Linked Data and Libraries

How the Switch to Linked Data Has Affected Work Practices at the National Library of Sweden

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Abstract
This thesis explores how library practice has been impacted by linked (open) data. For libraries, adopting linked data principles means moving away from the long-established reality of MARC-formats and opening up their information resources to the internet. While the transformation of library systems to linked data is often described as the necessary next step for the library community promising enormous benefits, the reality of the transformation process is a challenging one. This thesis employs an interview study at the National Library of Sweden, the first national library worldwide that has adopted linked data as its core data-model, to provide deeper insights into how linked data is affecting the current work practices of library professionals from their own perspectives.

The findings suggest that linked data is significantly impacting library practice in a multitude of ways, fundamentally changing knowledge and information organization in the digital age. While linked data is still in the beginning stages of its implementation in the library community as a whole, the interviewed library professionals are confident about the benefits the transformation will bring eventually. While there are still many challenges and obstacles to tackle there is a strong believe that the advertised promises of linked data will come true in time. Furthermore, the results of the study suggest that linked data is only part of a paradigm-shifting change currently happening in the knowledge and information organization community, accompanied by many other developments that are as a whole fundamentally changing how information is organized, managed, shared and even perceived in today's digital information environment of the internet.

Key words
Library Linked Data, Open Data, Semantic Web, Resource Description Framework, Machine-Readable Cataloging Formats, National Libraries

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List of Abbreviations

AACR2	Anglo-American Cataloging Rules
AI	Artificial Intelligence
CSV	Comma-separated values
FRAD	Functional Requirements for Authority Data
FRBR	Functional Requirements for Bibliographic Records
GLAM	Galleries, Libraries, Archives and Museums
HTTP	Hypertext Transfer Protocol
IFLA	International Federation of Library Associations and Institutions
ILS	Integrated Library System
IT	Information Technology
JPG	Joint Photographic Experts Group
KB	Kungliga Biblioteket (eng. National Library of Sweden)
LAM	Libraries, Archives and Museums
LGBTQIA+	Lesbian, Gay, Bisexual, Transgender, Queer, Questioning, Intersex, Asexual +
LD	Linked Data
LOD	Linked Open Data
MARC	Machine-Readable Cataloging
OCLC	Online Computer Library Centre
OWL	Web Ontology Language
PDF	Portable Document Format
RDA	Resource Description and Access
RDF	Resource Description Framework
SKOS	Simple Knowledge Organization System
SPARQL	Standard Query Language for Linked Open Data
SW	Semantic Web
SWIB	Sematic Web in Libraries
URI	Uniform Resource Identifier
W3C	World Wide Web Consortium
XLS	Microsoft Excel Spreadsheet

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Chapter 1: Introduction

Today's digital information environment is characterized by the vast amounts of information produced at a rapid scale and by a multitude of different sources. The way information is managed, thus, becomes a critical aspect for how knowledge is created and accessed. For centuries, libraries have been key actors in organizing, sharing and safe-guarding information and knowledge in society and, due to the shifting technological landscape, have had the continuous challenge of adapting and aligning their practices with the evolving information needs of their users. For the last fifty years, information management within libraries has been largely structured by one specific format: MARC (*MAchine Readable Cataloging*) which transformed the traditional catalog card into a machine-readable record. But, in recent years, more and more library professionals have criticized the limited potential of MARC in today's information ecosystem of the internet and the call for a new format for describing, organizing and maintaining information has continuously risen louder. As information discovery by the end-user is focusing on the Web, libraries need to make their information resources available and accessible online. Previous studies have argued that linked data (LD) offers a solution to this problem (Alemu *et al.*, 2012; Rasmussen Pennington and Cagnazzo, 2019).

Linked data has been introduced as a tool and means to enable a new stage of the web, the so-called Semantic Web, Web of Data or Web 3.0. These terms refer to W3C's vision of transforming the 'Web of Documents' into a 'Web of Linked Data'. This refined version of the web is similar to a database and will enable computers to do more useful work and better understand the information they are handling, facilitating not only connections in-between documents but rather between single entities (data) within these documents (World Wide Web Consortium [W3C], 2015).

For libraries the implementation of linked data technologies currently means moving away from MARC-formats toward a new data format based on the principles of linked data called RDF (*Resource Description Framework*). RDF can be defined as a standard for data interchange on the web, structurally based on the use of URIs (*Uniform Resource Identifiers*) that make relationships between data entities apparent in the form of links. Its basic structure consists of a subject (representing the resource) and an object (representing its value), which are connected by a predicate (representing their relationship), forming a triple (W3C, 2014). Thereby, library data becomes structurally more flexible and can be applied within diverse online contents, integrating library resources better within the context of the web (Rasmussen Pennington and Cagnazzo, 2019). As Schreur (2012) suggests

> [L]ibraries must be leaders in this revolution. […] The time has come for a pivotal change in the entire information ecosystems and libraries cannot afford to let history simply repeat itself (p. 237).

