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**LibrarIN [101061516]: Value Co-creation and Social Innovation
for a new Generation of European Libraries**



D3.1 Digital Transformation and ICT v1.0

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Executive Summary

Digital transformation approaches to libraries are well underway. They are initiated as part of the changing landscape of available technologies, but the change in patrons’ behavior on how to access information. These changes are, in turn, raising the expectations of libraries’ ability to fulfill their mission to contribute to the democratization of knowledge. They are also leading to the expansion of the types of services libraries offer, how libraries collaborate with other actors to offer cultural programs and, subsequently, how physical library buildings are used.

This report presents first the insights derived from a systematic literature review of the current literature (2013-2023) on digital library services. Using the PRISMA scheme, the goal is to understand the existing landscape of empirical evidence for the digital transformation of libraries. To analyze the resulting 354 articles, we used the structural modeling approach (STM) that helped us to cluster the topics into several dominant themes. The results show that digital transformation in libraries has been addressed in the existing literature according to the following 17 topics (Table A):

Table A: List of the 17 identified Topics based on the results of the STM analysis

List of Topics	
Topic 1 – National cultural development toward SDGs implementation	Topic 10 – Usability and accessibility of e-services
Topic 2 – Electronic Library Services	Topic 11 – Digital literacy and training in Academic Libraries
Topic 3 – Digital skill and literacy development	Topic 12 – Creating digital repositories
Topic 4 – Funding of Research Innovation in European Union	Topic 13 – Social media use
Topic 5 – Intention to use digital library services	Topic 14 – Libraries as social hubs
Topic 6 – Digital skills development of librarians	Topic 15 – Access and inclusion of e-Government services
Topic 7 – Adapting to new requirements	Topic 16 – Openness policies
Topic 8 – Online cataloguing	Topic 17 – Users’ data management
Topic 9 – Usage of e-books and e-resources	

The review of the existing literature helps us understand how the digital transformation of libraries has been discussed in the past. In order to look into the future and contribute to the ongoing digital transformation efforts with our project, we also need to understand the current and future challenges libraries are facing while they are digitally transforming their services.

Therefore, we derived a semi-structured interview guide from the systematic literature review as the basis for nine interviews conducted with international library experts. The interview themes focus on topics such as the reasons for the digital transformation of libraries, necessary prerequisites, including competencies of librarians and patrons, the way that they co-create these digital innovations with their stakeholders, as well as the expected outcomes.



The analysis of the expert interviews shows that across different library types, the demands for digital transformation in library services are driven by both external and internal reasons, in particular through changes observed in technology and demands from stakeholders. While smaller public libraries struggle with resource deficiencies and the lack of digital competencies among their staff, we observe that large lighthouse projects transform their libraries both in the digital and in the physical space by providing innovative services. Co-creative elements can be discovered in the interactions with other stakeholders to reinvent the physical use of the library buildings, but also with their stakeholders by using for example design thinking approaches to rethink the way and formats in which library services are delivered.

Lastly, we used the current and future challenges and aggregated them into themes. In the form of a Delphi study, we asked 42 experts to review these themes and rank them in three rounds by their importance. Our results show that "Library's role in the ecosystem" and "Skills & Mindset" were considered as the most important issues in both the second and third rounds, garnering consistent recognition from the participants. Conversely, "(Lack of) Resources" and "Acquisition" rank at the bottom of the list, showing their lower perceived significance in the context of library concerns.

As the phenomenon of digital transformation can be approached from a number of different perspectives, we will be using the Delphi study ranking as the basis for our selection criteria for the year 2 case studies. For Task 3.1 (Digital transformation and ICT), we have decided to focus on two types of case studies:

- 1) Technological innovations for the digital transformation of libraries, especially the use of Artificial Intelligence, and
- 2) Innovation processes to co-produce the digital transformation, especially design thinking methods to co-design library services with stakeholders.



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List of Terms and Abbreviations

Abbreviation	Definition
AI	Artificial Intelligence
DGRL	Digital Government Reference Library
PI	Principal Investigator
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
STM	Structural Topic Model
WP	Work Package



1 Introduction

This report discusses how the digital transformation of libraries has been debated in the past and presents efforts to identify the current and future challenges that libraries face as they digitally transform their activities.

1.1 Purpose and scope

The research of Task 3.1 builds on and contributes to the overall work of Work Package (WP) 3, which aims to empirically investigate the ongoing efforts to co-produce innovative public services in ways that enable the co-creation of value.

As the overarching scope of the WP is rather broad and could be deepened from different angles, this research addressed the following research questions: i) what are the topics discussed in the academic debate on digital transformation in libraries to date? ii) what are the most relevant topics practitioners are dealing with in their daily work?

Based on the answers to these questions, we defined the empirical cases and the research process to investigate them over the next few years.

1.2 Approach for work package and relation to other work packages and deliverables

This first version of Task 3.1 took an exploratory approach that focused a) on understanding what the types of themes and topics were already covered in the literature on the digital transformation of libraries is; and b) on exploring from expert interviews what the current and future challenges of the digital transformation of libraries is. This approach allows us to work both on theoretically as well as practically relevant issues so that we work on issues that are relevant for library practitioners and we can at the same time contribute innovative knowledge to theory.

1.3 Methodology and structure of the deliverable

The objectives outlined in the previous points are multiple and they have been investigated using different methodologies. First, to understand the history of empirical evidence on the digital transformation of libraries, a systematic literature review was conducted, and data were analyzed through the Structural Modeling Approach (STM). Second, nine interviews with international library experts were conducted to disentangle the current and future challenges libraries face in addressing the digital transformation of their institution and their services. Finally, a Delphi study was conducted to identify the most relevant issues for practitioners and to prioritize future challenge.

The report is divided into five parts. The first discusses the methodology used to map the current debate on digital innovation within the empirical context of libraries. Based on the systematic literature review and the STM analysis, this section sheds light on the topics discussed in the current academic literature. The second part, informed by the results of the literature review, refines our understanding of the needs of library practitioners through a set of expert interviews.



Combining the results of the literature review with the data emerged from the empirical analysis, the third part offers some reflections on the practical relevance of the themes identified, based on the Delphi study. The fourth part presents the criteria identified for the selection of the cases to be investigated in the remaining years of the project. The final section is a summary of the main findings of this report and an outline of the next steps.



2 Research design

This section discusses the methodology used to map the current debate on digital innovation within the empirical context of libraries.

We followed a sequential mixed methods design (Roberts et al., 2019) combining automated text analysis with interpretative qualitative analysis, to explore topics in the academic literature and reports from professional library associations. The choice of this automated method was made because it allows us to incorporate any metadata from the documents, discover new topics and identify their relationships (Roberts et al., 2019). Our methodological approach consisted of three steps, as illustrated in Figure 1:

1. *Data Collection*: First, we collected scientific literature and reports from professional library associations documents on libraries using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (hereafter referred to as PRISMA) (Page et al., 2021) approach, which is a systematic and transparent method. As a result, we were able to identify a comprehensive set of documents for analysis.
2. *Structural Topic Model (STM)*: Subsequently, we employed Structural Topic Model (STM, (Roberts et al., 2019)) analysis of the collected documents to uncover latent topics in the text data we collected.
3. *Interpretation*: We then interpreted the output of the STM analysis to identify and cluster the topics. This allowed us to gain a deeper understanding of how the topics related to digital innovation in libraries were already discussed in the existing literature.

The following graphic shows the individual data collection and analysis steps as part of our research design:

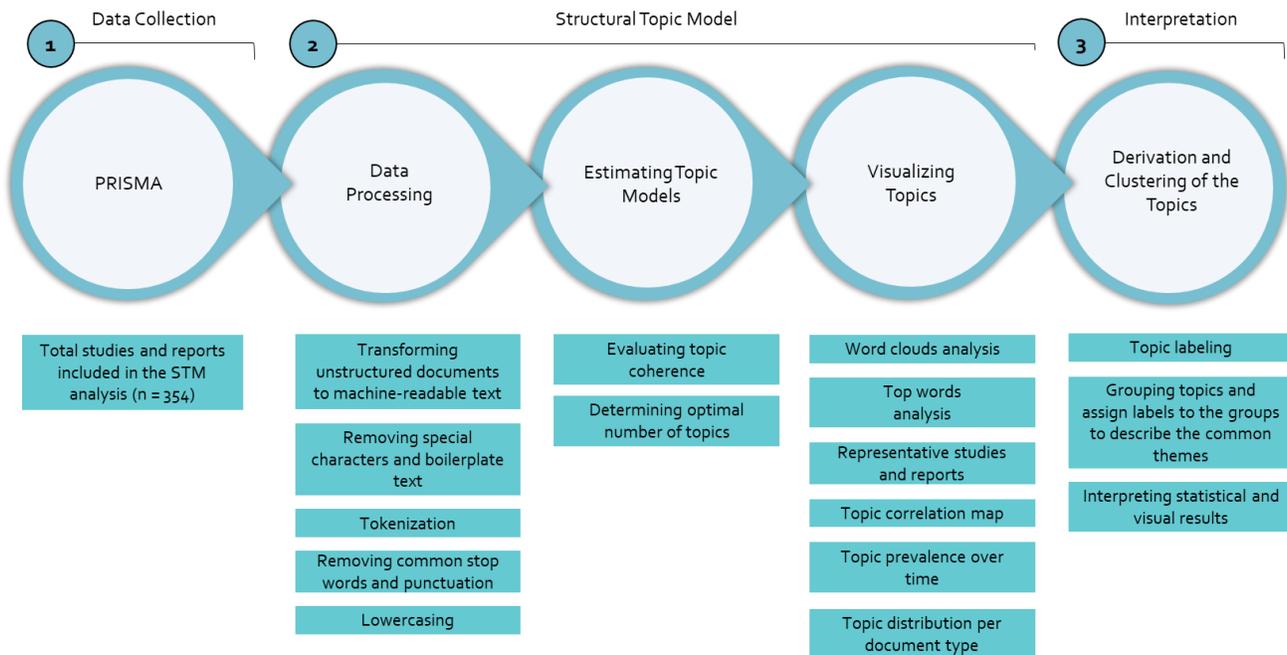


Figure 1: Structural Topic Model by Step Approach

2.1 Data Collection following the PRISMA protocol

We employed a systematic review using the PRISMA approach (Page et al., 2021) to investigate the linkages among digital innovation and libraries. We chose to adopt this approach because it allows us to be systematic in our data collection and to report on each step, which increases the transparency and replicability of the research.

Using this approach, we selected 354 articles: in the next paragraphs, we outline the methodological choices that guided our research process. Appendix A: PRISMA Checklist Appendix A presents the PRISMA checklist with the steps we followed in this study.

2.1.1 Eligibility criteria

For the review purposes, we include only those articles that meet the following eligibility criteria:

- *Language:* only academic publications in English were considered;
- *Time period:* Only articles published in the last 10 years, between 2013 and 2023. This period was selected as a reference by all the project's members;
- *Publication type:* Only articles published in international peer-reviewed journals were included in the sample; in addition, reports from professional library associations were considered;
- *Content availability:* Only articles for which the full text was available were considered in the analysis.

2.1.2 Information sources

In the second step of the literature search we selected the following databases: Google Scholar, EBSCO, Web of Science, and version 18.5 of the Digital Government Reference Library (Scholl, 2022) (hereafter DGRLv18.5).



