies, this topic should be investigated more properly, since Omeka, specially is viewed as a great alternative for individual or small projects as it is a more affordable option (Di Cresce, 2020).

Furthermore, for four of the respondents, IIIF implementation is difficult for institutions lacking dedicated resources and knowledgeable staff. As the responses of several interviewees show, facing the IIIF learning curve is a considerable challenge, while respondent 2 identified content migration as one of the key challenges stemming from a lack of resources. More specifically, respondent 4 explained that there is only one person in Germany working on digital repositories who learns about the IIIF through online courses, YouTube videos and IIIF documentation while their partner in Cuba is very small and sharing documents online is not the top priority. However, the literature review highlighted that individual researchers and small projects should carefully consider whether IIIF functionalities match their needs.

Moreover, these types of challenges are common to other institutions as discussed in the literature review. For example, UCD faced the challenge of minimal skills of their library staff on web standards, web annotations and data representation with JSON/JSON-LD (Howard, 2017, p.4) when integrating their resources into Europeana through IIIF. The same challenge was faced by other institutions that are Europeana providers in which technical and time resources are identified as some of the main challenges for IIIF implementation (Task Force on Preparing Europeana for IIIF Involvement, 2017, p .9). This lends greater weight to respondent 5's suggesting that making the IIIF implementation more universal would be an improvement since the many technical skills required for implementation are not held comprehensively.

According to the literature review, it is not only the staff expertise that is limiting IIIF implementation. In addition, low awareness of IIIF among staff and high-level managers are challenges for those providers (Task Force on Preparing Europeana for IIIF Involvement, 2017, p .9; Howard, 2017, p.4). Similarly, regarding wider understanding of the IIIF, respondent 3 believes that a bigger promotion of IIIF would increase the use of the platform.

Moreover, low awareness and understanding of what the IIIF is and its possibilities to CHIs and other institutions can enhance differences between bigger and smaller institutions, thus creating a digital divide between the CHIs (Padfield *et al*, 2022, p.3). A similar problem of access to the full extent of IIIF capabilities was brought out in the interviews, since smaller institutions lack not only the necessary human resources but also infrastructure as pointed out by respondent 4.

As the categorization of the respondents shows (Table 2), smaller projects tend to deploy the image API only, which one can argue is evidence of a differentiation between them and larger institutions with more technical and human resources.

## 6. Conclusions

Throughout this study, I have identified the advantages and challenges of IIIF implementation for re-use and dissemination for cultural heritage resources on the Web. In demonstrating the challenges associated with the accessibility of digital images from the provider institutions (CHIs and Universities), I argue that, while necessary improvements are



clearly identified throughout this dissertation, the IIIF has been mostly beneficial for institutions and their users alike.

Moreover, one can state that more than simply beneficial, the IIIF has been transforming the accessibility of images as it solves problems or needs long expected by the more than 130 institutions that have so far adopted it. As I noted in the introduction, the deployment of different frameworks and servers to deliver images was keeping institutional repositories locked in silos, which consequently made it harder to share their content on the Web. From their users' perspective, however, ways to not only to view images but to interact with them (comparing, annotating, rotating, zooming, etc) in a single interface are increasingly sought after.

This transformation is evident from the number of digital images compliant with the IIIF, which has reached more than one billion so far. Moreover, the IIIF has provided a means to view on-the-fly resources from any compliant repository in any compliant viewer. The ability to provide and access content through interoperability is frequently mentioned as also the ability to provide high-resolution images that can be easily shared. Interoperability eliminates duplication of images by the provider, since it can create on-the-fly derivatives that alleviate their servers. Similarly, the need to download images by the user and duplication of images is minimised since different objects can be put together in the same browser.

In addition, the IIIF has tackled other types of needs of the provider institutions such the extensibility of their products and services, availability of codes and APIs and scalability of their systems. This is because the IIIF is open-source software whose APIs and web semantic models enable institutions not only to share images but to provide high-resolution images at low cost and rapidly. In addition, institutions can build new products around the IIIF or deploy compliant tools like Omeka for exhibition or educational purposes.

The methodology of this study was to use the literature review as a basis for collecting information on the IIIF state of the art and then conducting open-ended interviews to understand the advantages and challenges associated with IIIF implementation for the provider institutions.

Overall, the findings from the interviews confirm what was found in the literature review, which identified that the IIIF is mostly implemented for its interoperability, facilitation

of user engagement and aggregation support. Although the low costs and low IT requirements associated with the IIIF are mentioned in the literature as an advantage, the reality is that some expertise and resources are needed for a successful IIIF implementation which can be a challenge for small institutions or those lacking dedicated resources. Indeed, while IIIF implementation material is available (as demonstrated in the literature review), the IIIF has been mostly implemented by major institutions with more resources at their disposal. Moreover, as pointed out in the literature review, as the IIIF grows, the digital divide between small and big institutions are more evident, even though at some point the eventual maturity of the protocol may help to minimize this divide.

Thus, this study shows that prior to IIIF implementation different technical and knowledge aspects should be carefully thought through and planned. On the IIIF side, there is also a clear need for improvement in the promotion of the protocol (making documentation in other languages would be an improvement) and the development of specific support for institutions lacking resources.

The ability to provide and access content through interoperability is frequently mentioned as also the ability to provide high-resolution images that can be viewed and shared in different browsers. Interoperability eliminates the need to download images by the user and duplication of images by the provider, since they are able to create on-the-fly derivatives that alleviate their servers.

The IIIF also positively impacts users of GLAMs, university libraries and other CHIs as they can provide access to a great number of materials while reuniting dispersed materials and facilitating collaborative work through the internet, which enhances research practices and learning/teaching in the humanities.

Europeana, which encourages its provider institutions to make their content available and accessible through frameworks and policies, has also been participating in the IIIF's promotion and development. Since 2016, it has been enabling institutions to deliver their digital images into their data model through the IIIF.

However, to share images online, institutions need to be conscious that the selection decisions must respect copyrights. The open access movement has been motivating institutions

alike to share their material for different purposes and, as a result, the IIIF has been chosen to support their open access policies.

Similarly, institutions apply to the IIIF to make public domain or open access images available online but also materials under other licenses as the IIIF can limit access to resources through the authentication APIs. However, for those using Image API only, integrating other resources in their workflows can be problematic as this API lacks contextual metadata such as data on licences, copyrights, and provenance.

When institutions implement both the Image API and Presentation API, the IIIF standard can bring more value and power to the digital images. This is because the Presentation API provides the metadata for the user. However, most institutions use only Image API as they are looking for only basic functions, such as deep zooming of high-resolution images.

Although the IIIF is seen as an alternative for aggregation efforts, it still requires some development. In this regard, the lack of metadata standardization means that the searching and discoverability of IIIF manifests is impeded. As explained, the metadata in the Presentation API is not readable by machines and no standard scheme is required.

Moreover, the modernization of DAMs and the migration to microservices that have been taking place in libraries and other information provider institutions have led to a need for information systems updates and more suitable workflows to accommodate the IIIF. Thus, the roles of libraries have been changing to accommodate new research workflows and research dissemination behaviours. I argue that the IIIF has been supporting these new roles while allowing institutions to maintain their traditional resources for structural description.

One of the goals of this study was to understand IIIF implementation in Portugal. From the literature review it was possible to identify institutions or projects that have implemented the IIIF or are planning to. Only five Portuguese institutions that have implemented the IIIF were identified. One can argue therefore that Portuguese CHIs and universities are mostly not aware of the IIIF. Moreover, most of the handful of examples mentioned still do not have the experience of deploying the IIIF into their projects.

For a full study of IIIF implementation in Portugal, a level of maturity would be an advantage. On the other hand, a study that follows the implementation process from step one could be significant. In the future, I would like to focus on one institution's process of

implementing the IIIF from the beginning, which will offer scope for a more in-depth investigation into the particularities of the case.

This study has aimed to give a comprehensive state of the art and aims in some degree to serve as a support document for those implementing the IIIF. Therefore, with this study itself, I am contributing to knowledge of the IIIF in the context of digital resources in the cultural heritage sector and universities with an extensive overview of its implementation, and the challenges and benefits that comes with it for the institutions, Also, this study gives a wide-ranging overview of what kinds challenges and needs these institutions are facing to be able to give access to their digitized resources, both before IIIF implementation and afterwards.

Since the IIIF is a relatively new standard and yet to be developed and implemented more universally, this study places itself as a contribution to the early study of the IIIF and the institutions implementing it. Also, I hope this study will support other dissertations on the subject in the future.

As a suggestion, I propose that the IIIF can be incorporated into institutions and universities (especially in Portugal) through IIIF-compliant tools such Omeka or Exhibit for learning or exhibition purposes. As I showed in the study, individual researchers can also make their own manifests and experiment using the different tools available. However, as pointed out by the respondents in the interviews, the promotion of the protocol is important not only for potential users but for institutional staff.

The learning curve for the staff is another topic to be investigated and invested by top managers, not only for IIIF implementation but for the digital transformation of information provider institutions as a whole.