One library that has been taking huge strides in implementing linked data technologies into their own library catalog and is leading the way of better integrating library data into the web, is the National Library of Sweden (*Kungliga Biblioteket*, KB). With their launch of LIBRIS XL on the 11th of June 2018, the National Library of Sweden became the first national library in the world to adopt to cataloging in BIBFRAME[1] and thereby opening up their catalog as linked data to the web (Wennerlund and Berggren, 2019). Other libraries are following in their footsteps and are developing their own linked data projects as the topic is continuously gaining more interest and traction within the library and overall cultural heritage community.

In a systematic literature review on the implementation of linked data technologies in the library community, Gaitanou *et al.* (2022) suggest linked data is slowly but surely turning into a mainstream trend for library cataloging as major libraries worldwide have started their own linked data projects. Furthermore, most literature on the topic seems to foreground the utmost importance for libraries to join in the linked data transformation (Gaitanou *et al.*, 2022). While much research is focusing on the end-goal of a successful linked data implementation and the accompanying benefits for the library community, little empirical research has focused on the difficult truth of the actual transformation process as well as on the perspectives of library professionals in practice. Warraich and Rorissa (2020) state, that so far only a small number of studies on the perceptions and attitudes of library professionals surrounding linked data technologies and the Semantic Web as a whole have been conducted.

This thesis, thus, focuses on exploring the application of linked data in the library and how its implementation has transformed work practices within the library. While previous research has centred around the expected benefits as well as challenges of linked data, the scope of this thesis is exploring the ways in which linked data has actually transformed how library professionals do their work in practice and what their perspectives on this shift are. Since the National Library of Sweden has been one of the earliest implementers of this new data format in their cataloging system, this library is in the unique position of having worked with linked data for quite some time, providing the library professionals at KB with valuable insights into the transformation process and its consequences.

The topic is approached from the perspective of library staff at the National Library of Sweden and how they perceive the implementation of linked data in the

[1] BIBFRAME is a conceptual model for structuring bibliographic data based on the principles of linked data. The project was first initiated by the Library of Congress in 2012 with the aim of showing libraries the path in their transition from MARC21-formats to linked data (Library of Congress, n.d.).

Swedish union-catalog LIBRIS XL and the changes it has brought to their work practices. Furthermore, it will analyse how beneficial the transformation has been so far and in what sense the promises of linked data and the Semantic Web have become a reality. The most impactful lessons as well as past and current hurdles of the transformation will be discussed. The thesis also points an eye to the future, inquiring on what comes next for KB, now that the transformation has been performed, what doors for future developments have opened up due to the successful implementation and what broader implications linked data holds for changing future work practices at the library and beyond.

Research Context

Purpose and Objectives

Linked data has been advocated as the next step for information organization in the digital sphere. While attitudes towards this development range from bright-eyed enthusiasm to outright fear, linked data's potential and immense promise for the LAM-community (*Libraries, Archives and Museums*) are pushed to the forefront. In order to support the advancement of the Semantic Web and linked data, Rasmussen Pennington and Cagnazzo (2019) call for more concrete demonstrations of linked data's potential to spread awareness as well as provide proof of the benefits the transformation to linked data brings.

This thesis, therefore, aims at providing deeper insights into one of the first successful linked data implementations within the library community, LIBRIS XL at the National Library of Sweden, exploring the actual changes linked data has prompted for the current work practices of library professionals. It, furthermore, investigates the topic from the so far often neglected perspective of library professionals which Warraich and Rorissa (2020) point to. Through the help of semi-structured interviews with library staff at the National Library of Sweden, this thesis seeks to create a conversation with these library professionals and gain a deeper understanding of how these recent developments have affected their real-life work practices.

The objectives of this thesis, thus, are defined as:

- Foregrounding the perceptions and attitudes of library professionals concerning linked data in general as well as its implementation at the National Library of Sweden.
- Explicating the benefits as well as challenges of the implementation process and its consequences for the current work practices at the National Library of Sweden as they are perceived by the library staff.
- Understanding the impact of linked data on future library practice and the digital information environment.

Research Questions

In order to achieve the previously stated objectives, the following research questions have been formulated:

- How do library professionals perceive linked data and the effects of its implementation on their work practices?
- How and to what extend has the transformation to linked data technologies affected the work practices of library professionals?
- What are the major challenges as well as benefits of 'doing' linked data in practice and has the transformation been worth it so far?
- What broader implications does the introduction of linked data hold for library practices in relation to the future development of the digital information environment?

Relevance of the Study

Studying how the implementation of linked data technologies has transformed work in the library community is relevant for a number of reasons. Since the topic of linked data has been getting a lot of attention in theoretical studies, investigating the effects of linked data at an actual workplace from the perspective of library professionals actively engaging with the new data model on an everyday basis, can provide a new perspective on the topic and can contribute to advancing the knowledge in the field. Warraich and Rorissa (2018) call for more qualitative studies to explore these perspectives more deeply.