In general, we made the decision to consider more than a single database in order to increase the possibility of including as many relevant studies as possible in the coverage of the subject investigated. With regard to DGRLv18.5, we decided to include it specifically because it is strictly related to issues related to the digital world and the public sphere. In addition, to gain a comprehensive perspective, we considered input from international research group members who identified literature in their domain. The search was conducted from December 2022 to March 2023, with a final update in May 2023.

2.1.3 Search strategy

Our initial search included a review of three systematic literature reviews (Ashiq et al., 2022; Llewellyn, 2019; Wójcik, 2019) on the topics covered, from which we extracted the themes that had been addressed in the academic literature to date. These included the type of library and related innovations implemented, as well as innovation drivers and challenges faced by libraries. The literature review highlighted the importance of considering the users and patrons of libraries, the role of libraries, the types of services they provide, as well as the future path for these institutions. The results of this initial search guided our subsequent search and coding strategy.

During the search process, we applied six search strings. We developed the search strings based on four types of libraries known in the literature and the specific keyword “digital” to account for the maximum inclusion of potential articles. We applied quotation marks to search exclusively for the identified terms while applying AND/OR Boolean operators to combine them. Finally, we used asterisks to include suffixes. Specifically, we used the following search terms for screening Google Scholar, EBSCO, and Web of Science:

- 1) “digital*” AND “academic library”,
- 2) “digital*” AND “university library”,
- 3) “digital*” AND “public library”,
- 4) “digital*” AND “municipal library”,
- 5) “digital*” AND “community library”.

In addition, for the search in the DGRLv18.5 database, we used “Library” OR “Libraries” (6) to include all variations of the keyword.

2.1.4 Selection process

The literature search yielded an initial sample of 1,403,294 full papers. As summarized in Figure 2, we applied the multi-stage process suggested by Page et al. (2021) to review records that do not fit the scope of our investigation. Once the preliminary collection of records was identified, we adopted a twofold approach to screening the studies.

First, the eligible databases were divided between the research team, which consisted of two experienced researchers and four research assistants. Specifically, three research assistants analyzed individually the papers extracted from the databases. Then, we excluded studies according to the eligibility criteria listed above: we thus considered 883 articles for the screening step.



We then analyzed the remaining pool of records by title and abstract to determine whether to include or exclude a specific document according to our criteria. As an example, if an article focuses on software libraries or if libraries themselves as institutions were not the main subject of the article, we excluded them from our sample.

The process was not straightforward, as it requires the researchers to come to the same conclusions about the analysis, *i.e.*, to reach an intercoder agreement (Lombard et al., 2006). Moreover, it was not always easy to extract information from abstracts and titles (Belur et al., 2021) alone: to increase the reliability and the accuracy of the process, the articles that could not be clearly included or excluded were set aside to be discussed first among the research assistants and, if further doubts remained, with the senior members. These discussions between the whole research team took place in weekly meetings on Zoom and were crucial in reducing the possibility of error and uncertainty, limiting the relevance of individual judgement, and resolving disagreements about the inclusion of a particular paper. These meetings considerably strengthen the decision-making behavior of the group (Belur et al., 2021) and, as a result, duplicates were then removed, resulting in a database of 390 records.

In addition to the academic literature, we also included a number of sources identified through screening of library association websites and partner sources, *i.e.*, grey literature. The primary search resulted in 38 additional records of which 16 were excluded because they did not meet the language criterion.

Finally, by combining the studies from the grey literature search with the other studies previously identified through the database screening, we include 354 articles in the review. Among these, a final remark concerns the articles (9) dealing with “community libraries”: due to their limited number, we read them carefully and found that the term was used interchangeably with public library or the authors even referred to them later in the text as public libraries. The term community library is used when discussing the services that either “academic” or “public” libraries provide to meet the needs of a community. For this reason, we have decided to consider only two types of libraries for our review: public and academic libraries.

The following figure summarizes the identification of studies from databases and reports from websites, as well as the identification, screening, and inclusion steps in form of the PRISMA flow chart:

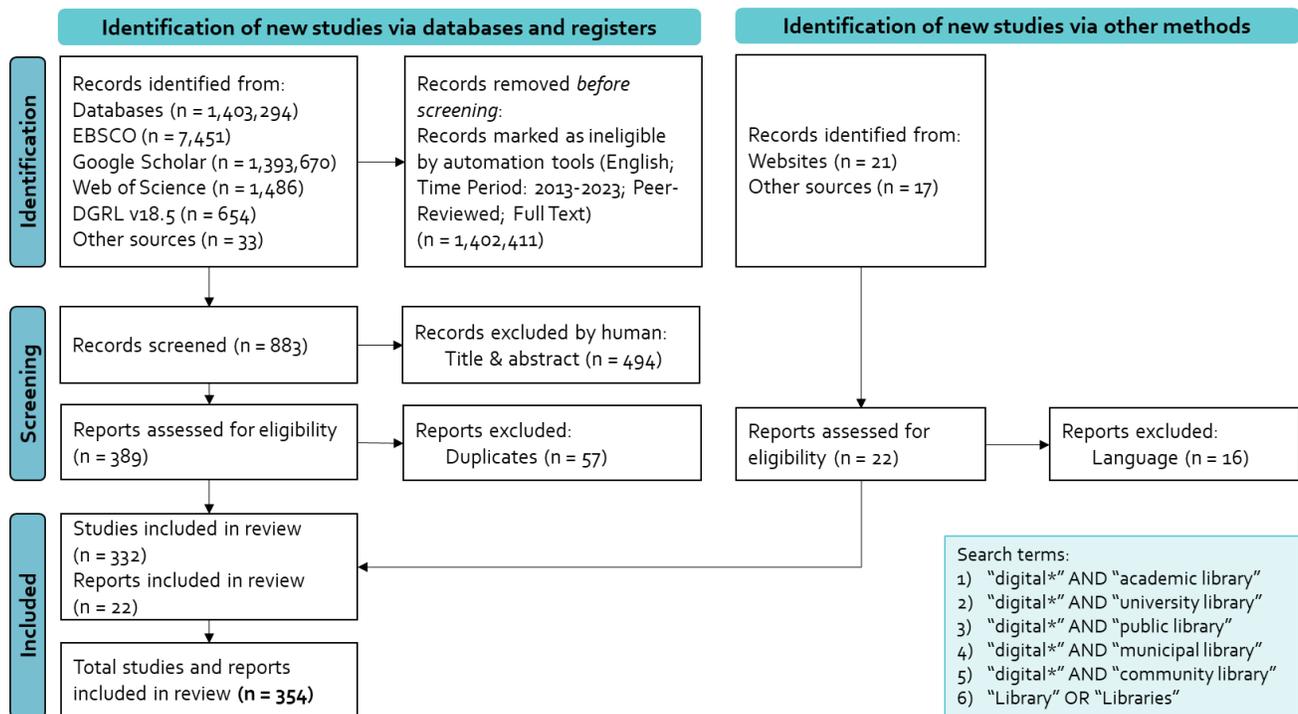


Figure 2: The selection process, based on the PRISMA flow diagram.

Appendix B: List of records included presents the full list of records included in the final review.

2.1.5 Data collection process

As discussed above (2.1.4), the lead researcher designed the study and supervised the research team, while the research assistants reviewed the data collected. Specifically, the four databases were distributed among the research assistants, who carried out the initial search, which directly referred to the four library types mentioned above. The research team discussed the screening process and coding scheme to define the inclusion and exclusion criteria, considering the overall aim of the research. Each research assistant then independently coded the results of the first five articles in their database, according to the type of library and its connection to digitization issues, and, after this first round of analysis, the research team shared the results to confirm and discuss their relevance. As with the selection process, we then discussed the results among the whole team, focusing on those entries that were unclear or could not be placed in a particular category. We discussed these entries together to ensure that we interpreted them consistently (Lombard et al., 2006). Informed by these findings, five more articles were selected in the second round of analysis until a consensus was reached on how the team should proceed with coding the remaining articles. As soon as this consensus in coding was reached, the research team then divided the remaining articles and coded them according to the process described above.

2.1.6 Data items

The corpus of the literature includes 332 peer-reviewed journal articles and 22 practitioner reports from library professional organizations. For the analysis, we included the reviewed articles in a database in preparation for the next analytical step using the Structural Topic Model, a computer-assisted text

analysis method. The information extracted allowed us to identify six topic areas related to the digital transformation of libraries.

2.1.7 Reporting bias assessment

To reduce the risk of bias that could affect the cumulative evidence, we only included international peer-reviewed journal articles in the review. We then considered input from international research group members who identified literature in their field to supplement our search with other important studies. We also conducted regular searches of the selected databases to ensure that we did not miss any relevant publications during the extended data collection period, and finally, we conducted individual analyses and weekly group assessments to clarify doubts and ensure that the analysis was consistent with the aim of the review.

2.2 Data analysis using Structural Topic Modeling

For the preparation of the data collected and the analysis of the large body of literature identified through the first steps of the PRISMA analysis, we employ the Structural Topic Model (STM) procedure, an unsupervised topic modeling approach recently developed by (Roberts et al., 2019). STM is a powerful machine learning technique to automatically uncover latent topics from large text corpora. STM is particularly suitable for analyzing literature (Sharma et al., 2021) and policy documents (Guenduez & Mettler, 2023), both of which make up our data.

We first prepared the text data we collected for the STM analysis. We performed several common processing steps using the *R package stm* (Lucas et al., 2015; Roberts et al., 2019). These included stemming, which reduces words to their core forms; removing punctuation, special characters, and stop words (such as “the”, “is”, “at” and “in”), and removing repetitive terms such as journal names, running titles, and pagination.

Once the data was prepared, we used the *R stm package* to estimate the structural topic model (Roberts et al., 2019). The first step was to determine the number (k) of topics (Lucas et al., 2015). To do this, we conducted a semantic coherence analysis. The results of this analysis are presented in Figure 3.

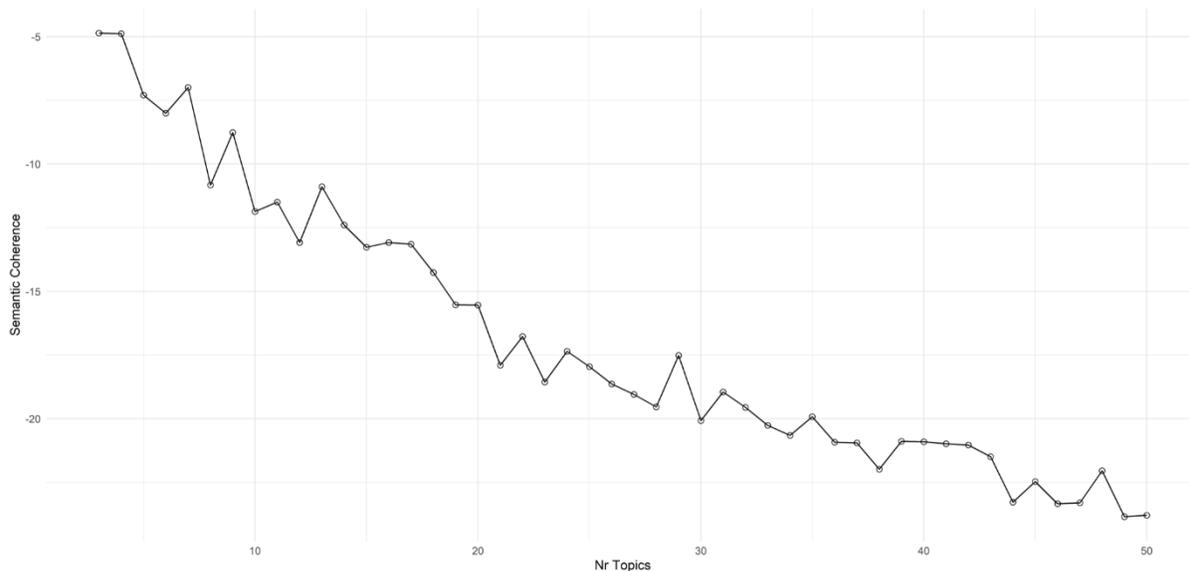


Figure 3: Semantic coherence analysis

The figure shows the relationship between the number of topics (k) and their semantic coherence. Semantic coherence is a measure of how well the topics can be interpreted and differentiated from each other. However, there is a trade-off between high semantic coherence and specificity. As the number of topics decreases, semantic coherence increases. The topics become more general and less specific. Conversely, as the number of topics increases, the topics become more specific. The semantic coherence decreases, which often makes it difficult to distinguish between the topics.