Nevertheless, the challenges associated with digital transformation are not only technical. As said by one the interview respondents what is most challenging is to persuade people to adopt new ideas. However, the need to keep up with the growing number of adopters in the GLAM sector, the need to modernize systems, to become interoperable and to provide users with more sophisticated tools and interfaces will, at some point, cause institutions to adapt as to staff training.

Hence, I believe that this study shows that the advantages of the IIIF serve as incentives for institutions and staff to learn and become more eager to transform their services. However,

the IIF should not be imposed where there is a defined workflow. The implementation of the IIF should be carefully thought out according to the institution's requirements and resources.

Yet, what is evident in this study is a movement towards the implementation of the IIF and in this regard, institutions should look for information and be mindful that the sector could demand this implementation sooner or later. As was shown both in the literature review and in the interviews, the requirements of partnerships and interinstitutional projects are making the IIF an important element for the accessibility of digital images on the web for the Cultural Heritage sector and universities.

## 7. Bibliography

Amaral, K. (2022). *Harvard Library IIF Infrastructure Redesign*. IIF Annual Conference 2022, Harvard University.

Angelaki, G., Badzmierowska, K., Brown, D., Chiquet, V., Colla, J., Finlay-McAlester, J., Grabowska, K., Hanneschläger, V., Harrower, N., Howat-Maxted, F., Ilvanidou, M., Kordyzon, W., Król, M., Losada Gómez, A. G., Maryl, M., Reinsone, S., Suslova, N., Sweetnam, M., Śliwowski, K., & Werla, M. (2019). How to Facilitate Cooperation between Humanities Researchers and Cultural Heritage Institutions. Guidelines Digital Humanities Centre at the Institute of Literary Research of the Polish Academy of Sciences. <https://doi.org/10.5281/zenodo.2587481>

Ark Alliance (n.d). *About ARKs*. Retrieved October 2022, from <https://arks.org/about/>

Ark Alliance (n.d.). *Home*. Retrieved September 2022, from <https://arks.org/>

ARMA Consortium (2021). Selection and Digitization Plan. Leiden University Libraries & Bibliothèque Nationale de France (Eds). Retrieved October 2022, from <https://www.medieval-reads.eu/docs>

ARMA Consortium. (2022). Recommendations on the Implementation of IIF. Dros, E. & De Niet, M. (Eds). Retrieved November 2022, from [https://pro.europeana.eu/files/Europeana\\_Professional/Projects/Recommendations\\_on\\_implementation\\_of\\_IIF\\_by\\_ARMA\\_GS\\_project\\_July\\_2022.pdf](https://pro.europeana.eu/files/Europeana_Professional/Projects/Recommendations_on_implementation_of_IIF_by_ARMA_GS_project_July_2022.pdf).

Arroyo-Ramírez, E., Berdini, A., Black, S., Cram, G., Gronsbell, K., Krabbenhoft, N., Lynch, K., Preston, G., & Smedberg, H. (2021). Speeding Towards Remote Access: Developing Shared Recommendations for Virtual Reading Rooms. In M. A. Matienzo & D. Handel (Eds), *The Lighting the Way Handbook: Case Studies, Guidelines, and Emergent Futures for Archival Discovery and Delivery* (pp. 141-167). Stanford University Libraries. <https://doi.org/10.25740/gg453cv6438>.

Awesome IIF, (n.d.) *Shim Image Servers*. Retrieved October 2022, from <https://github.com/IIF/awesome-iiif/blob/master/readme.md#shim-image-servers>

Babcock, K. & Di Cresce, R. (2019) Impact of International Image Interoperability Framework (IIIF) on Digital Repositories. In Varnum, K. J. (Ed.). *New top technologies every librarian needs to know* (pp. 181-196). ALA Neal-Schuman.

Babcock, K., Lee, S., Rajakumar, J., & Wagner, A. (2020). Where Do We Go From Here: A Review of Technology Solutions for Providing Access to Digital Collections. *Code4Lib Journal*, 47. <https://journal.code4lib.org/articles/15000>

Baskauf, S. (2022, September 7). CommonsTool: A script for uploading art images to Wikimedia Commons. *Steve Baskauf's blog*. Retrieved October 2022, from <https://baskauf.blogspot.com/2022/09/commonstool-script-for-uploading-art.html>

Borgman, C. L. (2000). *From Gutenberg to the global information infrastructure. Access to Information in the Networked World*. (eBook). The MIT Press.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101.

Breeding, M. (2017). OCLC Further Enhances CONTENTdm. *Smart Libraries Newsletter* 37 (11), 5-6. <https://librarytechnology.org/document/23329>

Breeding, M. (2018). Current Trends and Future Possibilities for Managing Digital Media Collections. *Computers in Libraries*, 38(6), 16–18.

BRUMFIELD LABS (2017). *IIIF Implementation Guide*. International Image Interoperability Framework. Retrieved September 2021, from [http://iiif.io/assets/acc\\_implementation\\_guide\\_011017.pdf](http://iiif.io/assets/acc_implementation_guide_011017.pdf)

Brumfield, B., Brumfield, S., Irving, A., Kotarski, R., Padfield, J., Raemy, J., McLaughlin, A., & Madden, F. (2021). *PIDs in IIIF Webinar* (1.1). Zenodo. <https://doi.org/10.5281/zenodo.5780055>

Burrows, T. (2018). Connecting Medieval and Renaissance Manuscript Collections. *Open Library of Humanities*, 4(2), 1-23. <https://doi.org/10.16995/olh.269>

Candela, G., Sáez, M. D., Escobar Esteban, MP., & Marco-Such, M. (2020). Reusing digital collections from GLAM institutions. *Journal of Information Science*, 48(2). 1–17. <https://doi.org/10.1177/0165551520950246>

Card, B., Droth, M., Scutt, T., & Turner, S. V. (2019). Beyond the PDF: Expanding Art History Digitally with *British Art Studies*. *Visual Resources*, 35(1–2), 155–170. <https://doi.org/10.1080/01973762.2019.1553446>

Carvalho, R. S. (2019). To be part of... Architecture, decoration or iconography. Documenting Azulejo as integrated heritage. *ISPRS Ann. Photogramm. Remote Sens. Spatial Inf. Sci.*, 4(2/W6), 39–46. DOI:[10.5194/isprs-annals-IV-2-W6-39-2019](https://doi.org/10.5194/isprs-annals-IV-2-W6-39-2019)

CHDS. (2018, June 18). Sitich in time: Mahabharata delivered online. *Cultural Heritage Digitisation Service*. Retrieved October 2022, from [A Stitch in Time: Mahābhārata Delivered Online | Cultural Heritage Digitisation Service](#)

Chowdhury, G. G. & Ruthven, Ian. (2015). *Cultural heritage information : access and management*. Facet Publishing

Cramer, T. (2015). *IIIF Consortium Formed*. The International Image Interoperability Framework. Retrieved May 2021, from <https://iiif.io/news/2015/06/17/iiif-consortium/>

Crane, T. (2016). *Authentication API Deep Dive* [PowerPoint slides]. Retrieved October 2021, from: <https://goo.gl/W5cSnj>

Crane, T. (2017). *Introduction to IIIF*. Digitarti. Retrieved October 2020, from: <https://resources.digitarti.com/iiif/an-introduction-to-iiif>

Crane, T. (2018). Beyond the Viewer: Fragments and links in annotation space. *Cultural Heritage and the Web*. Retrieved May 2021, from <https://medium.com/digitarti-ch/beyond-the-viewer-fragments-and-links-in-annotation-space-b3284e25f34#f26e>

Cusimano, F. (2019). Conservation libraries & Data Curation: From Custos catalogi to Digital Libraria: the case of Ambrosian Library. *JLIS: Italian Journal of Library, Archives and Information Science*, 10(1), 126-139. <http://digital.casalini.it/10.4403/jlis.it-12513>

De Vos, M. (2017). IIIF datasets in Europeana: A scholar's delight. *Europeana Pro*. Retrieved September 2020 from <https://pro.europeana.eu/post/iiif-datasets-in-europeana-a-scholar-s-delight>.

Delmas-Glass, E. (2015). Yale Center for British Art's Reformation to Restoration Project: Applying IIIF Mirador Technology to Support Digital Scholarly Collaboration and



Research. *D-Lib Magazine*, 21(7/8). Retrieved October 2020 from: <http://www.dlib.org/dlib/july15/07inbrief.html>

Dempsey, L. (2016). Library collections in the life of the user: Two directions. *LIBER Quarterly: The Journal of the Association of European Research Libraries*, 26(4), 338–359. <https://doi.org/10.18352/lq.10170>

Dempsey, L., 2012. Libraries and the informational future: Some notes. *Information Services & Use*, 32(3-4), 203-14.: <http://dx.doi.org/10.3233/ISU-2012-0670>

Dragoni, M., Tonelli, S., & Moretti, G. (2017). A Knowledge Management Architecture for Digital Cultural Heritage. *Journal on Computing and Cultural Heritage*, 10(3), 1–18. <https://doi.org/10.1145/3012289>

EGAN, P., & MURPHY, Ó. (2022). Sharing as CARE and FAIR in the Digital Humanities. In J. O’Sullivan (Ed.), *The Bloomsbury Handbook to the Digital Humanities*, (pp. 267-270). Bloomsbury.