The authors, furthermore, suggest that training programs are essential to further develop the knowledge of information professionals working in the field as future professionals (Warraich and Rorissa, 2018). By understanding the ways in which the implementation of linked data is changing work practices at the library, the implications of linked data for professionals working in the field are foregrounded, highlighting what training is necessary for future professionals and where future training programs should set their focus.

Moreover, as W3C (2011) indicate, linked data has the potential to actively influence the efficiency of library services. Thus, analysing how it has affected work practices so far can lead to insights into areas where further improvement is necessary and possible. Since the implementation of linked data within the library community is still in its early stages, getting an impression of the actual work practices of library professionals at a library which has successfully transformed their catalog to linked data, can highlight where following implementers should focus their efforts on first and which challenges they might be able to evade.

Lastly, since one of linked data's biggest potentials is to significantly impact the accessibility of library resources, understanding the value of linked data for the overall cultural heritage community and researchers in relating fields is of great importance. Linked data enables unprecedented ways of engaging with library resources that can be specifically interesting for scholars in the fields of the digital humanities and social sciences (Antopolsky, 2022).

Disposition

The thesis is divided into eight chapters. While the first chapter has introduced the overall topic as well as the research context and questions, the second chapter discusses the background of linked data, establishing the underlying idea of the Semantic Web and linked data as the means to accomplish it, as well as introducing the National Library of Sweden as the case of study. The third chapter gives an overview of previously published literature on the implementation of linked data in the library community as well as the benefits it promises and the challenges the adoption has faced so far. Special attention will be paid to the study of the perceptions and attitudes of library professionals towards the topic. The literature review is followed by the fourth chapter which discusses the theoretical framework of the thesis, foregrounding linked data as a paradigm shifting data model for information organization and introducing practice theory as a framework for the analysis and discussion of the results. The fifth chapter describes the methodology of the study as well as the selection of materials. Chapter six presents the results of the study and in chapter seven these results will be discussed with regards to the research questions and theoretical framework. The thesis ends with a conclusion on the current state of linked data at the National Library of Sweden and its effects on the work practices of library professionals, summarizing the most important findings and exploring future research avenues.

Chapter 2: Background

The following chapter aims to provide the background information on linked data and the National Library of Sweden. Firstly, the term linked data will be defined as well as the general development of linked data technologies and the Semantic Web to its current state will be presented. Secondly, the National Library of Sweden as an institution and its current connection to linked data will be introduced.

The Semantic Web and Linked (Open) Data

The idea of the Semantic Web was initially introduced in the year of 2001 as an extension of the World Wide Web. Tim Berners-Lee's vision of this next stage of the web would be able to not only facilitate relationships between documents but between the data elements within those documents – transforming the web from a 'Web of Documents' into a 'Web of (Linked) Data' (Rasmussen Pennington and Cagnazzo, 2019).

> The ultimate goal of the Web of data is to enable computers to do more useful work and to develop systems that can support trusted interactions over the network. […] Semantic Web technologies enable people to create data stores on the Web, build vocabularies, and write rules for handling data. Linked data are empowered by technologies such as RDF, SPARQL, OWL, and SKOS (W3C, 2015).

After the realization of this vision proved to be quite difficult, the hype around the Semantic Web disappeared relatively quickly again. In 2006 the idea resurfaced through the introduction of 'Linked Data' as the new label for reviving the vision of the Semantic Web (Danowski and Pohl, 2013). Rasmussen Pennington and Cagnazzo (2019) define linked data as the tool or means to bring about the goal of the Semantic Web. But rather than one specific technology, linked data can be understood as "a continuously evolving set of best practices for the publication of structured data on the web" (p. 644). At its core, linked data is made up of different standards, methods and publishing models that aim at promoting the consistency, shareability and, most importantly, interoperability of the data on the internet (Rasmussen Pennington and Cagnazzo, 2019).

The so-called Linked Data Principles are:

- Using URIs as names for things,
- Using HTTP URIs to enable people to look up those things on the web,

- Providing useful information through the application of standards such as RDF[2], SPARQL[3], etc., when someone looks up the URI and,
- Linking to other URIs to enable the discovery of other things (Berners-Lee, 2010).

In 2010, Berners-Lee, furthermore, complemented these four basic rules with a five-star rating system for 'Linked Open Data'. As described above, 'Linked Data' mainly relates to the technical interoperability while 'Open Data' brings attention to its legal interoperability (Baker, *et al.*, 2011). Open data focuses on publishing data under an open license and aims at making data freely available and useable via the web (Danowski and Pohl, 2013). As shown in the table below the fifth and ultimate stage of linked open data encompasses data that uses an open W3C standard, like RDF, to identify things and links the data to other relevant data in order to provide more context.