The determination of the optimal number of topics is not a simple task. There is no “right” or “wrong” number of topics. The appropriate number of topics depends on the specific research objective. In our study, we wanted to find topics that were as specific, coherent, and clearly distinguishable as possible.

We evaluated models with different topic models, including 4, 7, 9, 13, 17, 20, 29 and 35 topics. We qualitatively assessed the output of each topic model, including the top words, word clouds, and representative research articles. We found that the model with 17 topics produced the most appropriate for our study.

2.3 Results of the Structural Topic Model (STM)

In the following, we briefly describe the results by highlighting the topics we identified, the time trends, topic prevalence, and the topic proportion between public and academic libraries.

2.3.1 Interpretation and Clustering of the Topics

The STM analysis provides a variety of outputs to interpret and describe the topics, including top words (words with the highest probability of association with the topic, as well as the most frequent and exclusive words), word clouds representing the most important words and their frequency in the context of the topic, and representative texts containing the relevant top words and closely linked to the topic (Roberts et al., 2019).



To describe and label the topics, we used the following procedure: first, we processed the top words, word clouds, and representative studies individually and, based on this, described and labeled the topics. In subsequent meetings, we discussed our interpretations of each topic. In case of disagreement, we discussed different interpretations by considering and discussing the top words, word clouds, and analyzed additional representative studies to better understand how the top words were used and what topics they formed in these studies. Based on our findings, we adjusted our descriptions and labels accordingly. We repeated this process for each topic until agreement was reached. This way, we identified 17 different topics and labeled them based on the results of the STM analysis, as reported in Table 1.

Table 1: List of the 17 identified topics based on the results of the STM analysis

List of Topics	
Topic 1 – National cultural development toward SDGs implementation	Topic 10 – Usability and accessibility of e-services
Topic 2 – Electronic Library Services	Topic 11 – Digital literacy and training in Academic Libraries
Topic 3 – Digital skill and literacy development	Topic 12 – Creating digital repositories
Topic 4 – Funding of Research Innovation in European Union	Topic 13 – Use of social media
Topic 5 – Intention to use digital library services	Topic 14 – Libraries as social hubs
Topic 6 – Digital skills development of librarians	Topic 15 – Access and inclusion of e-Government services
Topic 7 – Adapting to new requirements	Topic 16 – Openness policies
Topic 8 – Online cataloguing	Topic 17 – Users’ data management
Topic 9 – Usage of e-books and e-resources	

In a next analysis step, we grouped the 17 topics into six thematic clusters based on their shared thematic content to be able to identify the gap between the published research and current practices and challenges that the experts reported during the interviews. The clusters and their corresponding underlying topics are depicted in Table 2.

Table 2: List of topics grouped into six thematic clusters

List of Topics	Second level	Third level
Topic 1 – National cultural development toward SDGs implementation	National cultural development toward SDGs implementation	Policies and strategies for development (on national and supranational level)
Topic 4 – Funding of Research Innovation in European Union	Funding of Research Innovation in European Union	
Topic 16 – Openness policies	Openness policies	
Topic 2 – Electronic Library Services	E-services access	User centrality in e-services



List of Topics	Second level	Third level
Topic 9 – Usage of e-books and e-resources		
Topic 5 – Intention to use digital library services	Intention to use digital library services	
Topic 10 – Usability and accessibility of e-services	Usability and accessibility of e-services	
Topic 17 – Users’ data management	Users’ data management	
Topic 7 – Adapting to new requirements	Adapting to new requirements	Adapting to new requirements
Topic 3 – Digital skill and literacy development		
Topic 6 – Digital skills development of librarians	Digital skills and literacy	Digital skills and literacy
Topic 11 – Digital literacy and training in Academic Libraries		
Topic 13 – Use of social media		
Topic 14 – Libraries as social hubs	Social inclusion and interaction	Social inclusion and interaction
Topic 15 – Access and inclusion of e-Government services		
Topic 8 – Online cataloguing	Online cataloguing	
Topic 12 – Creating digital repositories	Creating digital repositories	Building digital infrastructure

The six clusters we identified relate to the development and use of digital technologies in libraries. These clusters are:

- Policies and strategies for development (on national and supranational levels), grouping studies mainly related to the implementation of national cultural development towards the achievement of specific SDGs and the enforcement of frameworks and policies, also at the European level.
- User centricity in e-services, grouping together articles dealing with the use of library services – particularly digital ones – by different stakeholders and the accessibility features of the above services.
- Adapting to new requirements, which brings together articles that explore organizational change in libraries, such as the introduction of project management, trends in changing service provision or the changing work of librarians.
- Digital skills and literacy, which brings together studies on the state of the art and the need to increase digital skills and literacy, both for librarians and for users.
- Social inclusion and interaction, which brings together articles relating to the social sphere and the role of libraries, both in the physical world and in the online world.



- Building digital infrastructure, grouping articles outlining the need to build a proper (digital) infrastructure.

2.3.2 Time trends

The STM analysis enables us to determine the temporal evolution of the identified topics based on the publication year of the documents and the respective prominence of the topics in the corresponding publications. The results of this analysis are presented in Figure 4.

The results show that many topics are relatively stable over time (*i.e.*, *Topic 13 – Use of social media*). Looking more closely at the different topics, some of them show a slight fluctuation during the period analyzed. Indeed, some of them show an increase in the popularity of the studies, which is gradual for some topics (*i.e.*, *Topic 1 – National cultural development toward SDGs implementation* and *Topic 4 – Funding of Research Innovation in European Union*), while more pronounced for others (*i.e.*, *Topic 2 – Electronic Library Services* and *Topic 3 – Digital skill and literacy development, Topic 17 – Users’ data management*).

Others, on the other hand, show a downward trend in recent years, indicating a partial decrease in popularity (*i.e.*, *Topic 7 – Adapting to new requirements, Topic 8 – Online cataloging, Topic 9 – Usage of e-books and e-resources*). In addition, other topics (*i.e.*, *Topic 5 – Intention to use digital library services* and *Topic 6 – Digital skills development of librarians*) although showing modest waves over the years, are growing again in the last period, demonstrating their centrality to the interests of the research community.

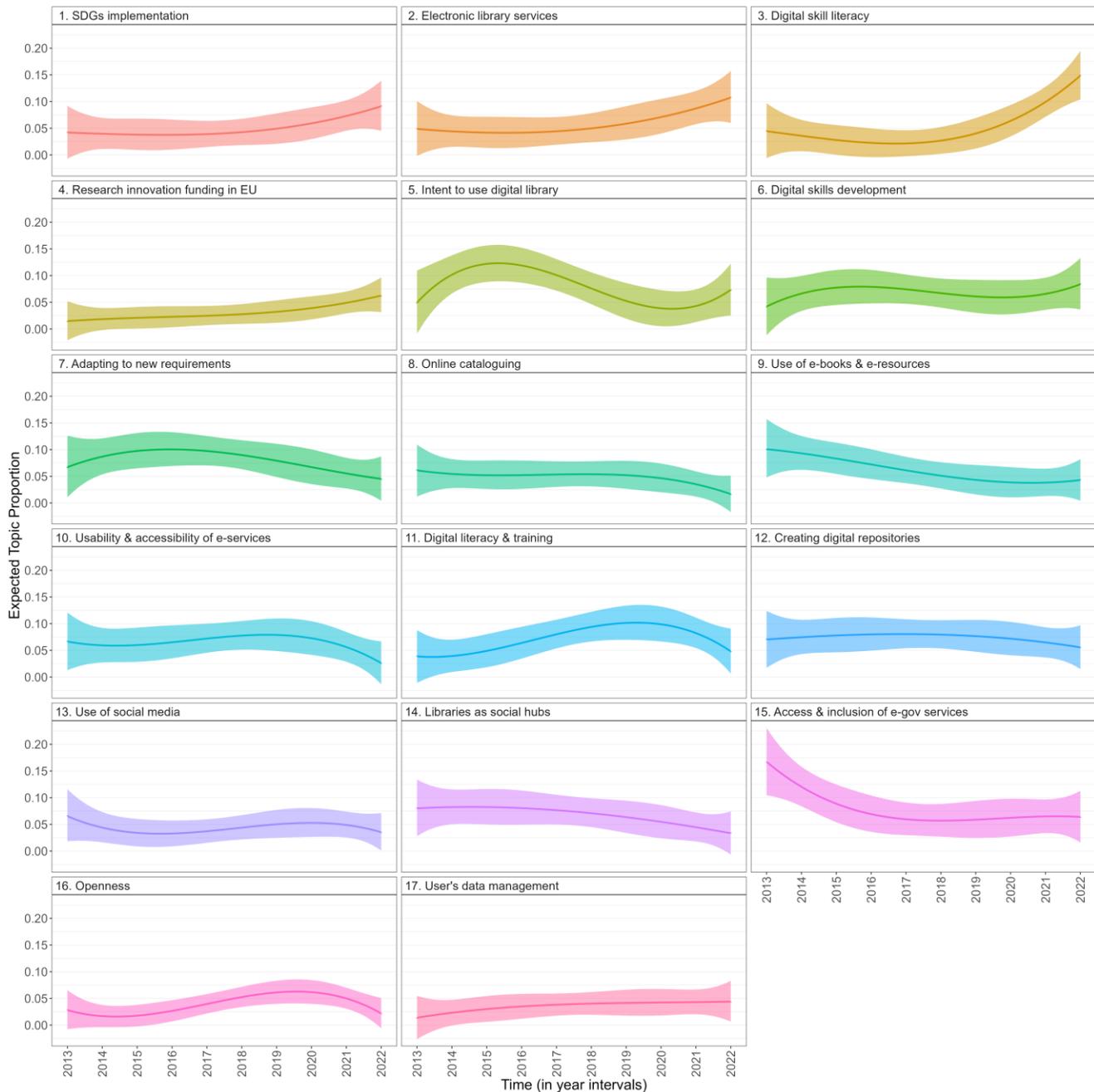


Figure 4: Time trends

2.3.3 Topic prevalence

To increase our understanding of the main characteristics of the sample of selected articles, we interpreted the results of the STM analysis, which also provides information on the prevalence. The topic prevalence is a measure of how prominent a topic is in a document. The prevalence is measured by how frequently a topic appears in a document. It can be calculated at the level of a single document or the complete data set with all documents. The basis for calculation is the proportion of words in the document that are assigned to a given topic. It appears that the dominant topic in the academic



discussion is Topic 15 (*Access and inclusion of e-gov services*), closely followed by Topic 7 (*Adapting to new requirements*). This means that the articles in the sample often address the role of libraries as facilitators of access and inclusion in e-government services (Topic 15), and also point to the urgency for libraries to address the changes that digital technologies have brought about in organizational structures, service provision and works (Topic 7).