Emanuel, J. P. (2018). Stitching Together Technology for the Digital Humanities with the International Image Interoperability Framework (IIIF). In R. Kear & K. Joranson, *Digital Humanities, Libraries, and Partnerships* (pp. 125–135). Elsevier. <https://doi.org/10.1016/B978-0-08-102023-4.00009-4> Engerer, V. P. (2021). ‘Attention, attention, exploring minds acknowledge digital structure!’ The shift to digital humanities has happened, so what should information scientists do in response? *Digital Scholarship in the Humanities*, 36(1), 43–63. <https://doi.org/10.1093/llc/fqaa008>

Ferreira, M. P. (2022). Digital matters: Early Iberian manuscripts from the Lisbon vantage point. *Journal of Medieval Iberian Studies*, 14(1), 69–81. <https://doi.org/10.1080/17546559.2021.2019816>

Ferreira, S. L., Macambyra, M. M., & Lima, V. M. A. (2018). Imagens interoperáveis: Uso do VRA Core e da estrutura IIIF na construção de bibliotecas digitais. *Informação & Tecnologia (ITEC)*, 5( ja/ju 2018), 4-17. <https://doi.org/10.22478/ufpb.2358-3908.2018v5n1.38194>

Foket, L., Verbeke, D., Ducatteeuw, V., Rombaut, E., Lamsens, F., & Verbruggen, C. (2022, June 7-8). *Using IIF to teach Digital Humanities: practice-oriented approach to digital literacy skills*. IIF Annual Conference and Showcase (IIF), Cambridge, MA (USA)

Freire, N., Manguinhas, H., Isaac, A., Robson, G., & Howard, B. (2017). Web Technologies: A Survey of Their Applicability to Metadata Aggregation in Cultural Heritage. In *Expanding Perspectives on Open Science: Communities, Cultures and Diversity in Concepts and Practices- Proceedings of the 21st International Conference on Electronic Publishing*, 235-244. <https://doi.org/10.3233/978-1-61499-769-6-235>

Robson, Glen (2021). *IIF Workshop*. International Image Interoperability Framework <https://training.iif.io/iif-online-workshop/>

Freire, N., Robson, G., Howard, J. B., Manguinhas, H., & Isaac, A. (2020). Cultural heritage metadata aggregation using web technologies: IIF, Sitemaps and Schema.org. *International Journal on Digital Libraries*, 21(1), 19–30. <https://doi.org/10.1007/s00799-018-0259-5>

Fritschi, R. (2017). e-codices–Virtual Manuscript Library of Switzerland: Great Achievements and Even Greater Challenges to Come. *Digital Philology: A Journal of Medieval Cultures*, 6(2), 244–256. DOI: <https://doi.org/10.1353/dph.2017.0013>

Frunzeanu, E., Robineau, R., & MacDonald, E. (2016). Biblissima’s Choices of Tools and Methodology for Interoperability Purposes. *CIAN-Revista de Historia de Las Universidades*, 19(1), 115-132. <https://doi.org/10.20318/cian.2016.3146>

Glasmann, K. (2017). Nationalmuseum Sweden goes IIF. *EuropeanaTech Insight*, 6. Retrieved October 2021 from <https://pro.europeana.eu/page/issue-6-iif> \1 "article-2

Gomez, J., S. Clarke, K., & Vuong, A. (2020). IIF by the Numbers. *Code4Lib Journal*, 48. <https://journal.code4lib.org/articles/15217>

Gorman, G. E. & Clayton, Peter. (1997). *Qualitative research for the information professional: a practical handbook*. Library Association Publishing

Hiltmann, T., & Schneider, P. (2021). *Automated Processing and Exploitation of Heraldic Data from European Archives and the necessary prerequisites for a data-driven historical research*. Workshop: Innovation on new digital exponential technologies towards

the generation of Business Models, Alicante, Spain. <https://www.digitaltreasures.eu/wp-content/uploads/2022/01/Automated-Processing-and-Exploitation-of-Heraldic-Data-from-European-Archives-Philipp-Schneider-and-Torsten-Hiltmann.pdf>

Hirsch, R., & Appleby, M. (2021). *The new Beinecke digital collections platform*. IIF Bi-Weekly Community Call. Retrieved March 2021 from <https://stanford.zoom.us/rec/share/3ycuwILIK6POIUpQlQJV53CkOVDb0XstlQW2wB2a5SKK5W7AWWBll7KI8qvdMt8S.3Xq0vAIPzFZNus3v?startTime=1615395416000>

Howard, J. B. (2017). Opening Doors to Interoperability and User Engagement: IIF at University College Dublin. *EuropeanaTech Insight*, 6. Retrieved October 2021, from <https://pro.europeana.eu/page/issue-6-iif#article-1>

IIF (2020a). *IIF Community*. Retrieved November 2020, from: <https://iif.io/community/#community-groups-committees>

IIF (2020b). *IIF Community Call - Towards a National Collection and IIF*. [Video]. Youtube. <https://youtu.be/ji0oOBEaRMk>

IIF (2021a). *For Implementers - International Image Interoperability Framework*. Retrieved October 2021, from: <https://iif.io/technical-details/>

IIF (2021b). *Presentation API 3.0* Retrieved October 2021, from from: <https://iif.io/api/presentation/3.0/>

IIF (n.d.). *IIF Consortium*. Retrieved October 2020, from <https://iif.io/community/consortium/>

IIF. (2020c). *Supporting Teaching and Scholarship using Omeka and IIF*. [Video]. Youtube. <https://youtu.be/rkY4sfDbjU0>

Isaac, A. & Freire, N., (2019, April 13). Europeana and the FAIR principles for research data. *Europeana Pro*. <https://pro.europeana.eu/post/europeana-and-the-fair-principles-for-research-data>

Kallio, H., Pietilä, A. M., Johnson, M., & Kangasniemi, M. (2016). Systematic methodological review: developing a framework for a qualitative semi-structured interview guide. *Journal of advanced nursing*, 72(12), 2954–2965. <https://doi.org/10.1111/jan.13031>

Keller, A., & Kreyenbühl, E. (2022). Reaching out to the crowds: IIF as a scholarly practice. *IIF Annual Conference 2022*, Harvard University, USA.

Kitamoto, A. (2019, September). IIF Curation Platform: Creating and Sharing Virtual Image Collection on a Global Scale. *2019 Glocal Humanities in the Era of Hyperconnectivity*. Daegu, Republic of Korea. <http://agora.ex.nii.ac.jp/~kitamoto/research/publications/kadh19.pdf>

KRB (2022). *Connecting Medieval Monastic Manuscripts: metadata aggregation using IIF manifests* [Video]. YouTube. <https://www.youtube.com/watch?v=dumxOPMyWDM>

Kriukow, J. (2020). *Qualitative coding and thematic analysis in Microsoft Word* [Video]. YouTube. <https://www.youtube.com/watch?v=XOYhkUC21wQ>

Levy, M. (2019). Some Perspectives on the Practice of Sharing Collection Data. *Umanistica Digitale*, 3(4), 21-32. <https://doi.org/10.6092/issn.2532-8816/9039>

Long, S. A. (2018). Review: International Image Interoperability Framework (IIF); Gallica; e-codices: Virtual Manuscript Library of Switzerland. *Journal of the American Musicological Society*, 71(2), 561–572. <https://doi.org/10.1525/jams.2018.71.2.561>

Magnuson, L (2016, February 25). Store and display high resolution images with the International Image Interoperability Framework (IIF). *ACRL TechConnect*. <https://acrl.ala.org/techconnect/post/store-and-display-high-resolution-images-with-the-international-image-interoperability-framework-iif/>

Manoni, P. (2019). The Mellon Project at the Vatican Library: Web thematic pathways of Medieval manuscripts from the Vatican collections using International Image Interoperability Framework. In *Miscellanea Bibliothecae apostolicae Vaticanae XXV*. (pp. 265-281). Biblioteca Apostolica vaticana. <https://digital.casalini.it/10.1400/271855>

Manoni, P. (2022). “Discoverability” in the IIF digital ecosystem. *Journal of Library Science, Archival Science and Information Science*, 13(1), 312–320. <https://doi.org/10.4403/jlis.it-12770>

Matienzo, M.A., & Handel, D. (Eds). (2021). *The Lighting the Way Handbook: Case Studies, Guidelines, and Emergent Futures for Archival Discovery and Delivery*. Stanford University Libraries. <https://doi.org/10.25740/gg453cv6438>

Mayo, C., Jazairi, A., Walker, P., & Gaudreau, L. (2019). BC Digitized Collections: Towards a Microservices-based Solution to an Intractable Repository Problem. *Code4Lib Journal*, 44. <https://journal.code4lib.org/articles/14445>