Stage	Explanation	Example of Data Format
★	Data available on the web (whatever format) but with an open license, to be Open Data	PDF, JPG
★★	Data available as machine-readable structured data	XLS
★★★	Data available as in stage 2 plus in a non-proprietary format	CSV
★★★★	Data available as in stage 3 plus the use of open standards from W3C (RDF and SPARQL) to identify things, in order to enable people to point to your data	RDF
★★★★★	Data available as in stage 4 plus linking your own data to other people's data to provide context	Linked RDF

Figure 1. 5-Star Scheme of Linked Open Data (Based on Berners-Lee (2010)).

One of the earliest milestones concerning the linked data efforts was the extraction of data from Wikipedia and ensuing publication of this data as linked data within the project DBpedia in early 2007. Since then, the linked (open) data cloud is continuously growing as more and more data and data sources are transformed to linked data and published on the web (Danowski and Pohl, 2013). Figure 2 and 3 show the Linked Open Data Cloud as it was first published in 2007 and its most current state as of May 2020. It visualizes the global network of interconnected data sources that make use of linked data and Semantic Web technologies. As the figures showcase, the scale of the Linked Open Data Cloud has increased drastically, highlighting that

[2] RDF is a framework for modelling as well as exchanging data on the internet.
[3] SPARQL is the querying language which is used for querying RDF data.

linked data is continuously establishing itself as a way of publishing information online. It, furthermore, highlights how data from institutions with a multitude of different backgrounds, like geography, social networking, linguistics, government, media, etc., are connected in a global network.

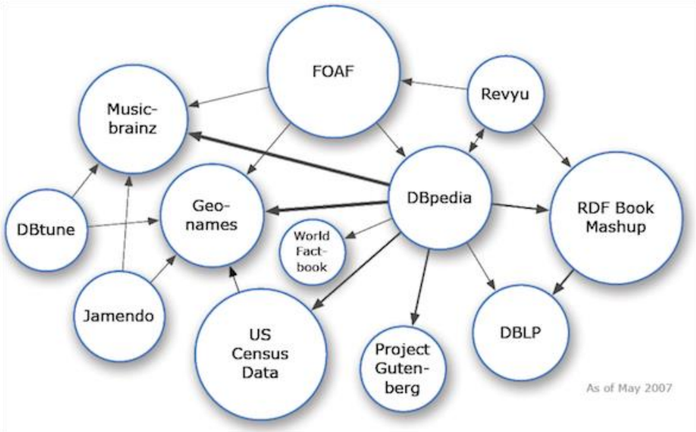

Figure 3. The Linked Open Data Cloud as of May 2007. (The Linked Open Data Cloud, n.d., CC BY).