Figure 5 shows the prevalence of the 17 topics in descending order and the top words for each topic.

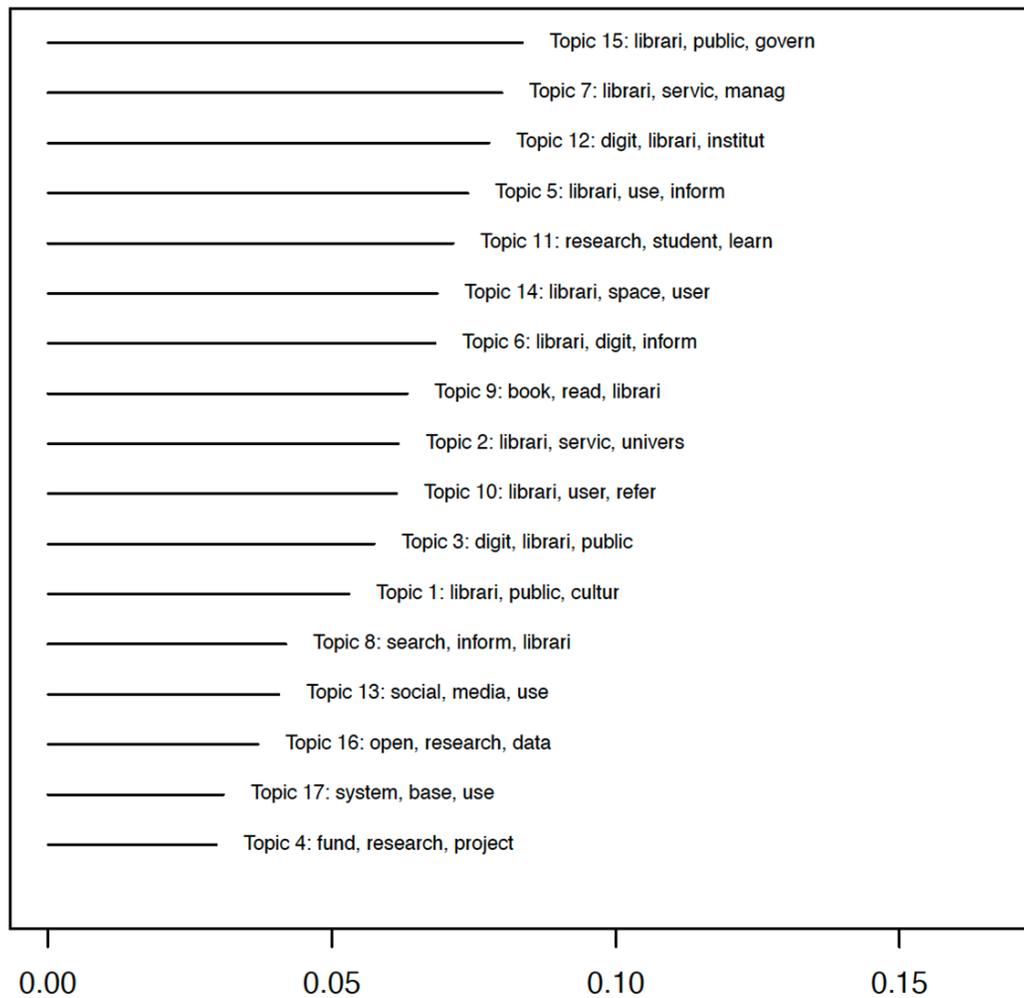


Figure 5: Topic prevalence



2.3.4 Topic proportion

STM allows the inclusion of document-level metadata as a covariate in the analysis. This allows to explore the relationships between the covariate and the identified topics. In this study, we included library type, i.e., “public library” and “academic library” as a covariate in the analyses to explore the correlation between the topics and the empirical context. The results of this analysis are shown in Figure 6. The analysis reveals several correlations: some topics, such as Topic 1– *National cultural development toward SDGs implementation*, Topic 3 – *Digital skill and literacy development*, Topic 13 – *Use of social media*, Topic 14 – *Libraries as social hubs* and Topic 15 – *Access and inclusion of e-Government services*, are strongly associated with public libraries. Topics like Topic 6 – *Digital skills development of librarians*, Topic 7 – *Adapting to new requirements*, Topic 10 – *Usability and accessibility of e-services*, and Topic 11 – *Digital literacy and training in Academic Libraries* is stronger associated with academic libraries.

For other topics, such as Topic 2 – *Electronic Library Services*, Topic 4 – *Funding of Research Innovation in European Union*, Topic 8 – *Online cataloguing* and Topic 17 – *Users’ data management*, there are no significant differences.

In conclusion, we can see that the *stimuli* and challenges brought about by digital technologies affect both public and academic libraries. However, some issues can be explored in more depth by library type.

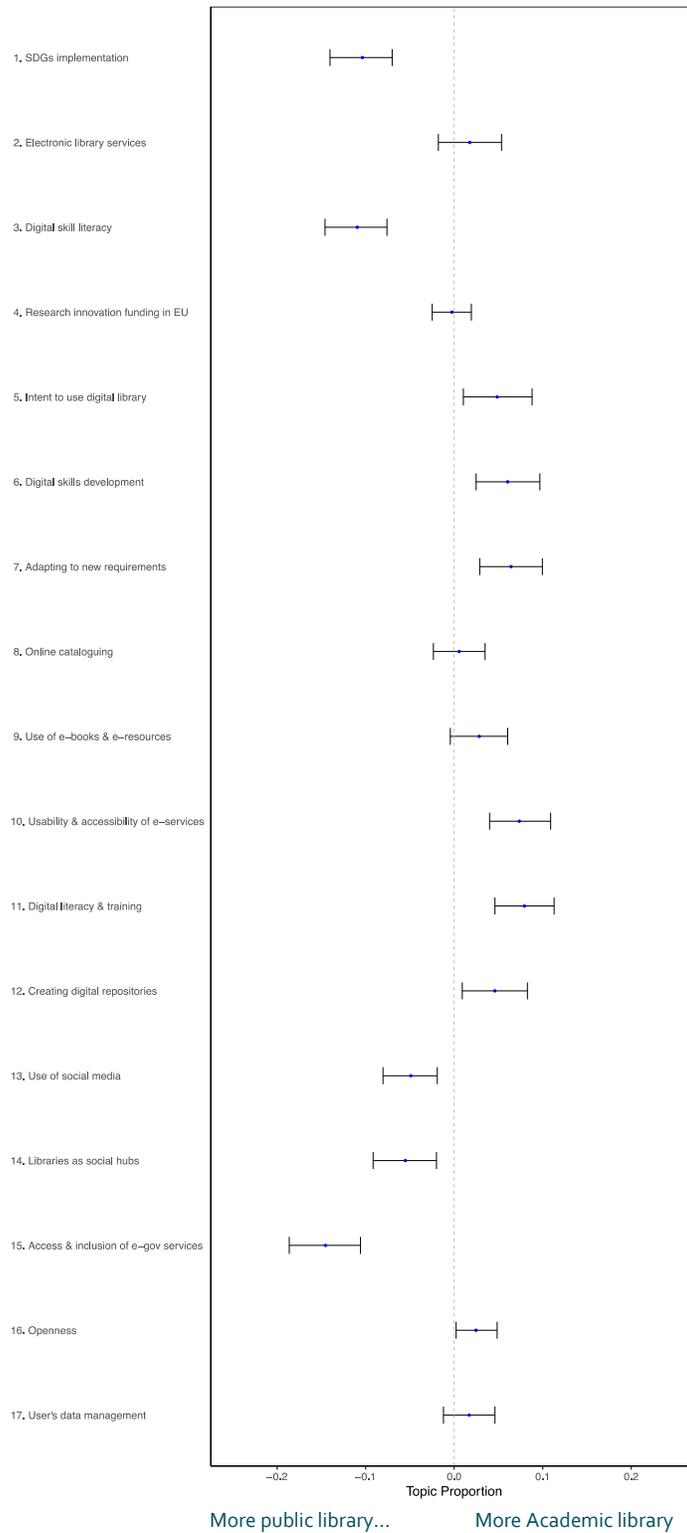


Figure 6: Topic proportion considering Public and Academic Libraries



In this analysis, document type, *i.e.*, whether reports or scientific articles are used, was also included as a covariate in this analysis. This covariance analysis, as Figure 7 illustrates, allows us to determine which topics are more or less addressed in the two document types.

The results show that Topic 1 – *SDGs implementation*, Topic 4 – *EU research innovation funding*, and Topic 16 – *Openness* are addressed significantly more in the reports. In contrast, electronic library services (Topic 2) and data skills development (Topic 6) are addressed significantly more often in scientific publications.

For all other topics, we find trends. The majority of the remaining topics are covered predominantly in research articles, with the exception of Topic 15, which tends to be covered more in reports. However, these differences are not significant.