McAulay, E. (2021). Always Be Migrating. *The Code4Lib Journal*, 50. <https://journal.code4lib.org/articles/15568>

McKenna, L. (2022). Translation of research interviews: Do we have a problem with qualitative rigor? *Nurse Author & Editor*, 32(1), 1–3. <https://doi.org/10.1111/nae2.31>

Meeus, S., August, T., Trekels, M., Reyserhove, L., & Groom, Q. J. (2021, December 7). Network analysis of specimen co-collection. *BioHacketon Europe 2021 (1-10)*. Biohackrxiv.org <https://doi.org/10.37044/osf.io/4ahng>

Mmmonk. (n.d.). *About Mmmonk*. Retrieved October 2022, from <https://www.mmmonk.be/en/about-mmmonk>

Nishioka, C., & Nagasaki, K. (2019). Measurement and Visualization of IIF Image Usages. In A. Jatowt, A. Maeda, & S. Y. Syn (Eds.), *Digital Libraries at the Crossroads of Digital Information for the Future* (Vol. 11853, pp. 308–311). Springer. [https://doi.org/10.1007/978-3-030-34058-2\\_30](https://doi.org/10.1007/978-3-030-34058-2_30)

Nishioka, C., & Nagasaki, K. (2021). Understanding IIF image usage based on server log analysis. *Digital Scholarship in the Humanities*, 36(Supplement\_2), ii210–ii221. <https://doi.org/10.1093/llc/fqab040>

Padfield, J., Bolland, C., Fitzgerald, N., McLaughlin, A., Robson, G., & Terras, M. (2022). *Practical applications of IIF as a building block towards a digital National Collection*. Zenodo. <https://doi.org/10.5281/zenodo.6884885>

Paulter, M. (2018, December 6). Detailed depictions with IIF, Wikidata and Wikimedia Commons. *Bodleian Digital Library*. Retrieved September 2022, from <https://blogs.bodleian.ox.ac.uk/digital/2018/12/06/detailed-depictions-with-iif-wikidata-and-wikimedia-commons/>

Pierazzo, E. (2019). Quale infrastruttura per le edizioni digitali: Dalla tecnologia all’etica. *Textual Cultures*, 12(2), 5–17. <https://doi.org/10.14434/textual.v12i2.27685>

Ponzi, E. with Manoni, P. (2020). Thematic Pathways on the Web: IIIF annotations of manuscripts from the Vatican collections: Il “Progetto Mellon” della Biblioteca Vaticana. La storia della miniatura incontra lo Spotlight. *Rivista di storia della miniatura*, pp. 212-216.

Porena, M. (2019). *INTERNATIONAL IMAGE INTEROPERABILITY FRAMEWORK. Uno standard per le immagini digitali del patrimonio culturale* [Diploma di Specializzazione, Sapienza , Università Di Roma]. Sapienza University Repository. [http://tesi-dolinfge\\_bal.uniroma1.it/id/eprint/272](http://tesi-dolinfge_bal.uniroma1.it/id/eprint/272)

Prescott, A., & Hughes, L. M. (2018). Why do we digitize? The case for slow digitization. *Archive Journal*. <https://eprints.gla.ac.uk/165726/>

Raemy, J. A. (2017). *The International Image Interoperability Framework (IIIF): Raising awareness of the user benefits for scholarly editions*. [Bachelor’s thesis, Haute école de gestion de Genève]. [10.13140/RG.2.2.34211.89125](https://doi.org/10.13140/RG.2.2.34211.89125)

Raemy, J. A. (2020). *Enabling better aggregation and discovery of cultural heritage content for Europeana and its partner institutions* [Master’s thesis, Haute école de gestion de Genève]. ResearchGate. [10.13140/RG.2.2.14690.35521](https://doi.org/10.13140/RG.2.2.14690.35521)

Raemy, J. A., & Schneider, R. (2019). *Suggested measures for deploying IIIF in Swiss cultural heritage institutions (White paper)*. HES-SO University of Applied Sciences and Arts, Haute école de gestion de Genève. <https://zenodo.org/record/2640416>

Reed, J. (2017 May 23). The case for serving your IIIF content over HTTPS. *jack reed*. Retrieved November 2021, from <https://www.jack-reed.com/2017/05/23/the-case-for-serving-your-iiif-content-over-https.html>

Reed, J., (2018). *Introduction to IIIF*. IIIF. Retrieved from May 2021, from <https://training.iiif.io/iiif-5-day-workshop/day-one/iiif-introduction.html>

Regimbal, J., Vigiensoni, G., Hutnyk, C., & Fujinaga, I. (2020). IIIF-Based Lyric and Neume Editor for Square-Notation Manuscripts. In E. De Luca & J. Flanders (Eds.), *Music Encoding Conference Proceedings 2020* (pp. 15–18). Humanities Commons. <https://doi.org/10.17613/d41w-n008>

Renton, S. (2017). *IIIF: a picture paints a thousand words* [PowerPoint slides]. Retrieved October 2022, from <http://hdl.handle.net/1842/21050>

Robson, Glen (2016). Implementing the International Image Interoperability Framework at the National Library of Wales *Journal of Digital Media Management*, 4(4), 353-359. <https://hstalks.com/article/4649/implementing-the-international-image-interoperabil/>

Roddis, T (2017, November 10). Everything You Always Wanted to Know About IIIF\* (\*But Were Afraid to Ask). *Cogapp*. Retrieved from November 2021, from <https://blog.cogapp.com/everything-you-always-wanted-to-know-about-iiif-but-were-afraid-to-ask-6f7acc7d56c3>

Roddis, T. (2021, May 12). *IIIF workflow*. IIIF Discussion. Retrieved May 2021, from <https://groups.google.com/g/iiif-discuss/c/fVmfTZvEJ-0>

Roddis, T., Lancefield, R., Campbell, J., Cossu, S., & Hawkins, N. (2020). IIIF at Scale. In N. Proctor (Ed.), *Selected Papers from MW2020*. MuseWeb <https://mw20.museweb.net/paper/iiif-at-scale/>

Rodrigues, E., & Shearer, K. (2017). Next Generation Repositories: Behaviours and Technical Recommendations of the COAR Next Generation Repositories Working Group. *Copyright, Fair Use, Scholarly Communication, Etc.*, 64. <http://digitalcommons.unl.edu/scholcom/64>

Ronallo, J. (n.d.). *IIIF Workshop*. Preliminary Inventory of Digital Collections. Retrieved October 2021, from <https://ronallo.com/iiif-workshop-new/presentation-api/manifests-and-image-servers.html>

Rosa, I. (2019). Digital Library *Polona*: Digitization, Technology, Cooperation. *Slavic & East European Information Resources*, 20(1–2), 23–30. <https://doi.org/10.1080/15228886.2019.1628495>

Salarelli, A. (2017). International Image Interoperability Framework (IIIF): A panoramic view. *JLIS: Italian Journal of Library, Archives and Information Science*, 8(1), 50–66. <https://doi.org/10.4403/jlis.it-12090>

Santarém Segundo, J. E., Silva, M. F., & Martins, D. L. (2019). Revisitando a interoperabilidade no contexto dos acervos digitais. *Informação & Sociedade: Estudos*, 29(2). <https://doi.org/10.22478/ufpb.1809-4783.2019v29n2.38107>

Silva, A. L. (2022, December 15). *International Image Interoperability Framework (IIIF) em património cultural*. BAD.

Silva, A. L., Bernardes, M., Neves, B., & Miguéis, A. M. E. (2020). Almamater: A herança cultural da Universidade de Coimbra em Acesso Aberto. *Ciência da Informação*, 48(3), 314-318. <https://revista.ibict.br/ciinf/article/view/4982>

Snydman, S., Sanderson, R., & Cramer, T. (2015, May 19-22). *The International Image Interoperability Framework (IIIF): A community & technology approach for web-based images [Conference paper]*. Archiving 2015, Getty Centre, Los Angeles. <http://purl.stanford.edu/df650pk4327>

Stein, A., & Thompson, S. (2015). Taking Control: Identifying Motivations for Migrating Library Digital Asset Management Systems. *D-Lib Magazine*, 21(9/10). <https://doi.org/10.1045/september2015-stein>

Szynkielewska, M. (2022, October 6). ARMA - discovering medieval reading culture. *Europeana Pro*. Retrieved October 2022, from <https://pro.europeana.eu/post/arma-discovering-medieval-reading-culture>

Task Force on Preparing Europeana for IIIF involvement. (2017). *Report of Task Force on Preparing Europeana for IIIF involvement*. Retrieved May 2021, from: <https://pro.europeana.eu/project/preparing-europeana-for-iiif-involvement>

Terras, M. (2008a). *Digital Images for the Information Professional* (eBook). Routledge. <https://doi.org/10.4324/9781315257785>

Terras, M. (2008b). Digital Heritage: Applying Digital Imaging to Cultural Heritage. *Literary and Linguistic Computing*, 23(2), 244–246. <https://doi.org/10.1093/llc/fqn002>