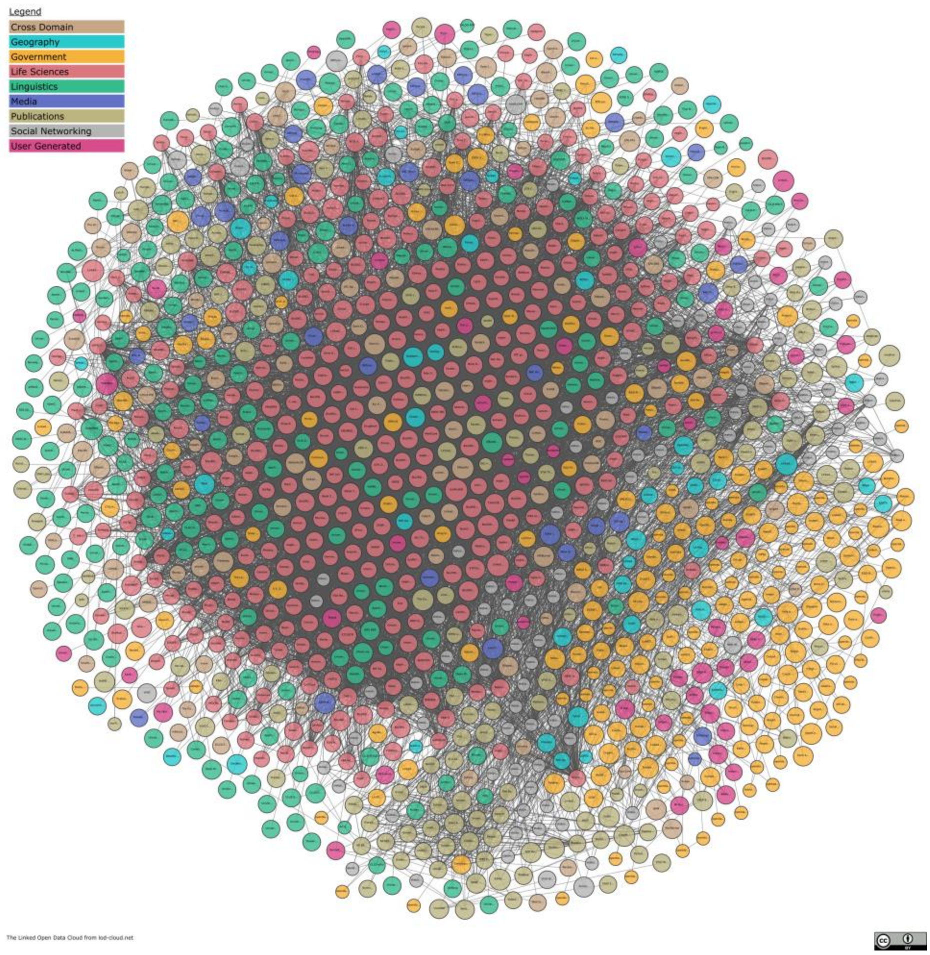

Figure 2. The Linked Open Data Cloud as of May 2020 (The Linked Open Data Cloud, n.d., CC BY).

The year 2008 marks the start of linked data services within the library community as Ed Summers, a developer at the Library of Congress, publishes an unofficial version of the Library of Congress Subject Headings as linked data. The National Library of Sweden is quick to follow and exposes parts of its catalog LIBRIS as linked data in the same year (Danowski and Pohl, 2013). Since then, many libraries around the world have begun to follow in their footsteps, starting their own projects of developing linked (open) data services and transforming their own catalogs to linked data.

The National Library of Sweden

The history of the National Library of Sweden, or *Kungliga Biblioteket* in Swedish, dates back to the 1500s when the initial collections were compiled by the Vasa kings and stored in the Royal Palace. Since then, the library's collections have grown to over 18 million items, including not only books but newspapers, periodicals, manuscripts, maps, music scores as well as digital resources, including e-books, digitized newspapers and archival materials (National Library of Sweden, 2022a).

With the introduction of the first Legal Deposit Act in 1661, the library began collecting printed copies of everything that was printed within Sweden as a way for the crown to control all publications before they were made accessible to the general public. While it acted as a form of censorship in the beginning, the Legal Deposit Act has supported KB in collecting the entirety of the Swedish national heritage in published form to this day. Over the years the deposit act was further expanded to encompass film, music, radio, TV, video games, interactive media and multimedia publications. Since 2012 digital materials are also included in the Legal Deposit Act for Electronic Materials (National Library of Sweden, 2022a).

When the Royal Library officially became the National Library of Sweden in 1877, the guiding principles were formerly defined as collecting, describing, giving access and preserving the library's collections. This mantra still continuous on to the present day but has expanded further over the years (National Library of Sweden, 2022a). In 2011 the National Library was, furthermore, tasked with the coordination and development of the Swedish public library sector and since 2022 KB has been given a new assignment by the government:

> [T]o suggest how collaboration in the Swedish library sector can be strengthened, as well as to contribute to the long-term development of certain national digital library services for prioritised target groups (National Library of Sweden, 2022b).

They also introduced three focus areas which are positioned as central for the quality and further development of the Swedish library sector:

1) Accessibility and relevance for everyone.
2) Contribution and compliance with the developments in society.
3) A well-functioning national infrastructure (National Library of Sweden, 2022b).

Additionally, the National Library is tasked with administrating and developing the Swedish Union Catalog LIBRIS which contains around 10 million titles, books, newspapers, magazines as well as pictures from over 500 libraries around Sweden. In 2018 KB launched a new generation of the LIBRIS catalog named LIBRIS XL, which "is a custom built open source system based on BIBFRAME 2.0 and linked open data" (Wennerlund and Berggren, 2019, p. 2).

Linked Data at the National Library of Sweden

The National Library of Sweden started their linked data journey as early as 2008 when the first data from LIBRIS was exposed as linked data. It was also around that time, that KB began thinking about the future direction of the Swedish union catalog LIBRIS (Wennerlund and Berggren, 2019).

> Ideas related to linked data, Web 2.0 and the semantic web began to develop in the wider world. The Libris content had become increasingly diverse and the MARC model was not suitable for describing new types of data, e.g. e-resources (Wennerlund and Berggren, 2019, p. 3).

In 2018 the old cataloging system based on the Voyager-platform was migrated to a linked data based system and more than 10 million records were transformed from MARC21 to BIBFRAME 2.0 (Wennerlund and Berggren, 2019). With the launch of LIBRIS XL, the National Library of Sweden became the first national library in the world to realize linked data as its core data model and is cataloging with BIBFRAME 2.0. In the related press release announcing the launch, the transformation is described as a "paradigm shift", opening up the data in LIBRIS for the rest of the web, search engines as well as other organisations. Furthermore, the new format is credited with enabling a higher quality of data as well as greater precision when it comes to resource description (National Library of Sweden, 2018).