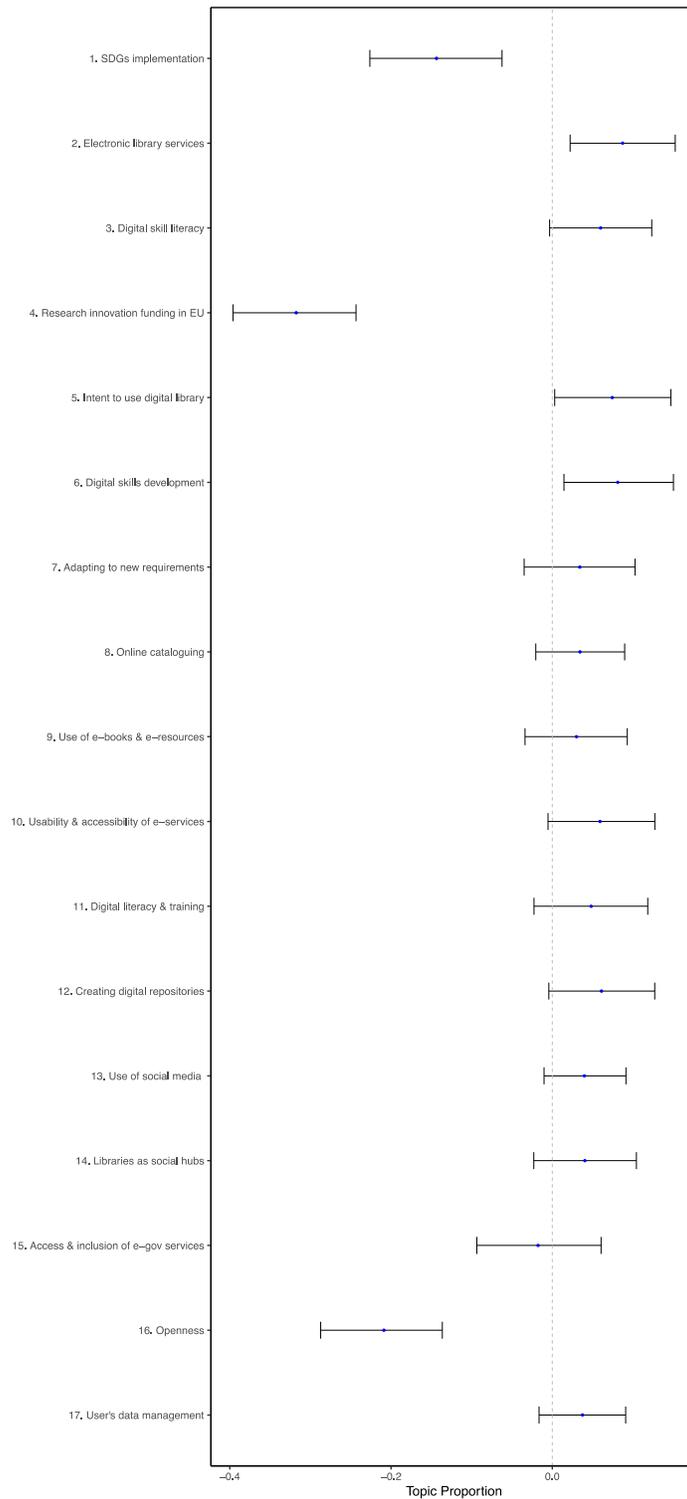


Figure 7: Topic proportion considering Document Type

3 Expert interviews

In addition to the systematic literature review, the Principal Investigator (PI) conducted a series of interviews with library experts to understand the current state of digital transformation in different types of libraries, with the aim of identifying the alignment or gap between research knowledge and the needs of library practitioners. The interviews expand on the findings of the literature review, as the protocol was designed to address issues such as the (digital) challenges libraries are currently facing, the strategy they are implementing to address them, and the role of the library building in this transformation. The interviews followed a semi-structured approach, as it is well suited to exploring respondents’ opinions and allowing for probing for more information (Barriball & While, 1994).

3.1 Research design of expert interviews

For that purpose, we identified the major professional library associations and conducted research interviews with them. The interviews, conducted between March and May 2023, lasted about 60 minutes and were conducted online by Zoom, recorded with the permission of the interviewees. The audio files were then transcribed verbatim.

The data was recorded with the permission of the participants, transcribed verbatim and analyzed using within-case and cross-case analyzes to identify key trends related to the project’s key areas of focus, digital transformation, innovation hubs and networks.

3.2 Results of expert interviews

The first aspect that emerged from the analysis of the interviews is that it is possible to identify some main themes that shed light on how the key areas covered by the grant – digital transformation, innovation hubs and networks – are being perceived by practitioners. Table 3 shows the results of this cross-analysis.

Table 3: Main trends emerging from the interviews

Digital Transformation	Innovation Hubs	Networks
Digital transformation of mission, collection, and processes	Libraries as a third space to exchange ideas, collaborate and meet	Barriers to cooperation between libraries , in particular across national borders
Interaction of technological artifacts with the physical space and materiality of books/collections	Libraries as physical hubs to connect research and society, but also to share (digital) data and information	Need to think outside the box and increase dialogue with other stakeholders
Digital innovation in support of digital society and library sustainability	Physical spaces as assets to redefine the role of libraries	Importance of informal networks and increasing links with users

Through cross-analysis of the interviews, we then identified seven overarching themes, which are aggregated for reporting purposes in Table 4 below. The themes show that the current issues faced by libraries go beyond the existing reports from the literature and focus on openness, the changing role of libraries in a larger ecosystem, a renewed focus on how the skills and mindsets of not only patrons,



but especially librarians need to be developed, the types of collaborations libraries are starting, how libraries are developing into a third space, and a recurrent theme that focuses on the lack of resources.

Table 4: Aggregate themes and related keywords emerging from the expert interviews

Main Theme	Keyword
Openness	(Research) Data Management
	European Open Science Cloud
	Open Science
	Open Education
	Findable, Accessible, Interoperable, and Reproducible (FAIR) Data
Library's role in the ecosystem	Innovating for and with the community
	Libraries as intermediaries to public services
	Preservation of (cultural) knowledge
	Human rights and values
	SDGs implementation
Skills & Mindset	Improve navigating skills
	New digital skills
	Changing librarians mindset
	Changing leaders role
Collaborations	Citizen Science
	Library collaboration
	Library-Stakeholder collaboration
	User collaboration
Library as a third space	Broadening library buildings
	Design thinking
	Redesigning library buildings
	Library as social and cultural hub
(Lack of) Resources	Lack of budget
	Technological infrastructure
Acquisition	Digital acquisition
	Negotiations with publishers

4 Delphi study

To better assess the practical relevance of the themes identified in the interviews and to better understand what the practical relevance of our research can be for the future of libraries, we conducted a Delphi Study. This is a structured survey method that uses iterative rounds of anonymous questionnaires confirming or changing the ranking of the themes extracted from the expert interviews. The goal is to rank the experts' insights in a specific domain according to their relevance (Day & Bobeva, 2005; Von Der Gracht, 2012).

In each of the three rounds, we asked the experts to rank the topics in order of their perceived importance. The aggregated responses from each round are then used to generate a new ranking for the next round (Von Der Gracht, 2012). The process continues until either the experts reach a consensus on the ranking of the topics, or a new round does not bring any significant changes and the ranking results remain stable (Schmidt, 1997).

The Delphi Study is well suited for our research purposed because it is an iterative process that allows us to rank the topics, we identified in the expert interviews according to their practical relevance. In this way, the Delphi approach helps us to identify areas of consensus and disagreement among the experts. This is important because it allows us to develop recommendations based on experts' opinions about how relevant or disputed a given topic is in practice to solve future challenges of libraries.

4.1 Results of the Delphi Study

We used convenience sampling (Etikan et al., 2016) to recruit a panel of 42 practitioners for the Delphi Study. The panel consisted of practitioners from public and academic libraries.

We started the Delphi Study by presenting the participants with the list of key factors that we extracted from the expert interviews. We asked them to rank these topics in order of importance. After receiving the responses, we closed the first round of survey and analyzed the data. We used Kendall's Coefficient of Concordance (W) (Schmidt, 1997) to measure the level of agreement between the participants. The coefficient ranges from 0.1 (very weak agreement) to 0.9 (unusually strong agreement).

In the first round, we observed a low Kendall's W value of 0.27, indicating a lack of agreement among the survey participants on the significance of individual issues (Dhillon et al., 2021). This result hinted at a considerable diversity of opinions among the participants.

Based on the results of the first round, we re-ordered the topics according to their relevance and started the second round. We asked the participants in the second round to indicate their agreement with the new ranking, and in case they disagreed, they were free to suggest a different order.

This process was reiterated for the third round. When we proceeded to the second and third rounds, we noticed an improvement in the level of agreement. The calculated W -values increased to 0.47 and 0.44, respectively, indicating a shift toward medium agreement (Schmidt, 1997). This indicates that



participants became closer in their views, but still had considerable divergence in their ratings. The lack of consensus is further substantiated by the wide distribution of responses and the presence of outliers.

An analysis of the number of participants in each round revealed slight variations. In the initial round, 20 individuals took part, while the second round saw 17 participants, and the third round had again 21 participants involved in the issue ranking process. The marginal decrease in the W-value from 0.47 in the second round to 0.44 in the third round may be due to the inclusion of new respondents in the latter stage, whose perceptions may have deviated from the established trends.

We noticed that the ranking of the topics and the level of agreement stagnated after the second round because the similar W values in the second and third rounds indicate that a medium level of consensus had been reached (Dhillon et al., 2021). The stagnation in agreement indicated that further rounds were unlikely to produce significant changes in rankings or levels of agreement. We thus stopped the survey after the third round, as additional rounds were unlikely to yield significantly higher W values.

Our results show that “Library's role in the ecosystem” and “Skills & Mindset” were considered as the most important issues in both the second and third rounds, garnering consistent recognition from the participants. Conversely, “Acquisition” and “(Lack of) Resources” rank at the bottom of the list, showing their lower perceived significance in the context of library concerns.

Overall, the results of the Delphi survey unveil a lack of consensus among participants in the initial stages, but as the process advanced, we witnessed a partial convergence of opinions. Our results illustrate the diversity of perspectives among respondents. While some issues remained contentious, other issues were identified by a large number of participants as consistently being the most important and least important.



5 Case selection criteria

On the basis of the results of the analyzes carried out in the first year, the next step for the research group was to identify the criteria for selecting the cases to be studied in the remaining years of the project. The following paragraphs therefore present the criteria developed for the selection of the empirical cases.

5.1 Framing the boundaries of the empirical investigation

The overall aim of this part of the research project is to understand why libraries are investing in digital transformation activities, their goals and expected outcomes for their users, the drivers for digital transformation, and the processes of changing internal mindsets, competencies, and cultures. This phenomenon is rather complex and could be approached from several perspectives, but the close link to the up-to-date research analyzed in the literature review section ensured the robustness of the premises, necessary to shed light on otherwise overlooked nuances of the relationship between libraries and digital technologies.

By examining and comparing the results of the literature review, the expert interviews, and the Delphi study, we were able to better define the boundaries of our research. As Table 5 shows, the comparison between the STM results and interviews allowed us to shed light on the gap between the research and the practice (red and dotted line). This gap is also confirmed by the Delphi study, which suggested to us to go deeper into topics such as “Library’s role in the ecosystem” and “Collaborations”, which appear to be relevant and understudied topics in the current debate and are closely related to the overall theme of the grant to understand how libraries are engaging in co-value production activities. In addition, the development of digital skills and attitudes and strategic choices remain central, even if they are already addressed in existing studies.

Table 5: Research-practice gap: digital transformation of libraries

Topic derived from the literature (STM analysis)	Current practice themes (Expert interviews)	Ranking of the importance of the themes (Delphi study)
1. Policies & Strategies	1. Openness (policies & strategies)	1. Library’s role in the ecosystem
2. Digital skills & literacy	2. Digital skills & mindset	2. Digital skills & mindset
3. Adapting to new requirements	3. Collaborations	3. Openness (policies & strategies)
4. User-centricity in e-services	4. Library’s role in the ecosystem	4. Collaborations
5. Social inclusion & interaction	5. Library as a third space	5. Library as a third space
6. Building digital infrastructure	6. (Lack of) Resources	6. (Lack of) Resources
	7. Acquisition	7. Acquisition

Starting from these premises, we decided to narrow down the focus and identify two cases for investigation (Ragin & Becker, 1992): (i) the technological innovation dimension of digital

transformation, which will allow us to deepen topics such as skills development, the co-production of digital transformation and the provision of resources; and (ii) the procedural and methodological aspects of digital transformation, which will instead offer insights into attitudes and mindsets, but also into the role of libraries in the ecosystem and as third spaces for the community.