Terras, M. (2015). Cultural Heritage Information: Artefacts and Digitization Technologies. In Chowdhury, G. & Ruthven, I. (Eds), *Cultural Heritage information*, London: Facet. (pp. 63-88). Facet. <https://doi.org/10.29085/9781783300662.005>

Toner, G., Stifter, D., Cnockaert-Guillou, N., Färber, B., Hayden, D., Mhaonaigh, M. N., Tucker, J., & Yocum, C. G. (2022). *Developing a Digital Framework for the Medieval*



*Gaelic World: Report (Draft)* [Project Report]. Irish Research Council Arts and Humanities Research Council. <https://mural.maynoothuniversity.ie/15621/>

Towards a National Collection (2020a). *About us*. Retrieved November 2020, from <https://www.nationalcollection.org.uk/about>

Towards a National Collection (2020b). *Projects*. Retrieved November 2020, from <https://www.nationalcollection.org.uk/projects>

Towards A National Collection (2021a), *Andrew Wilson - Embedding IIF resources into teaching and course work at University of St. Andrews* [Video]. Youtube. <https://www.youtube.com/watch?v=s66ul6-PQ3g>

Towards A National Collection (2021b). *Luca Carini - Explore the Raphael Cartoons at the V&A* [Video]. Youtube. <https://youtu.be/FwBbNw2Ko6c>

Towards A National Collection (2021c). *Luna Carini - Image Registration & Alignment* [Video]. Youtube. <https://youtu.be/FwBbNw2Ko6c>

Towards A National Collection (2021d). *Joe Padfield - Re-using IIF resources in documentation solutions* [Video]. Youtube.. <https://youtu.be/emS-4n7cxwo>

Towards A National Collection (2021e). *PIDs in IIF Webinar Discussion* [Video]. Youtube. <https://youtu.be/3JzisjZDLr4>

UCB (2022, May 31). *UBC Library joins the IIF Consortium*. Retrieved November 2022, from <https://about.library.ubc.ca/2022/05/31/ubc-library-joins-the-iif-consortium/>

Van Zundert, J. (2018). On Not Writing a Review about Mirador: Mirador, IIF, and the Epistemological Gains of Distributed Digital Scholarly Resources. *Digital Medievalist*, 11(1), 5. <https://doi.org/10.16995/dm.78>

Vanderperre, N. (2017). *Publicatie: Opzetten IIF beeldenserver en een eenvoudige webportaal* [Publication: Setting up IIF image server and a simple web portal]. In De cultureelerfgoedstandaardentoolbox (CEST). Retrieved September 2021, from [https://www.projectcest.be/wiki/Publicatie:Opzetten\\_IIF\\_beeldenserver\\_en\\_een\\_eenvoudige\\_webportaal](https://www.projectcest.be/wiki/Publicatie:Opzetten_IIF_beeldenserver_en_een_eenvoudige_webportaal)

Veramme, S. (2021). *IIIF Report: Through Tangibility Enriched: Getting Started with IIIF and Linked Open Data Technology for Heritage Workers*. (p. 50). Amsab-ISH. <https://www.amsab.be/images/pdf/diamond/IIIF-Report.pdf>

Witt, J. C. (2018). *Anatomy of a Basic Manifest*. Retrieved October 2020, from <https://iiif.github.io/training/iiif-5-day-workshop/day-two/5-anatomy-of-a-basic-manifest.html>

Wronkowska, S. (2018 December 6), *How to utilize IIIF when building a national library* [Conference presentation]. IIIF Conference, National Library of Norway. <https://mediasite.nb.no/Mediasite/Play/978e0127b3664d40bdc40007f044128c1d>

Xue, S., Li, Y., & Ren, L. (2020). Representing the Chinese Seal Stamping Catalogs Using IIIF & Serverless. Proceedings of the ACM/IEEE Joint Conference on Digital Libraries in 2020, 547–548. <https://doi.org/10.1145/3383583.3398549>

Ying, W., & Shulman, J. (2015). “Bottled or Tap?” A Map for Integrating International Image Interoperability Framework (IIIF) into Shared Shelf and Artstor. *D-Lib Magazine*, 21(7/8). 10.1045/july2015-ying

Zeng, M. L. (2019). Semantic enrichment for enhancing LAM data and supporting digital humanities. Review article. *El Profesional de La Información*, 28(1), 1-35. <https://doi.org/10.3145/epi.2019.ene.03>

Zhou, Y., & Long, Y. (2020). Digital image preservation in library discovery: Integrating Ex Libris and IIIF APIs. *Computers in Libraries*, 40(9), 16–20. <https://discovery.ebsco.com/c/t73ky3/details/3pqsotsyxf>

## 8. Appendix

### 8.1 Appendix I: IIIF adoption summary tables

The reasons for adopting IIIF by the studied providers				
Reasons	Users Needs and behaviors	External influence and outreach	Interoperability	Infrastructure /DAMS
To support research and research outputs	X			
To provide a collaborative space for scholars	X			
To support remote teaching	X			
To enhance user experience: viewing, interaction and storytelling	X			
To increase the presence of a specific working language		X		
To promote openness		X		
To showcase or create collections at a low cost		X		
To increase their presence on the internet		X		
To reach local and international audiences		X		
Sector influence		X		
To be internally and externally interoperable			X	
To disseminate and reuse of content and metadata	X		X	
To provide simple access to many documents from different institutions	X		X	
To enhance access through linked data			X	
To support aggregation and/or centralization			X	
To have control to the content being shared				X
To create of own solutions for long-term distribution and ingest				X
Modernization or migration of DAMS				X
To provide simple access of high-resolution images at speed time with reduced costs				X
To support small projects at low cost and with minimum of IT infrastructure				X
Adoption of a microservice approach				X
To present several images per record				X
To create on-fly files derivatives				X

Table 6 - The reasons of adopting IIIF by the studied institutions

<u>The challenges in IIF adopting by the studied providers</u>		
<b>Challenges</b>	<b>Internal challenges</b>	<b>IIF Challenges or requirements</b>
Lack of control of IIF roadmaps		X
Lack of technical support or expertise	X	
Different number of internal and external participants	X	X
Organizational compartmentalization (internal silos)	X	
IIF instruction language is mainly English		X
Poor awareness of IIF by curatorial and senior management staff	X	
Lack of time and capability	X	
Lack of funding	X	X
Policy or Institutional challenges	X	
Web standards (JSON and Web annotation) are new to the staff	X	
Converting images files to TIFF or JPEG2000	X	X
Integrating new technology to older infrastructure or practices	X	
Fear of mass harvesting of the native resolution data	X	
Copyrights and privacy issues	X	
Preservation and long-term accessibility in development		x
Lacks on promotion and universality.		X
Metadata aggregation is not supported, making hard for resources to be searched and discovered as the manifest metadata is not readable by machines.		X
The metadata schemes and specific elements in the manifests are not standardized/mandatory which mean the metadata is highly variable among institutions.		X
IIF focus more on provider of resources than the user which limits the use of potential use of IIF by researchers.		x

Table 7 - The challenges of adopting IIF faced by the studied institutions.

The benefits by adopting IIF by the studied providers				
Benefits	Users Needs and behaviors	External influence and outreach	Interoperability	Infrastructure /DAMS
Reduced costs and time				X
Increased user experience by providing interactable viewing	X			
The ability to maintain and present the used metadata schemes and formats (MARC, MET)	X			
Reproduced the same “on-site” experience of a reading room or classroom	X			
Enhanced the quality of erased documents	X		X	
Internal Interoperability			X	
External interoperability				
Opportunities to collaborate with other institutions	X	X		
Improved system scability and extensibility				X
Eliminated the duplication of images				X
The ability to provide up to millions of high-resolution images online		X	X	
Enhanced research practices	X			
The ability to provide own resources while accessing other institutions 'resources via Internet (e.g.: compare copies of the same work remotely)	X	X	X	
The ability to see the same shared image in diferent viewers	X		X	
Embedding IIF images to existing records	X			
To separate the image presentation from the storing platform				X
The ability to provide access of images without compromising copyrights or accessibility policies			X	

Table 8 - The benefits from adopting IIF by the studied providers.

## 8.2 Appendix II: Interview Questions Guide

Question themes	Questions
Personal information	Q1: Interviewee's job title
Institution information	Q2: Institution type Q3: Country Q4: Users characteristics Q5: Digital services offered
IIIF implementation background	Q6: In what context was the IIIF implemented? Q6.1: When and how did the idea of adopting IIIF come about in your institution? Q6.2: how did your digitization and digital services plans develop before you adopted the IIIF? Q7: In which stage is your implementation? Q8: What is the amount and type of material available in IIIF? Q9: What are the IIIF functionalities/services that are implemented? Q10: The implementation of IIIF is for external or internal use? Q11: What are the departments or partners involved in the implementation? Q12: Before the implementation, did a testbed take place?
Reasons behind IIIF adoption	Q13: What were the issues or needs that led to the IIIF implementation? Q14: What were the goals and expectations related to the implementation of the IIIF? Q15: How is the IIIF complaint with your institution's digitization and online accessibility strategy?