But, the switch to linked data also was accompanied by its own set of challenges. Since most libraries in Sweden are still using MARC as their core data model, the National Library must be able to import and export data in MARC21 to effectively interact with the library community. This requires the library to create specific export transformation mappings from LIBRIS XL to the specific MARC-format each library uses which is a labour intensive process. Furthermore, the change in data format led to a decline in cataloging productivity during the summer of 2018 which already had been a big concern leading up to the launch (Wennerlund and Berggren, 2019). All in all, Wennerlund and Berggren (2019) report that the benefits of linked data have not become immediately apparent but that the National Library of Sweden is still making huge efforts in improving the system further.

As of 2022, KB has published a roadmap for further developments of LIBRIS which presents the long-term goals as well as activities concerning the National Union Catalog. The goals presented there are:

- Further transforming the LIBRIS-data from MARC21 to RDF/BIBFRAME,
- Enhancing manual and automated work flows for the cataloging tool in LIBRIS,
- Improving the conditions for a more effective future development, and
- Using the new infrastructure for end-user services (National Library of Sweden, 2022c).

To achieve these goals, the National Library has put a number of activities into place: Working on improving cataloging-workflows and expanding the MARC21-format to BIBFRAME as their import- and export-format. KB is, moreover, developing ways to extract and link ‘works’ from the instance and extend the use of linked data in the cataloging tools of LIBRIS. Lastly, the National Library of Sweden is conducting a usability study on the modernisation of end-user services, LIBRIS web search and inter-library loans (National Library of Sweden, 2022c).

Chapter 3: Literature Review

The objective of the following literature review is to give an overview of previous research on the implementation of linked data technologies in the library community, the benefits it promises and the challenges it faces as well as how the transformation has affected library professionals in the field. While the topic has been discussed for quite a long time now and has gained more traction as the years have passed, little attention has been focused on exploring the perspectives of information professionals working in the field. This review will give insights into the published literature, while trying to highlight studies that specifically focus on the perceptions and attitudes of library professionals with the aim of showcasing the development of linked data within the library community to its current state.

Linked Data and the Library Community

Schreur (2012) describes the shift towards linked data technologies as a revolution for the world of information creation and exchange which comes at the cost of significant changes for some of the core practices of libraries such as collection management, preservation, cataloging as well as reference and patron services. For many libraries these practices have so far been connected to the well-established data format MARC which in more recent literature has been argued as being inarticulate in the information environment of the Semantic Web, characterized by its dependency on common standards and formats. Furthermore, MARC-records themselves are unable to communicate any semantic meaning (Schreur, 2012). As a result, library resources currently exist in closed-off information silos that are not integrated well into the ecosystem of the internet.

In previous studies it has been argued that linked data offers a solution to this problem: The closed-off pools of bibliographic data and information resources can be opened and seamlessly integrated into the Web of Data through the use of linked data technologies, making library resources more easily accessible via the internet:

> Linked open data releases each museum, archive, or library's collection from its silo, allowing it to be replaced in the context of similar cultural heritage collections and knowledge sets from around the world (Marden *et al.*, 2013, p. 3).

This immense power of linked data to connect cultural heritage collections and resources with each other, becomes even more impactful in a time and age where massive amounts of information are created on the internet every day, argues

Schreur (2012). As the library end-user turns to the internet in their search for information, discovery on the web becomes a crucial factor for information providers and linked data is the means to accomplish it.

Nevertheless, perceptions of linked data seem to vary greatly in the library community. While Frederick (2017a) suggests that linked data is oftentimes described as something "obscure, mythical and theoretical" (p. 7) in practice, other studies already point to a high degree of visibility and understanding of linked data in the library community (Mitchell, 2016). LaPolla (2013) has been one of the first researchers to identify the need for studying the perspectives of library professionals regarding linked data and his results already suggest a general awareness of the surveyed librarians regarding Semantic Web technologies and linked data as well as their perceived importance for the future. He, moreover, calls for more concrete studies on the type of work that is actively happening at libraries in this regard. Since this initial study only a few other researchers have followed his path.

Warraich and Rorissa's findings (2020) also indicate a good understanding amongst academic librarians regarding linked data technologies as well as their proposed benefits. Nevertheless, the authors point out that the reality of linked data technologies and connected institutional plans still is stuck in its early stages waiting for their practical implementation. This sentiment is reflected by other authors like Mitchell (2016) who indicates that the library community as a whole is yet awaiting a full transformation to linked data technologies and foregrounds the limited possibilities for its adoption especially for smaller libraries.

The *Data Deluge Column* by Donna Ellen Frederick gives further insights into the perspectives of librarians on their shifting role in this new information environment. The current reality of many library professionals seems to be an existence in an in-between stage of development, where new technologies are introduced gradually while old systems based on MARC are still an indispensable part of everyday library practice. Frederick (2017a) speaks of a clear disconnect between the theoretical work set on implementing linked data technologies and the real-life practice of cataloging. Seeman and Goddard (2015) agree that while LD as a topic is gaining increasing attention and enthusiasm from the library community, the work practices of many library professionals have not kept pace.