Looking at the technological dimension, we decided to consider the development of Artificial Intelligence (hereafter AI), as this technology has the potential to influence “everything that happens in and around organizations” (Bailey et al., 2022, p. 1) and is increasingly being used in libraries, which are seen “as a crossroads of knowledge, [where] the flexibility of AI as a topic for themed programming, special events, and community outreach is limitless” (Dekker et al., 2022, p. 19).

Turning then to the procedural dimension, a scan of the existing literature revealed that, while design thinking approaches are considered to be crucial in libraries (Clarke et al., 2020), “there is no systematic exposure to this design material across the field of librarianship as a whole” (Clarke et al., 2020, p. 751) and much of the state of the art in libraries is by word-of-mouth (Clarke et al., 2020). It therefore seems relevant to explore the issue further in order to provide more structured evidence for both the academic and practitioner communities.

In conclusion, these two streams, as Gasparini and Kautonen (2022) pointed out, are closely linked, since design approaches allow us to face complex and unexpected problems, such as those posed by digital technologies and, in particular, AI.

The following sections therefore briefly outline some of the main issues that have been discussed to date in relation to the above topics and the criteria used to define the empirical context of the study.

5.2 The technological innovation dimension of digital transformation: Artificial Intelligence

The diffusion of AI solutions is gaining momentum in all sectors of society and this is not surprising because, even if AI was born in the field of computer science, the applications of its learning algorithms, go beyond the binary logic (Bresnahan & Trajtenberg, 1995) at the core of the other digital technologies, are continuously spreading across different domains (Cockburn et al., 2019).

Considering the empirical *locus* of the investigation AI is playing an increasingly important role in “reading, learning and research” (Van Wessel, 2020, p. 1), the key activities of libraries. Digital transformation issues therefore seem particularly interesting when they are linked to AI, which – due to its ability to exceed human capabilities, especially in some areas such as speed and precision of data processing (Gasparini & Kautonen, 2022) – has implications for managers (van Noordt & Misuraca, 2020), the design of mixed human-machine teams (Puranam, 2018), and the subsequent change required in organizational culture (Raisch & Krakowski, 2021).

The implementation of AI in libraries, also because of the amount of data held by these organizations, could thus be seen as a key case (Thomas, 2011) of the digital transformation phenomenon. Indeed, as the exploratory interviews with library experts revealed, libraries could be a place for experimentation



with AI and the results could be scaled up to other public service domains, making it increasingly relevant to investigate the phenomenon in this empirical context.

Specifically, in the words of one of the experts: *“libraries have much to contribute to the development of AI data, content, and expertise. [...] We should as libraries use our position and that position is that all around the world, we are seen as trusted and ethical source of data/of content. [...] Not only on the technical side, but especially on the moral side as well. If you do it the right way, you can be a frontrunner in AI development”*. And this concept was underlined by another non-European informant, who pointed out that *“we [= libraries] can be an entry point for these things”*.

However, despite the increased attention from libraries, the research relating AI to the empirical context has only emerged in recent years (Hervieux & Wheatley, 2021), even though scholars are also increasingly recognizing the urgency of expanding academic research and “knowledge sharing from practitioners” (Tait & Pierson, 2022, p. 258).

Moreover, the results of an environmental scan of AI policies implemented by European Member States show that few strategies address how the technology is being developed in the library context, mirroring the scattered scenario presented by (Bradley, 2022). In fact, although the majority of Member States already have an AI strategy (see for an overview (Raquel et al., 2022)), only six Countries address the library context. Furthermore, to check how the issue is being addressed by practitioners, we looked for national library strategies. The results here are twofold: on the one hand, few Countries have a specific strategy for their libraries (such as for instance Denmark, Ireland, Norway, Slovakia or Spain), but on the other hand, few of them discuss AI in their pages.

This lack of attention to the rise of AI is confirmed by a study of university libraries in the US and Canada, where the authors found that none of the 25 libraries, they selected were addressing AI issues in their strategic plans (Wheatley & Hervieux, 2019). Thus, notwithstanding the hype and the role they could play for society as a whole in leading the development of AI, libraries still need to better understand this multifaceted phenomenon in order to exploit its potential, but also to learn how to coexist with it (Gasparini & Kautonen, 2022).

As in other domains, discussions about AI development include the potential for this set of technologies to transform or eventually take over human jobs (see, for instance, (Arlitsch & Newell, 2017)), which also brings into focus the roles and skills needed to interact with these machines. Other studies provide an overview of the applications of AI for libraries (see, for instance, (Hervieux & Wheatley, 2022; Kaushal & Yadav, 2022)), that are increasingly shaping libraries and information services (Luca et al., 2022).

Starting from these premises, it seems important to dive deeper into the implementation and usage of AI within libraries: indeed, “librarians are there to perform set tasks that until now could not be done by machines” (Calvert, 2017, p. 171). Therefore, investigating how AI applications are interwoven with organizational processes and services is crucial to better unpack the many facets of the phenomenon.



5.3 The procedural and methodological aspects of digital transformation: design thinking approaches within libraries

Since we live in a VUCA (short for *volatility, uncertainty, complexity, and ambiguity*) and wicked problems are all around us, libraries are a breeding ground for explicit and implicit knowledge management, helping us to thrive in our information and knowledge society (Dresel et al., 2020; Loh et al., 2021; Pandey, 2016). Their traditional role as a physical place for public access to information and knowledge has progressively changed and the involvement of patrons in the development of new services become more and more important (Bech-Petersen, 2020; Bilandzic & Johnson, 2013; Decker, 2020; Passehl-Stoddart & Snipes, 2020; Whang et al., 2017). In this scenario, design thinking as a human-centered approach, holds the premises to help libraries and librarians to reflect on and improve their products and services (Clarke et al., 2020).

Notwithstanding these premises, there is no common definition of design thinking within the selected empirical domain: when discussing design thinking for libraries, the IDEO Design Thinking Toolkit for Libraries is often mentioned (IDEO, 2015), which describes design thinking as a deeply empathic and intuitive process consisting of three phases: inspiration, ideation, and iteration (IDEO, 2015). Other authors (Clarke et al., 2020; Loh et al., 2021; Whang et al., 2017) describe this approach as a holistic, iterative process that considers the needs and experiences of patrons. Through ongoing engagement with patrons, design thinking enables librarians to develop empathy with their constellation of stakeholders and cultivate an openness to innovation and transformation (IDEO, 2015; Whang et al., 2017). For the sake of clarity, this report defines design thinking in libraries as above.

This fragmented picture is also reflected in the current academic debate on the subject. Design thinking in libraries has been studied much more rigorously in academic libraries than it has been in public libraries. In an online survey conducted in 2018, over 60% of the US librarian participants reported being somewhat familiar or very familiar with design thinking (Clarke et al., 2020), and 27% of the respondents were actively using design thinking and methods in their libraries (Clarke et al., 2020).

However, Pandey (2016) mentioned that design thinking toolkits are often too abstract and this also implies the need to integrate such methodologies into librarians' training (Clarke & Bell, 2018), calling for a new model of library education that focuses more on design thinking approaches, learning by doing, and lifelong learning (Clarke & Bell, 2018, 2021).

In spite of all this, libraries are not standing still. Examples of design thinking being applied in libraries are the Chicago Public Library (CPL) and the Aarhus Public Library (Bech-Petersen, 2020; Dindler et al., 2016; IDEO, 2015). Specifically, the latter has been described as “a library for people – not for books” and as an “ongoing prototype” (Bech-Petersen, 2020, p. 7). Both libraries were part of the development of the IDEO Design Thinking Toolkit for Libraries and used design thinking to address mainly two themes: digitalization, and families and children (Dindler et al., 2016; IDEO, 2015). Besides these two lighthouses, design thinking is often used to redesign the library service models, such as at the Hillsboro Public Library (Chase, 2017), the State Library Victoria (Conyers et al., 2015), or the Ann



Arbor Library at the University of Michigan (Haines & Rodgers, 2021). In addition, design thinking enables libraries to create and redesign their physical spaces, such as at the University of Oregon (UO) Libraries (Passehl-Stoddart & Snipes, 2020), the University Library of Hildesheim (Frank & Schrader, 2020), or the University of California Berkeley Library (McGrath, 2016). Design thinking also covers digital transformation and innovation, for instance, the Harvard Business School's Baker Library used the approach to create digital products to improve course assignments and disseminate electronic faculty research (Dolan et al., 2017). The University of Sydney Library used service design thinking to create a user-centered systematic review service (Luca & Ulyannikova, 2020). A particular focus on the needs and challenges of transfer students through the design thinking approach is being undertaken at the University of Washington (UW) Library (Whang et al., 2017).

5.4 Research process

The phenomenon-driven nature of the research has a twofold consequence. On the one hand, as a phenomenon is defined as "regularities that are unexpected, that challenge existing knowledge and that are relevant to scientific discourse", no scientific theory has enough scope to account for it alone (Von Krogh et al., 2012, p. 278). Therefore, considering that scientific work could be seen as an ongoing dialogue between scholars (Colquitt & George, 2011), the adoption of multiple theoretical lenses at this stage allows us to gain a deeper perspective, disentangle the extant explanations of the phenomenon, and work towards new ones (Piekkari & Welch, 2018).

Thus, to start defining "*what is this a case of*" (Thomas, 2011, p. 515), we combine literature from the fields of public service management, computer science, public management – specifically value creation and co-production – and organization science. The choice of these theoretical lenses was made according to the characteristics of the phenomenon under study, but also in relation to the public service innovation and co-production framework that guides the whole project. It is worth noting that this literature provides us with a preliminary theoretical orientation: novel perspectives may emerge and be considered as the research progresses.

This initial familiarity with different theoretical perspectives allows us to avoid entering "the field without any knowledge of prior research" (Suddaby, 2006, p. 634), with the idea of continuously combining the theoretical starting point with the evidence that will emerge in the empirical world (Dubois & Gadde, 2002).

5.5 Case study selection criteria

As the overarching aim of the research is to investigate a contemporary phenomenon in depth – digitally transforming libraries – and within its real-world context (Yin, 2018), we utilize the case study approach. The core element of this approach is its focus on the dynamics (Eisenhardt, 1989), with the final aim to shed light on a "large number of details [...]. Its concern is not to exclude what it cannot command, but rather to avoid omitting some detail that might turn out to be important in explaining what happened in the situation being studied" (Schramm, 1971, p. 3). Following this statement, Yin (2018, p. 13) mentions as details "individuals, organizations, processes, programs, neighborhoods, institutions and event", which are central topics in this research.



We will therefore adopt criteria that follow the logic of purposeful sampling, that is “selecting *information-rich cases* for study in depth” (Patton, 1990, p. 169). Specifically, for the AI cases we apply two strategies. First, we rely on *snowball sampling*: through a series of expert interviews conducted between August and September 2023 with knowledgeable informants in the field (including both library association affiliates as well as library researchers), we seek to build a chain of good cases for study; then, informed by the results of these interviews and through *intensity sampling*, we aim to find rich examples of AI implementation within libraries, that “manifest the phenomenon intensely, but not extremely” (Patton, 1990, p. 171).

When considering design thinking cases instead, we have not yet conducted expert interviews on the topic. The definition of the cases is therefore based on the evidence generated by the literature review, triangulated with secondary data (such as library reports and websites) with the ultimate aim of finding rich examples of the phenomenon (*i.e.*, intensity sampling).

The following paragraphs will show the phenomenological and methodological criteria on which we base the investigations of years 2 and 3 of the grant period.