<p>IIIF adoption challenges</p>	<p>Q16: What were the expected risks in the context of the implementation?</p> <p>Q17: What were the main challenges of the implementation?</p> <p>Q18: What were the identified risks from the implementation?</p>
<p>IIIF Benefits</p>	<p>Q19: What are the main internal and external benefits of IIIF?</p> <p>Q20: What kind of feedback staff and users report about the IIIF?</p> <p>Q21: Did the institution conduct surveys or interviews to measure the satisfaction of staff and users?</p>
<p>Feedback and improvement</p>	<p>Q22: What goals or expectations were met?</p> <p>Q23: What kind of feedback staff and users report about the IIIF?</p> <p>Q24: In which way IIIF can be improved?</p>

*Table 9 Interview questions Guide in Portuguese*

## 8.3 Appendix III: Interviews

### 8.3.1 Interview 1

#### *Personal information*

Q1: Interviewee's job title

A1: [Not disclosed]

#### *Institution information*

Q2: Institution type

A2: Library

Q3: Country

A3: [Country]

Q4: Users characteristics

A4: Scholars, researchers, regional scientists,

Q5: Digital services offered

A5: Digital library [...], nation wide network of terminals for copywriting protected publications (Academica), several open APIs (OAI-PMH, open API for bibliographic data, open API for [...])

#### *IIIF implementation background*

Q6: In what context was the IIIF implemented?

A6: This question is unclear, would you please rephrase it?

Q6.1: When and how did the idea of adopting IIIF come about in your institution?

A6.1: The answer for this question involved some inquiry and I cannot be sure it it's 100% accurate):

I believe that The National Library of Poland joined IIIF Consortium in 2017. At that time we were undergoing a full remake of our systems to better fit our data openness policy. In 2017 we also received around 20m euros in funding for digitisation of 1m digital publication in cooperation with The Jagiellonian University. One of the requirements of the project was to



share those publication in a way that enables mass access to them. IIIF seemed to be the way to facilitate that access.

Q6.2: how did your digitization and digital services plans develop before you adopted the IIIF?

A 6.2: The IIIF itself did not impact our plans in any way. Before IIIF we implemented our own API [API site] that enabled users to download metadata and some of the images.

Q7: In which stage is your implementation?

A7: [Digital library website] uses both Presentation and Image API

Q8: What is the amount and type of material available in IIIF?

A8: Around 1,8-1,9 million publications that have IIIF manifests

Q9: What are the IIIF functionalities/services that are implemented?

A9: We make public IIIF Image and Presentation API manifests

Q10: The implementation of IIIF is for external or internal use?

A10: The main goal is to improve external use of our resources but we use IIIF in development process as data providing tool.

Q11: What are the departments or partners involved in the implementation?

A11: If I understand the question correctly we involved our on IT division to implement Image API and an external software company to implement Presentation API

Q12: Before the implementation, did a testbed take place?

A12: Our development process always includes a testbed.

#### *Reasons behind IIIF implementation*

Q13: What were the issues or needs that led to the IIIF implementation?

A13: We strived to improve our data openness. Our open API facilitated metadata harvesting but did not provide a mean for downloading images in full resolution, that's where IIIF came in handy.

Q14: What were the goals and expectations related to the implementation of the IIIF?

A14: The goal was to improve our data openness. No other reason was needed.

Q15: How is the IIF complaint with your institution's digitization and online accessibility strategy?

A15: We support full accessibility of full resolution materials that can be made public according to copyrights. That's why we didn't need to hide our manifests and image links inside them.

### *IIF Implementation challenges*

Q16: What were the expected risks in the context of the implementation?

A16: The only risk was that image harvesting would overload our servers, and it happened on several occasions when some bigger workshops took place and a large group of people used our API.

Q17: What were the main challenges of the implementation?

A17: I don't believe we faced any challenges.

Q18: What were the identified risks from the implementation?

A18: We did not identify any risks.

### *IIF benefits*

Q19: What are the main internal and external benefits of IIF?

A19: The main internal benefit is a possibility of using our resources during development process of new products. Some of our employees also use IIF to develop image recognition and handwriting detection tools.

Q20: What kind of feedback staff and users report about the IIF?

A20: Some researchers mentioned slight problems with our implementation of metadata part of IIF Presentation API. Since those issues had been resolved we didn't receive any complaints or feedback.

Q21: Did the institution conduct surveys or interviews to measure the satisfaction of staff and users?

A21: No, we did not.

### *Feedback & Improvement*

Q22: What goals or expectations were met?

A22: I believe that we promoted data openness in our country and were met with enthusiasm during several international events and workshops. IIF also helped a lot during the development of a new version of [website] (scheduled to launch next year)

Q23: What kind of feedback staff and users report about the IIF?

A23: Besides some minor technical issues in the beginning we received none.

Q24: In which way IIF can be improved?

A24: There should be more mandatory elements of manifests. Some of the metadata elements should be mandatory and have be mapped to a popular metadata standard (based on schema.org or RDF or any other popular schema), for example title and release date. The annotation part of IIF is slightly too complicated and for this reason we decided not to use it.

### 8.3.2 Interview 2

#### *Personal information*

Q1: Interviewee's job title

A4: [Not disclosed]

#### *Institution information*

Q2: Institution type

A4: "Research center and university"

Q3: Country

A3: [UK]

Q4. Users Characteristics

A4: "Our users can be anyone. The general public, researchers, students, staff, administrators, developers- they all have an interest in our collections and media.

To tell you about the development team: we are a small team- 9 members, who cover all aspects of development (analysis, design, development, testing, maintenance & support)- everyone does everything. "

Q5: Digital services offered

A4:" We work on all services that Library & University Collections needs- covering

- Library Management System

[URL]

- Institutional Repository

[URL]

- Collections Websites

[URL]

- Archives Repository

[URL]

- Image Repository (LUNA)

[URL]

- Exhibitions Repository

[URL]

As well as supporting many additional websites, CRIS system, Resource Lists, Digital Preservation systems, Museums cataloguing system, Digitisation Workflow systems etc”.

### *IIIF Implementation background*

#### Q6: What is the context of the implementation

Q6: “IIIF was implemented WITHIN the LUNA DAMS. We are very fortunate that we work closely with this vendor-supplied application, and we helped to shape the IIIF functionality within LUNA. In essence we did not have to implement IIIF servers, because our repository provided the functionality. Once they released a patch which included IIIF and we implemented, all of our images suddenly became IIIF. We did implement Cantaloupe- a very straightforward Java based IIIF server for smaller scale use (not BAU)”.

#### Q6.1 When and how did the idea of adopting IIIF come about in your institution?

A6.1: “2015- Europeana Tech Conference in Paris was our first exposure to the power of IIIF- we had a good body of content in the image repository, but it was not particularly interoperable, and we knew we could take our image provision to supply websites a step further. We first attended a IIIF event at the autumn working group in Ghent in 2015, becoming committed, and joined the consortium early 2016”.

#### Q6.2: How did your digitization and digital services plans develop before you adopted the IIIF?

A6.2: "I don't think IIIF has really changed the digitisation process. We have evolved quite a bit, using Goobi Workflow to do most of our digitisation "work", but in essence anything we digitise becomes IIIF as soon as we upload to LUNA, as normal.

However, we have, of course, changed to put IIIF at the heart of our collections services. So, now our collections websites reference images IIIF- we do not upload jpgs to the website

CMS (for example, visit [URL] or [URL]) . We also ensure that the Museums CMS does not have physical data attached, and we are trying to persuade more areas to use URLs”

Q7: In which stage is your implementation?

A7: ”I think we are fairly "mature", in that all of our images are available IIIF, and we have a light website CMS which mainly uses URLs, but we could go a great deal further. For example, while we have developed a base of digitised content through manifests, this is somewhat "unofficial" ([...]). I would like this to serve as a manifest endpoint for anyone to pick up our manifests, but our systems are in transition, and it may be that such a thing is not available until that work is done (LUNA->islandora for DAMS; DSpace -> Archipelago for web CMS; CodeIgniter->Drupal for web frontend)”

Q8. What is the amount and type of material available in IIIF?

A8: “We have around 300,000 images IIIF in our main LUNA repository, and another 30,000 or so in our repository where the content is hosted but not ours ([URL] ). We also have a Cantaloupe server supporting some other websites (eg [website name URL] ), and this has about 500 or so images there.

We have done investigation into the Presentation API v3's AV capabilities- for example  
[URL]

We have digitised the longest scroll in the IIIF "world"

[URL]

and we have done some investigations into search with my ex-colleague's [...] [NAME] annotation server

[URL]

Another colleague, [...], is sitting on the group developing the charter for IIIF-3D, although an API won't be ready for a while there.