The Potential Impact of Linked Data on Library Practice

Though previous studies might vary in their perspectives, one thing seems certain: Linked data has the potential to significantly impact the work practices of library professionals in a number of ways. In an interview with Adamich (2021), Andrew Pace, former executive director for Technical Research at OCLC, expresses what the transformation of the library community towards linked data truly entails:

> I think there is a misconception about linked data simply replacing traditional cataloging. The goal that I think my colleagues share is to change the very nature of cataloging from simply describing the item in hand, copy cataloging authorized fields, registering holdings information, and throwing new names and subjects into the long overly-constrained bottle neck of authority processing, to one of a new knowledge work (p. 14).

This new type of knowledge work is intrinsically connected to a transformation of library catalogs from thinking and working in terms of isolated bibliographic records to thinking in terms of individual statements or data (Sprochi, 2016). This allows libraries to focus on individual pieces of information and the relationships between them rather than on the bibliographic record as a whole. In previous literature this shift is often referred to as a paradigm shift for resource description as libraries move away from the long-established practice of creating, maintaining, storing and exchanging records towards the practice of linking individual entities of data. Moreover, through the adoption of linked data standards, they are turning their often rigid and closed-off systems into open and nearly infinite databases that are much better suited for today's rapidly expanding information environment (Schreur, 2012).

This new understanding of information organization is impacting the work practices of library professionals in various ways. When reviewing job listings for library positions, Frederick (2022) discovered evidence that linked data knowledge as well as related skill-sets are often present in the preferred knowledge and skill sections of library job postings even though the position itself is still focused on more traditional metadata work based on MARC and Dublin Core. Sprochi (2016), moreover, suggests that library professionals should possess a general understanding of linked data, RDF and other formats, such as JSON, Turtle and R3, in order to productively collaborate with software developers, ILS-designers and IT professionals.

Godby *et al.* (2019), moreover, propose that the transition from human-readable records to knowledge graphs entails the emergence of new tasks for library professionals as others become obsolete:

> ‘As we catalog in this new environment […] we are forced to think through the answer to the question: *What entities matter to this object?*’ Identifying ‘the entities that matter’ will drive the construction of the future bibliographic universe (p. 60).

In this new linked data environment, information professionals will have to focus on identifying relationships among data entities rather than creating and normalizing text strings in bibliographic records (Godby *et al.*, 2019). Warraich and Rorissa (2020) describe this shift as a move away from librarians being “custodians of resources to linking electronic resources on the Web for better visibility” (p. 1036). Pace (2018), furthermore, suggests that this move away from formatting strings and cleaning up data will give catalogers the chance to refocus on their materials again. He, moreover, proposes that work practices will become more efficient as library staff is freed from the redundant processes of aggregation, data clean-up and authority work. As library professionals can focus more of their attention on their area of expertise and the connected materials, hidden collections and materials can further be discovered. Lastly, Pace (2018) points out that linked data enables the use of external data sets which might encourage collaboration with other communities of practice. This sentiment is supported by Alemu *et al.* (2012) who bring up the possibility of combining linked data with social web technologies, leading to a mixed-metadata approach which combines expert-controlled and user-generated metadata.

As the previous discussion highlights, the introduction of linked data into the library community is beginning to change library practice. These changes are not only affecting libraries but are further affecting the information and knowledge environment as a whole. Rasmussen Pennington and Cagnazzo (2019) propose that linked open data

> […] changes the traditional relationship between holder, interpreter and consumer of knowledge. LOD can enrich user experience, empowering them to manipulate and attribute their own meaning to cultural heritage collections (p. 648).

As traditional boundaries are breaking apart, the different players of the knowledge community might have to take on new roles as well as shed old ones. Schreur (2012) suggests that the transformation of the library community to linked data is accompanied by four necessary changes:

- A new paradigm for exchanging data that is characterized by its openness;
- A shift from creating data stored in records towards linking data as it is found in individual statements;
- A move from creating records towards incorporating data from its original source and,
- A shift in focus from accumulating more records towards managing statements in triple stores.

Moi (2020), furthermore, highlights how libraries will expand their services from a limited national or local context to a truly global one. Nevertheless, as the title of this section foregrounds, the mentioned changes are so far mostly perceived as a possibility rather than a reality in previous studies. The prevailing standard in the library community is still MARC-data that is hosted on local library systems and the majority of library data that is currently created is still based on MARC21 (Frederick, 2017a).

Implementing Linked Data in the Library

The Benefits of Linked Data

As the previous section already indicates, the introduction of linked data into library practice might bring along a multitude of benefits. These benefits and promises of linked data for the library community have been discussed quite extensively in previous literature. Most notably, the *Library Linked Data Incubator Group Final Report* from the W3C Incubator Group (2011) gives insights into the expected benefits of a linked data approach. The report states that this new approach will offer

> significant advantages over current practices for creating and delivering library data while providing a natural extension to the collaborative sharing models historically employed by libraries (W3C, 2011).