5.5.1 Phenomenon-driven case selection criteria

As the research is phenomenon-driven, that is, the specific phenomenon – digitally transforming libraries – drives and shapes the conversation and leads the research to “pay attention to an issue that motivates further exploration” (Schwarz & Stensaker, 2016, p. 246), the process of sampling is also deeply influenced by its ability to harvest the features of the phenomenon under investigation, as well as the key elements relevant to the overarching aims of the research grant. Accordingly, the casing process will focus on libraries which will allow us to investigate:

1. co-production aspects, to explore the involvement of users/patrons, librarians, and other stakeholders in the implementation and use of AI or in the adoption of design thinking approaches;
2. value co-production outcomes, to shed light on the value created for patrons and users through the use of AI and design thinking approaches, and who benefits;
3. any differences in the implementation and use of AI and design thinking approaches between public, national, and academic libraries;
4. innovation outcomes, which includes cases that allow us to distinguish, for example, whether the innovation is for the provision of specific services or for internal process management; and
5. competence creation, thus we will select cases where it will be possible to examine what, if any, new competencies are needed to tackle the implementation of AI or the development of design thinking approaches.

5.5.2 Methodology-driven case selection criteria

To frame the boundaries of the phenomenon, we also rely on a series of methodological clarifications necessary to ensure that the selected case has concrete manifestations in practice (Yin, 2018).



These boundary decisions have been defined by triangulating secondary data (such as library and conference websites), the evidence emerging from the academic literature, and, for AI, the data collected through five exploratory interviews with experts in the field, conducted between late August and early September 2023. These boundary decisions are presented below:

1. Time period:

- AI: from 2018 onwards. The choice of this year was made because it was the first year of the *Fantastic Futures* conference, signaling the growing interest of both practitioners and academics;
- Design thinking: from 2015 onwards. This year was chosen because it is the year of publication of the IDEO Design Thinking Toolkit for Libraries, and therefore a turning point for the topic in the empirical context studied.

The selected cases will be examined in a parallel study, *i.e.*, the cases will be “happening and being studied concurrently” (Thomas, 2011, p. 517).

2. Relevant organization(s): in terms of the context of the research, the focus will be on different types of libraries. Indeed, as one of the experts states “AI is already being discussed in a more practical way in academic and national library environments where there are different approaches, different abilities to use it”. Therefore, academic and national libraries – with their own particularities – seem to be more at the forefront of AI implementation, and thus “where the focal phenomenon is likely to occur” (Eisenhardt, 2021, p. 149). In the same way, public and academic libraries are more involved in experiencing design thinking approaches;
3. Geographical area: the research will be grounded in several countries, both inside and outside Europe. The decision to include these latter countries was taken because US and Canadian libraries were widely mentioned both during the expert interviews and in the literature reviewed. We therefore believe that a priori consideration of only European libraries would hinder a comparison between these different areas, which could instead benefit the whole research and library community;
4. Type of evidence to be collected: the research will draw on multiple sources of data (Gioia et al., 2013). Specifically:
- Experts’ interviews, to get a grasp of the situation and to disentangle cases of interest. The experts are selected based on their experience in the field. Since the aim is to obtain the broadest possible perspective on the phenomenon, we decided to include not only European informants, but also experts from other countries, both from national and academic libraries;
 - Librarian interviews;
 - Secondary data, such as library reports, strategies, policies, and other relevant documentation;
 - Field observations within the empirical context, where possible.

Once the boundaries of the phenomenon have been defined, the next casing step is to define the nature and design of the case study, choosing between single- or multiple-case studies.

In this research, we decided to conduct a multiple-case study, hence a joint study of a few cases. This choice has been made because we believe that once the specificities of each case are unraveled, comparing different cases will help us to better understand the similarities and differences between them (Thomas, 2011) and shed light on what these might tell us about the significant dynamics.

The subsequent design decision regards the choice to conduct embedded case studies (Yin, 2018). As Scholz and Tietje (2002, pp. 9-10) pointed out, “embedded case studies involve more than one unit, or object, of analysis [...] and the multiplicity of evidence is investigated at least partly in subunits, which focus on different salient aspects of the case”. As an example, Figure 8, which elaborates on Yin (2018), provides an example of the initial overview of the design choices for AI cases. It is worth noting that at this stage of the research we are not yet able to clearly define the embedded sub-units (Unit of Analysis – UoA), but these smallest units could be library departments or different interest groups that might be affected by the development of AI.

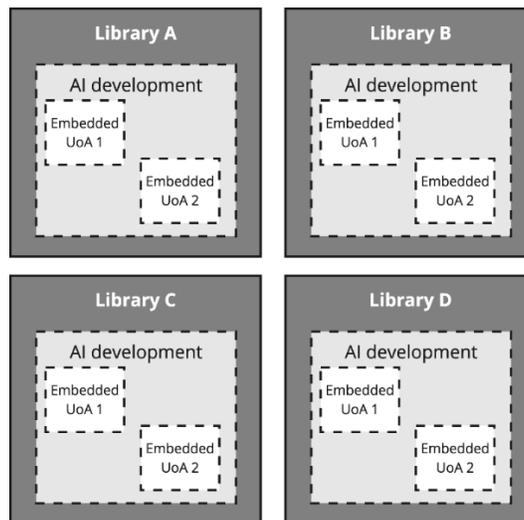


Figure 8: Case study design choices

Table 6 presents a summary of the case selection criteria for the two cases identified.

Table 6: Summary of case selection criteria

AI Implementation	Design thinking
Phenomenon-driven	
1. Co-creation and co-production aspects, to explore the involvement of stakeholders in the implementation of AI and design thinking approaches	
2. Value creation outcomes, highlighting the value created for librarians, patrons, and users by using AI and design thinking approaches	
3. Differences in the implementation and use of AI and design thinking approaches between the various types of libraries	
4. Innovation outcomes, which include cases that allow us to distinguish, for example, whether the innovation is for the provision of specific services or for internal process management	

5. Competence creation, to examine what, if any, new competences are needed to tackle the implementation of AI or the development of design thinking approaches		
Methodology-driven		
Time period	2018-today	2015-today
Relevant organization(s)	Academic and National Libraries	Academic and Public Libraries
Geographical area	Worldwide	
Type of evidence	Multiple data sources	
Design choices	Multiple-case study	
	Embedded	

Finally, it is important to underline the epistemological dimension of the research: the approach adopted will be explanatory (Scholz & Tietje, 2002; Yin, 2018). This means that considering the form of the research questions we intend to address (Yin, 2018), the research aims to investigate “*why*” the phenomenon of digital transformation, in its specific declinations of AI and design thinking approaches, occurs in the library context and “*how*” it affects the dynamics and the relationships within and outside the libraries’ boundaries, in the logic of value co-creation and co-production.

In conclusion, we acknowledge that even if we try to detail the steps of this cognitive journey, the process was and will not be linear, but rather “messy, idiosyncratic and difficult to articulate” (Van Maanen et al., 2007, p. 1149).

5.6 Overview of selected cases based on case-selection criteria

Based on our review of the literature and the initial expert interviews, we have identified a first list of potential cases for each of the two case studies on AI implementation and design thinking in libraries (Table 7).

Table 7: List of possible cases for digital transformation of libraries

Cases for AI implementation	Case for designing digital innovation
British Library	Aarhus Public Library
Finland National Library	Ann Arbor Library
Library of Congress	Chicago Public Library
National Library of France	Harvard Business School’s Baker Library
National Library of Sweden	Hillsboro Public Library
Norway National Library	State Library Victoria
Royal Danish Library	University of California – Berkeley
Queen’s University Library	University of Oregon Libraries
Stanford University Library	University of Sydney Library
	University of Washington Library



6 Conclusion and next steps

This report provides a synthesis of the research conducted in Task 3.1 along the first year of the project. This final section highlights the key outcomes of the study, as well as the activities expected for the next years.

6.1 Academic debate

The analysis of the 354 articles selected as a sample for the literature review allowed us to identify the most common themes discussed in the academic debate. Specifically, thanks to the application of the STM technique, we grouped them into seventeen themes and then highlighted their main characteristics.

Firstly, the different themes were grouped into six clusters according to their thematic content: i) policies and strategies for development, ii) user centricity in e-services, iii) adapting to new requirements, iv) digital skills and literacy, v) social inclusion and interaction, vi) building digital infrastructure.

Then, going one step further, the STM analysis allowed us to identify the main characteristics of these groups, focusing on the temporal evolution, the prevalence of the topics as well as their proportion, considering the type of library (i.e., academic or public) as well as the type of document (i.e., reports or scientific articles).

In a nutshell, the results showed that many topics are relatively stable over time, that the dominant topic is *Access and inclusion of e-government services*, that the *stimuli* of digital transformation affect public and academic libraries differently, and that most topics are covered in scientific articles.

6.2 Current state of digital transformation

Building on the results of the literature review, the research also sought to identify the current and future challenges faced by libraries in their day-to-day activities.

The experts interviewed placed a strong emphasis on three main themes that can be linked to the key areas covered by the research grant. Specifically, *digital transformation* was discussed, touching on changes in mission, and processes, but also the interaction between technological artifacts and the materiality of the library and its collection, as well as the role of digital innovation in supporting the digital society. On the other hand, regarding *innovation hubs*, experts in all the interviews pointed out that libraries could be seen as third spaces for the exchange of ideas and, consequently, as physical hubs connecting research and society. Finally, in relation to the development of *networks*, informants also emphasized the need to overcome barriers to cooperation with other libraries, and to improve dialogue with different stakeholders.

An in-depth analysis of the interviews then suggested a categorization of the themes that emerged across the interviews. Following a similar logic to the literature review, the key issues emerged were

grouped into seven themes: i) openness, ii) library's role in the ecosystem, iii) skills and attitudes, iv) collaboration, v) library as a third space, vi) (lack of) resources, and vii) acquisition.

These findings highlight that the current issues facing libraries go beyond what has been reported in the literature to date, and so there is a need to explore not only where the research fits into the academic debate, but also what the practical relevance of this study can be for the future of libraries.

6.3 Practical relevance of the research

Therefore, having identified the open issues in the academic debate, it was also a key task for this research to identify the most pressing issues for library practitioners.

Indeed, the comparison of the STM results with the interviews allowed us to identify the gap between research and practice. Then, to consolidate these findings, we asked a group of library experts to review the themes that had emerged from the previous analyses and to rank them in order of importance.

The results of the Delphi study enrich the previous findings and suggest that there is a strong need to explore the role of libraries in the ecosystem, *i.e.*, how libraries innovate for and with the community, how they act as intermediaries for public services, as well as issues around knowledge preservation. The Delphi study also highlighted the importance of exploring new forms of collaboration between libraries and other stakeholders, especially patrons and users.

6.4 Case selection and next steps

The analyses carried out during this first year suggested that digital transformation could be approached from several angles. We have therefore decided to narrow the focus and identify two cases for investigation: (i) the technological innovation dimension of digital transformation, which will allow us to explore issues such as skills development, co-production of digital transformation and resource provision; and (ii) the procedural and methodological aspects of digital transformation, which will instead provide insights into attitudes and mindsets, but also the role of libraries in the ecosystem and as third spaces for the community. By addressing these topics, we will be able to both contribute new perspectives to the academic debate and offer practical insights to librarians.