Our exhibitions platform utilises IIIF throughout (again LUNA, but it is designed to use any IIIF images) and the StorIIIFs and Slow Looking IIIF tools are great examples. This was built by CogApp Labs, a big IIIF player (you will see them at <https://github.com/IIIF/awesome-iiif> on the IIIF site ( <https://iiif.io> )”.

Q9: What are the IIIF functionalities/services that are implemented?

A9: “Through LUNA and Cantaloupe, Image API 2.1 and Presentation API 2.1. We don't have any v3 in the wild, though we have used it for experimentation. Most of our services use the Image API, but we do a lot of experimentation and demonstration with Presentation API (and Search). We are not using Authentication”.

Q10. The implementation of IIIF is for external or internal use?

Q10: "Both. Within the websites which use IIIF, it is of course internal technically, but the websites themselves are for internal and external. The whole point of IIIF is that our images can be used by external users".

Q11: What are the departments or partners involved in the implementation?

A11: “As mentioned above, LUNA imaging are the main ones. We did Cantaloupe ourselves, and we are moving to the Islandora DAMS with help from Born Digital consultancy in New England- this also uses Cantaloupe. Cogapp did the Exhibitions Platform, and our colleagues in the Digital Imaging Unit (where the content is created) and Archives have been very engaged and helpful.

Q12: Before the implementation, did a testbed take place?

A12: “We had a test implementation of LUNA, but as IIIF was new functionality, we were not going to break anything if it went wrong. The websites that USED IIIF were rigorously tested”.

Q13. What were the issues or needs that led to the IIIF implementation?

A13: “Laborious processes to move images around; flat websites with no deep zoom; no standard for image interoperability”.

Q14: What were the goals and expectations related to the implementation of the IIIF?

A14: “Greater user engagement; faster processes; allowing systems to talk to each other better; letting our images be used in the outside world more. Interoperability within the community too- the great thing about the [...] site is that it actually hosts content ACROSS institutions (we have content native to [institution name], [institution name] and ourselves,

without having to upload to the Cantaloupe server- it comes STRAIGHT from their collections)”).

Q15. How is the IIF complaint with your institution’s digitization and online accessibility strategy?

A15: “We expect everything to be available IIF (achieved through the DAMS); we don't have a strategy around supplying everything through a manifest, but we will probably get there. We do have a commitment to Open Source, and obviously making as many of our images open as possible, which IIF completely supports”.

#### *IIF implementation challenges*

Q16. What were the expected risks in the context of the implementation?

A16: “I don't think we saw many risks. There is a danger of putting something out through IIF which really shouldn't be public, but that should be captured prior to upload. The use of Cantaloupe (Image API only) for other people's content was contentious: it's just images, so you lose some important provenance/rights information, unless you're working with metadata (you only get that with Presentation API). That simply served a purpose- without the website the information is lost”.

Q17: What were the main challenges of the implementation?

A17: “Winning people over! There is a resistance to the way LUNA writes its URLs, as it is application specific, so we may need to look at a proxy UUID generator for future work”.

Q18. What were the identified risks from the implementation?

A18: “See above. However, as we move to a different system (LUNA-> Islandora), I do have some fears about whether we are able to offer IIF as effectively in a new system. We have many applications expecting the URL to be LUNA-style”.

#### *IIF benefits*

Q19: What are the main internal and external benefits of IIF?

A19: “Internal- lighter websites, systems talking to each other better, being able to present image content more nicely. External- Being part of a community (we have hosted a few



IIIF community events including the autumn meeting 2018), being able to interoperate with things like [...], having other people use our images and the [...] (which was unique) and [...]".

Q20: What kind of feedback staff and users report about the IIIF?

A20: "IIIF has been wholeheartedly welcomed internally. It is seen as central to what we do. However, it is still challenging often for non-technical staff to understand how to use the APIs, and getting the URL into receiving systems can be another step in the process.

We've also noticed, through [aggregation repository], that if an institution changes its base URL, all the places you refer to that image suddenly get a dead link. However, this can be resolved".

Q21: Did the institution conduct surveys or interviews to measure the satisfaction of staff and users?

A21: "No. We've hosted a lot of workshops and demonstrations, but never interviews or questionnaires".

### *Feedback & Improvement*

Q22: What goals or expectations were met?

A22: "Interoperability. Faster processes. Lighter system"

Q23: What kind of feedback staff and users report about the IIIF?

A23 "It is unremittingly positive!"

Q24: In which way IIIF can be improved?

A24: "IIIF is always improving. We look forward to 3D and more systems making v3 APIs available in more receiving systems. I sit on the [...], and every month more improvements are being suggested to the specs to allow viewers to do more and more with IIIF content etc.

Within our institution, I want to see a manifest endpoint that anyone could use- most other big institutions have this capability. I want to make more use of Mirador 3 and latest Universal Viewer (our implementations are very outdated). I want more internal systems to use IIIF as a matter of course- we have built the manifest store for Rare Books and Archives ([URL]) but I feel that staff are waiting for us to move onto the new infrastructure ([repository])

will be using Archipelago repository and Drupal web front-end), which is somewhat frustrating, as when we send a manifest to show new digitisation, they are always pleased with how it looks.

Please have a look at this page where all of our resources are referenced: [URL].

### 8.3.3 Interview 3

#### *Personal information*

Q1: Interviewee's job title

A1: [Not disclosed]

#### *Institution information*

Q2: Institution type

A2: Instituição de ensino Superior

Q3: Country

[Portugal]

Q4: Users characteristics

Utilizadores heterogéneos, desde investigadores a simples curiosos

Q5: Digital services offered?

A5: “Pesquisa, navegação, manipulação de imagens (ampliação, recorte, orientação, alteração de cor/luminosidade), descarregamento de imagens. coleções digitais temáticas. Pesquisa/navegação por linha de tempo”.

#### *IIIF Implementation background*

Q6: In what context was the IIIF implemented?

A6: “O IIIF está implementado para a disponibilização de objetos digitais variados (livros, manuscritos, cartas, mapas, fotografias, entre outros), no âmbito da biblioteca digital de fundo [...] da instituição.”

6.1: When and how did the idea of adopting IIIF come about in your institution?

A6.1: “A ideia surgiu em 2016, resultou da necessidade de melhorar a navegação e a pesquisa no frontend da Biblioteca Digital [...]. Tomámos conhecimento do IIIF numa conferência sobre acesso aberto e a oportunidade proporcionou-se porque o software que adotámos para os repositórios digitais tinha um add-on que implementava o IIIF. Houve, na altura, alguma verba disponível para fazer esse investimento”

6.2: how did your digitization and digital services plans develop before you adopted the IIIF?

A6.2: “Tivemos vários projetos de digitalização desde 2010. O primeiro, que serviu de base à infraestrutura de suporte, utilizava um formato de navegação baseado em ficheiros html que era criado por um software mantido e melhorado pela Biblioteca Nacional de Portugal chamado Content. A estrutura das obras seguia (e ainda segue) o normativo METS, com um modelo criado pela Biblioteca Nacional”.

Q7: In which stage is your implementation?

A7: “Temos instalado um image server (digilib) e API’s de imagem e apresentação”.

Q8: What is the amount and type of material available in IIIF?

A8: “Temos livro moderno, livro antigo, manuscritos, cartas, mapas, publicações em série, fotografias; a biblioteca digital inclui obras em vários volumes e publicações em série com vários n°s/fascículos”.

Q9: What are the IIIF functionalities/services that are implemented?

A9: “Como já referido, temos as API’s de imagem e de apresentação, prevemos para breve a implementação de anotações”

Q10: The implementation of IIIF is for external or internal use?

A10: “A utilização dos materiais pode ser interna e externa”.

Q11: What are the departments or partners involved in the implementation?

A11: “Temos uma parceria com uma empresa italiana que desenvolveu e dá suporte à implementação do IIIF, no âmbito do software DSpace-CRIS”.

Q12 Before the implementation, did a testbed take place?

A12: “Sim. Fizemos alguns testes de funcionalidade antes de adotarmos a solução”.

Q13: What were the issues or needs that led to the IIIF implementation?

A13: “Melhorar a apresentação e interoperabilidade do património digital de fundo [...] da instituição”.

Q14: What were the goals and expectations related to the implementation of the IIIF?

A14: “Melhorar a apresentação e interoperabilidade do património digital de fundo antigo da instituição. Potenciar a divulgação e utilização do património digital da instituição no âmbito da investigação e promoção junto do público em geral”.

Q15 How is the IIF complaint with your institution’s digitization and online accessibility strategy?

A15: “Pela forma como foi desenvolvido, o IIF usa modelos de dados ligados e protocolos standard da web, e permite, duma forma fácil, assegurar o acesso, a divulgação e a partilha de recursos digitalizados na Web”.

#### *IIF implementation challenges*

Q16: What were the expected risks in the context of the implementation?

A16: “Os principais riscos foram a disponibilidade de recursos humanos para efetuar a migração de conteúdos para o novo modelo e a sua validação. Contudo 95% desses conteúdos já foram migrados”.

Q17: What were the main challenges of the implementation?