Specifically, considering the technological dimension, we decided to focus on the development of AI, as this technological artefact is increasingly used in libraries, which are seen as "a crossroads of knowledge, [where] the flexibility of AI as a topic for themed programming, special events, and community outreach is limitless" (Dekker et al., 2022, p. 19).

To date, we have already begun to familiarize ourselves with the phenomenon through the implementation and in-depth analysis of national AI strategies and (national) library strategies. Preliminary results show that although most European countries have an AI strategy, few of them address the development of AI in the context of libraries.

A series of expert interviews are underway to begin to address the topic and show that libraries: i) are key actors in the development of AI, not only within their own boundaries, but for technological development in society; ii) could help to develop AI literacy within the community; and iii) could also play an advocacy role, including raising ethical awareness of AI.



Turning then to the procedural dimension, a review of the existing literature revealed that while design thinking approaches are considered crucial in libraries (Clarke et al., 2020), “there is no systematic exposure to this design material across the field of librarianship” (Clarke et al., 2020, p. 751). It therefore seems relevant to explore the issue further to provide more structured evidence for both the academic and practitioner communities.

The research over the next few years will therefore be an in-depth study of these phenomena, by means of a case study approach. In fact, the results of the first year of the study have laid the foundations for the methodological and phenomenological criteria on which future research will be based.

Informed by these findings, in the second year of the project we will complete the interviews with AI experts and gain an overview of how design thinking approaches are currently being addressed by library professionals and in the literature.

Once the groundwork has been laid, the main aim of the research carried out in Task 3.1 will be to finalize the identification of the cases to be studied and to carry out the empirical research together with the consortium partners.

Appendix A: PRISMA Checklist

Section/Topic	No.	Checklist item	Reported on page #
Title			
Title	1	Identify the report as a systematic review.	To be defined
Abstract			
Abstract	2	Report an abstract addressing each item in the PRISMA 2020	To be defined in the final article
Introduction			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	8
Objective	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	To be defined
Methods			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	8
Information sources	6	Specify all databases, registers, websites, organizations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	8
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	9
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	9-10
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	11
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyzes), and if not, the methods used to decide which results to collect.	11
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any	NA



Section/Topic	No.	Checklist item	Reported on page #
		assumptions made about any missing or unclear information.	
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	11
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	NA
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	NA
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	11
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	11
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	11
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	NA
	13f	Describe any sensitivity analyzes conducted to assess robustness of the synthesized results.	NA
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	11
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	NA
Results			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	10
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	NA
Study characteristics	17	Cite each included study and present its characteristics.	NA

Section/Topic	No.	Checklist item	Reported on page #
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	NA
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimates and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	NA
Results of syntheses	20a	For each synthesis, briefly summarize the characteristics and risk of bias among contributing studies.	NA
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	NA
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	NA
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	NA
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	NA
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	NA
Discussion			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	13-19
	23b	Discuss any limitations of the evidence included in the review.	NA
	23c	Discuss any limitations of the review processes used.	NA
	23d	Discuss implications of the results for practice, policy, and future research.	24-25
Other information			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	NA
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	NA
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	NA
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	1
Competing interests	26	Declare any competing interests of review authors.	NA



Section/Topic	No.	Checklist item	Reported on page #
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyzes; analytic code; any other materials used in the review.	To be clarified

Appendix B: List of records included

1. K. Ahlfeld. 2021. "Creating Community Archives: Giving Voice to the Unheard." *Journal of Library Administration*.
2. C. L. Al-Qallaf; A. Ridha. 2019. "A Comprehensive Analysis of Academic Library Websites: Design, Navigation, Content, Services, and Web 2.0 Tools." *International Information & Library Review*.
3. M. Alipour-Hafezi; H. R. Khedmatgozar. 2016. "E-lending in digital libraries: a systematic review." *Interlending & Document Supply*.
4. F. A. A. Alotaibi; F. Johnson; J. Rowley. 2022. "Google Scholar or University Digital Libraries: A comparison of student perceptions and intention to use." *Journal of Librarianship and Information Science*
5. C. Anderson; J. Pham. 2013. "Practical overlap: The possibility of replacing print books with e-books." *Australian Academic & Research Libraries*.
6. M. Asim; A. Khan; S. M. Arshad. 2022. "Community Libraries in the Capital of Pakistan: current status, issues and perspectives." *Library Philosophy and Practice*.
7. M. Ashiq; F. Jabeen; K. Mahmood. 2022. "Transformation of libraries during Covid-19 pandemic: A systematic review." *Journal of Academic Librarianship*.
8. D. Attis; C. Koproske. 2013. "Thirty trends shaping the future of academic libraries." *Learned Publishing*.
9. R. Audunson; S. Aabø; R. Blomgren; H.-C. Hobohm; H. Jochumsen; M. Khosrowjerdi; R. Mumenthaler; K. Schuldt; C. H. Rasmussen; K. Rydbeck. 2019. "Public libraries as public sphere institutions: A comparative study of perceptions of the public library's role in six European countries." *Journal of Documentation*
10. Y. Aydin. 2021. "Comparing University Libraries in Different Cities in Turkey with regards to Digitalisation and the Impact of the COVID-19 Pandemic." *Informacios Tarsadalom*.
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12. P. B. Ayris, Isabel; Cavalli, Valentino; Dorch, Bertil; Frey, Jeannette; Hallik, Martin; Hormia-Poutanen, Kristiina; Labastida, Ignasi; MacColl, John; Ponsati Obiols, Agnès; Sacchi, Simone; Scholze, Frank; Schmidt, Birgit; Smit, Anja; Sofronijevic, Adam; Stojanovski, Jadranka; Svoboda, Martin; Tsakonas, Giannis; van Otegem, Matthijs; Verheusen, Astrid; Vilks, Andris; Widmark, Wilhelm; Horstmann, Wolfram. 2018. "LIBER Open Science Roadmap." *LIBER*
13. M. Baggett; R. Gibbs. 2014. "Historypin and Pinterest for Digital Collections: Measuring the Impact of Image-Based Social Tools on Discovery and Access." *Journal of Library Administration*.
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15. K. W. Baluk; M. Griffin; J. Gillett. 2021. "Mitigating the Challenges and Capitalizing on Opportunities: A Qualitative Investigation of the Public Library's Response to an Aging Population Canadian". *Journal on Aging-Revve Canadienne Du Vieillissement*
16. A. Bandyopadhyay; M. K. Boyd-Byrnes. 2016. "Is the need for mediated reference service in academic libraries fading away in the digital environment?." *Reference Services Review*.
17. L. F. Baron; R. Gomez. 2013. "Relationships and Connectedness: Weak Ties that Help Social Inclusion Through Public Access Computing." *Information Technology for Development*.

18. H. Barrie; T. La Rose; B. Detlor; H. Julien; A. Serenko. 2021. "“Because I’m Old”: The Role of Ageism in Older Adults’ Experiences of Digital Literacy Training in Public Libraries." *Journal of Technology in Human Services*.
19. S. Barstow; D. Macaulay; S. Tharp. 2016. "How to Build a High-Quality Library Collection in a Multi-Format Environment: Centralized Selection at University of Wyoming Libraries." *Journal of Library Administration*.
20. R. A. Baryshev; S. V. Verkhovets; O. I. Babina. 2018. "The smart library project: Development of information and library services for educational and scientific activity." *Electronic Library*.
21. J. W. Bazeley; B. Yoose. 2013. "Technical Services Transparency Using a LibGuide to Expose the Mysteries of Technical Services." *Library Resources & Technical Services*.
22. S. J. Bell. 2014. "Staying True to the Core: Designing the Future Academic Library Experience." *Portal-Libraries and the Academy*.
23. J. C. Bertot; P. T. Jaeger; U. Gorham; N. G. Taylor; R. Lincoln. 2013. "Delivering e-government services and transforming communities through innovative partnerships: Public libraries, government agencies, and community organizations". *Information Polity: The International Journal of Government & Democracy in the Information Age*.
24. J. C. Bertot; B. Real; P. T. Jaeger. 2016. "Public Libraries Building Digital Inclusive Communities: Data and Findings from the 2013 Digital Inclusion Survey". *Library Quarterly*.
25. L. Besançon; N. Peiffer-Smadja; C. Segalas; H. Jiang; P. Masuzzo; C. Smout; E. Billy; M. Deforet; C. Leyrat. 2021. "Open science saves lives: lessons from the COVID-19 pandemic." *BMC medical research methodology*.
26. S. Betz; R. Hall. 2015. "Self-Archiving with Ease in an Institutional Repository: Microinteractions and the User Experience." *Information Technology & Libraries*.
27. R. K. Bhardwaj; M. Margam. 2016. "Online legal information system for Indian environment: A user's perspectives." *Library Review*.
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29. M. Bilandzic; M. Foth. 2013. "Libraries as coworking spaces Understanding user motivations and perceived barriers to social learning." *Library Hi Tech*.
30. M. Bilandzic; M. Foth. 2014. "Learning beyond books-strategies for ambient media to improve libraries and collaboration spaces as interfaces for social learning." *Multimedia Tools and Applications*.
31. M. Bilandzic; D. Johnson. 2013. "Hybrid placemaking in the library: designing digital technology to enhance users' on-site experience." *Australian Library Journal*.
32. J. Boczar; B. Pollock; M. Xiyang; A. Yeslibas. 2021. "Bridging the Gap: Using Linked Data to Improve Discoverability and Diversity in Digital Collections." *Information Technology & Libraries*.
33. C. Born; M. Henkel; A. Mainka. 2018. "How Public Libraries are Keeping Pace with the Times: Core Services of Libraries in Informational World Cities." *Libri-International Journal of Libraries and Information Studies*.
34. J. S. Bossaller. 2016. "Access to Affordable Care through Public Libraries." *Library Quarterly*.
35. D. Branch; D. Hovenden; J. Upton. 2019. "A Whirlwind of Change Data: How Libraries and Vendors Translate Data Into Discovery and Access". *Serials Review*.

36. R. Brian; B. John Carlo; T. J. Paul. 2014. "Rural Public Libraries and Digital Inclusion: Issues and Challenges." *Information Technology and Libraries*
37. R. P. Bringula; A. E. Catacutan-Bangit; M. B. Garcia; J. P. S. Gonzales; A. M. C. Valderama. 2022. "'Who is gullible to political disinformation?': Predicting susceptibility of university students to fake news." *Journal of Information Technology & Politics*.
38. R. Buller. 2017. "Lending Video Game Consoles in an Academic Library." *Portal-Libraries and the Academy*.
39. C. Bullock. 2014. "Knowledge and Dignity in the Era of Big Data" *Serials Librarian*.
40. S. K. Burke. 2016. "Public Library Administration: Transparency on the Website." *Library Quarterly*.
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43. T. J. Cain; F. M. Cheek; J. Kupsco; L. J. Hartel; A. Getselman. 2016. "Health Sciences Libraries Forecasting Information Service Trends for Researchers: Models Applicable to All Academic Libraries." *College & Research Libraries*.
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45. S. Carnes. 2018. "Investigating Options for Increased Awareness and Use of Disaster Preparedness, Response, and Recovery Resources Among Libraries and Librarians (Part One of a Two-Part Series)." *Journal of Hospital Librarianship*.
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