A17: “A migração para a nova versão da presentation API. A implementação das anotações. A simplificação e portabilidade da implementação adotada”.

Q18: What were the identified risks from the implementation?

A18: “A portabilidade da solução adotada pela instituição. O desenvolvimento que a implementação e adaptação que o IIF acarreta para a organização, dada a escassez de recursos humanos dedicados. A fraca divulgação da plataforma”.

#### *IIF benefits*

Q19: What are the main internal and external benefits of IIF?

A19: “A funcionalidade permitida, partilha e interoperabilidade de conteúdos. O potencial de divulgação”.

Q20: What kind of feedback staff and users report about the IIF?

A20: “O feedback é globalmente positivo”.

Q21: Did the institution conduct surveys or interviews to measure the satisfaction of staff and users?

A21: “Não. Foram feitas algumas ações de divulgação”.

*Feedback & Improvement*

Q22: What goals or expectations were met?

A22: “Desenvolvimento de algumas funcionalidades baseadas na adoção de anotações”.

Q23: What kind of feedback staff and users report about the IIF?

A23: “O feedback é positivo. Para alargar a utilização da plataforma deveria haver maior divulgação”.

Q24 In which way IIF can be improved?

A24: “A comunidade IIF é ativa e muito dinâmica. Aguardamos com expectativa a compatibilização da Content Search API com a nova versão da API de apresentação. A curva de aprendizagem para a implementação do IIF é bastante alta”.

#### 8.3.4 Interview 4

##### *Personal information*

Q1: Interviewee's job title

A1: [Not disclosed]

##### *Institution information*

Q2: Institution type

A2: "Research Center & University"

Q3: Country

A3: "Germany"

Q4: Users Characteristics

A4: "internal researchers"

Q5: Digital services offered

A5: " Digital facsimile with transcription (w/TEI)"

##### *IIIF Implementation background*

Q6: What is the context of the implementation

A6: "Libraries & Archives"

Q6.1: When and how did the idea of adopting IIIF come about in your institution?

A6.1: "We started to explore IIIF in 2021 and the main reason is that we want to use the zoom functionality to display digital facsimiles together with our transcriptions of texts using TEI Publisher".

Q6.2 How did your digitization and digital services plans develop before you adopted the IIIF?

A6.2: they were not very developed yet. In Cuba digitization is slower and it takes a lot of effort. Our partner institution released its first Omeka exhibition in 2021 and the first digital repository with DSpace also in 2021. So things were not very developed. However, they are

integrating IIIF in their digitization workflow together with other preservation, cataloging and description practices.

Q7: In which stage is your implementation?

A7: Not finished

Q8: What is the amount and type of material available in IIIF?

A8: "About one hundred digital surrogates of XIX manuscripts in TIFF".

Q9: What are the IIIF functionalities/services that are implemented?

A9: Zooming and navigation in a Open Sea Dragon Viewer

Q10: The implementation of IIIF is for external or internal use?

A10: "Internal use"

Q11: What are the departments or partners involved in the implementation?

A11: "IT and Computing Department and Library Services"

Q12: Before the implementation, did a testbed take place?

A12: Yes, we are testing now.

Q13: What were the issues or needs that led to the IIIF implementation?

A13: "Lack of expertise and dedicated resources. The problem that we are dealing with is that our partner institution is very small and it is located in Cuba, where there are other priorities like preserving physical documents rather than sharing online. So the budget is very small and there is only one person working on digital repositories and access. Plus this person just took the online course on IIIF, watched the youtube videos and read the documentation".

Q14: What were the goals and expectations related to the implementation of the IIIF?

A14: "We hope to facilitate reuse as part of digital editions and long-term access".

Q15: How is the IIIF complaint with your institution's digitization and online accessibility strategy?

A15: "It is integrated in our preservation program and digital repository".

*IIIF implementation challenges*



Q16: What were the expected risks in the context of the implementation?

A16: "Time schedule risks".

Q17: What were the main challenges of the implementation?

A17: "Lack of enough storage for big files, difficulty in converting TIFF into Pyramid or creating manifests from existing metadata records"

Q18: What were the identified risks from the implementation?

A18: "We have not finished with the implementation yet."

#### *IIIF benefits*

Q19: What are the main internal and external benefits of IIIF?

A19: "Reusability and interoperability benefits".

Q20: What kind of feedback staff and users report about the IIIF?

A20: "We have not got any yet".

Q21: Did the institution conduct surveys or interviews to measure the satisfaction of staff and users?

A21: "We have not finished yet with the implantation."

#### *Feedback & Improvement*

Q22: What goals or expectations were met?

A22: "So far yes, our partner institution has implemented IIIF in an Omeka installation and we are currently using it as part of our editions published with TEI Publisher. So yes, the answer is positive".

Q23: What kind of feedback staff and users report about the IIIF?

A23: "I am not aware of any user feedback so far because the project is under development, and I am not in charge of it. So I do not receive any user feedback. I am only offering consultancy and assistance to our partners based in Cuba."

Q24: In which way IIIF can be improved?

A24: “It requires infrastructure and resources that sometimes are not available in small institutions.”

### 8.3.5 Interview 5

#### *Personal information*

Q1: Interviewee's job title

A1: [Researcher & IT Assistant]

#### *Institution information*

Q2: Institution type

A3: "Unidade de Investigação"

Q3: Country

A3: "Portugal"

Q4: Users Characteristics

A4: "researchers"

Q5: Digital services offered

Q5: "Catalogação, inventariação e digitalização de documentos manuscritos e impressos musicais datados entre os séculos XII e XXI e disponibilização desta informação em sites"

#### *IIIF Implementation background*

Q6: What is the context of the implementation

A6: "Visualização de imagens em alta definição"

Q6.1: When and how did the idea of adopting IIIF come about in your institution?

A6.1: Em 2014-15. Surgiu porque começamos a ter problemas com o módulo Zoomify para o CMS Drupal que utilizávamos para a visualização de imagens na [plataforma]

6.2 How did your digitization and digital services plans develop before you adopted the IIIF?

A6.2: O plano de digitalização dos manuscritos musicais já tinha iniciado em 2005, e uma parte desses conteúdos foram disponibilizados publicamente na v1 da [plataforma], lançada em 2010-11. Assim, no momento de implementação do IIIF já se encontravam

digitalizados várias centenas de manuscritos musicais, muito embora tivéssemos disponibilizado apenas uma pequena percentagem em acesso aberto na internet.

Q7: In which stage is your implementation?

A7: "Já totalmente implementado"

Q8: What is the amount and type of material available in IIIF?

A8: "300.000 imagens em JPEG"

Q9: What are the IIIF functionalities/services that are implemented?

A9: "Visualização e navegação das colecções de imagens".

Q10. The implementation of IIIF is for external or internal use?

A3: "External use"

Q11: What are the departments or partners involved in the implementation?

A11: "Nenhum"

Q12: Before the implementation, did a testbed take place?

A12: "No"

Q13. What were the issues or needs that led to the IIIF implementation?

A13: "Porque o módulo anteriormente utilizado, o Zoomify, deixou de funcionar na versão 7 do Drupal".

Q14: What were the goals and expectations related to the implementation of the IIIF?

A14: "Maior facilidade e rapidez na visualização das imagens".

Q15: How is the IIIF complaint with your institution's digitization and online accessibility strategy?

A15: "Permitindo maior facilidade e rapidez na visualização das imagens, não sobrecarregando o servidor onde está alojado o site com os ficheiros das imagens libertando assim recursos. Permite também a partilha de notas (por ex., traduções) sobre cada uma das imagens".

### *IIIF implementation challenges*

#### Q16: What were the expected risks in the context of the implementation?

A16: “Dado que as imagens da [plataforma] têm de ser obrigatoriamente com uma boa definição, esta condicionante sobrecarregava os recursos do servidor de alojamento do site, pondo em causa a operacionalidade do site”.

#### Q17: What were the main challenges of the implementation?

A17: “A configuração do servidor IIIF (que ainda não se encontra totalmente resolvida) e a ligação com o Drupal. O maior desafio foi, no entanto, a migração das imagens e respectivos dados associados”.

#### Q18: What were the identified risks from the implementation?

A18: “O principal risco está no facto que a ligação entre o site e o servidor das imagens não se encontrar optimizada”.

### *IIIF benefits*

#### Q19: What are the main internal and external benefits of IIIF?

A19: “A facilidade de navegação e visualização das imagens”.

#### Q20: What kind of feedback staff and users report about the IIIF?

A20: “Positivo”.

#### Q21: Did the institution conduct surveys or interviews to measure the satisfaction of staff and users?

A21: "Não"

### *Feedback & Improvement*

#### Q22: What goals or expectations were met?

A22: “Optimização do sistema IIIF.”

#### Q23: What kind of feedback staff and users report about the IIIF?

A23: “Seria necessário otimizar a ligação entre o site e o servidor das imagens”

Q24: In which way IIF can be improved?

A24: “A implementação do IIF poderia ser mais universal, actualmente são necessários muitos conhecimentos técnicos para a sua implementação”.