In the library community linked data is, thus, viewed as another method for libraries to connect their otherwise isolated data as this new model makes library data more easily shareable, extensible and reusable (W3C, 2011).

Linked data provides libraries with the chance to open up their information silos and holds the opportunity of true interoperability of library data across libraries worldwide as it creates the possibility of a shared knowledgebase, a so-called ‘linking hub’ for libraries, argue Byrne and Goddard (2010). Moving towards a more cloud-based approach for storing and managing library and cultural heritage data might also be a more cost-effective way for libraries to collect their data according to W3C (2011). It can, moreover, lead to an enhanced connection as well as visibility of smaller institutions and projects as their data becomes equally connected in the shared knowledge base.

> Linked Data allows anyone to contribute unique expertise in a form that can be reused and recombined with the expertise of others. The use of identifiers allows diverse descriptions to refer to the same thing (W3C, 2011).

Furthermore, the ability of describing resources collaboratively not only includes other libraries, but extends further to other communities and individuals that are able to contribute their unique expertise as well. Data providers move from contributing entire records to providing portions of data in an environment where no single portion is too small or insignificant (W3C, 2011). As Schreur and Carlson (2020) point out, this could be an opportunity for libraries to free themselves from the "cycle of implicit bias" (p. 54) as they are no longer privileging one singular point of view and previously unknown information sources can contribute their knowledge. Alemu *et al.* (2012) also discuss the benefits of this open-system assumption where anyone can make metadata contributions from diverse perspectives, thereby enriching the data and benefiting from so-called network effects.

The creation of such a collaborative, open and global pool of data also facilitates the reuse of resource descriptions and eliminates the redundancies of the current cataloging process (W3C, 2011). As the workload of catalogers is reduced through the ability of using external data, they have the chance of focusing on their specific area of expertise which in turn might lead to an overall higher quality of resource descriptions in library catalogs and catalogued knowledge as a whole (Gaitanou *et al.*, 2022; Rasmussen Pennington and Cagnazzo, 2019).

When interviewing different libraries on the perceived benefits of their linked data implementation, Rasmussen Pennington and Cagnazzo (2019) state that the National Library of Sweden was able to already identify linked data's ability of multilingualism as a benefit of the approach. They, furthermore, were able to detect that a linked data format leads to better disambiguation within the data because of LD's data model, where each element is uniquely identified with an URI.

Through the adoption of widely used internet standards like RDF, library resources can, furthermore, be seamlessly integrated with other online services such as for example *Wikipedia* or *GeoNames* (Hallo *et al.*, 2016; W3C, 2011). As library materials are more thoroughly integrated into the ecosystem of the internet, multiple studies suggest that linked data improves the findability and discoverability of library data online (Gaitanou *et al.*, 2022; Hallo *et al.*, 2016; W3C, 2011; Warraich and Rorissa, 2018). Rasmussen Pennington and Cagnazzo (2019) were also able to identify this benefit as some of the interviewed libraries stated that, through the adoption of schema.org, their data was more easily discoverable through search engines and, thus, became more visible on the internet. Furthermore, the adoption of common standards makes it possible for communities outside the library environment to use their data.

Moving away from domain-specific data formats and software has also been argued to allow for an easier communication between library professionals and professionals from other fields as technologies and systems are based on the same or at least similar building blocks. This, furthermore, is suggested to improve the data publishing process as libraries are able to use more mainstream solutions and work with a wider choice of vendors (W3C, 2011). As library data is shared with communities outside the library sector, interest in the work of librarians can also increase further (Gaitanou *et al.*, 2022).

Another often mentioned benefit is the structural flexibility of LD's data model (Danowski and Pohl, 2013). While prior cataloging models like MARC have a difficult time at adapting to the ever increasing amount of information because of their structural rigidity, linked data is based on a data model that can more easily adapt to changes and grow and expand with demand. This makes it easy to add information further down the line, update or correct information and even portray conflicting information. Byrne and Goddard (2010), moreover, suggest that this can lead to the integration of different library systems as the data becomes more interoperable. Furthermore, linked data technologies allow for the modelling of data according to things of interest that are related to a bibliographic source, for example, people, events, places and themes (Rasmussen Pennington and Cagnazzo, 2019).

The following table summarizes the mentioned benefits and advantages of linked data once more:

The Benefits of the Linked Data Approach	**Key References**
Greater interoperability of library data	Gaitanou et al. (2022) & Rasmussen Pennington and Cagnazzo (2019)
Creation of a shared knowledge base for cultural heritage institutions	Byrne and Goddard (2010)
Cloud-based approach as a cost-effective storage solution	W3C (2011)
Collaborative resource description	W3C (2011)
Sharing diverse perspectives on information resources	Alemu *et al.* (2012), Fan (2022) & Schreur and Carlson (2020)
Reuse of resource description and multilingualism	Rasmussen Pennington and Cagnazzo (2019) & W3C (2011)
Reduced cataloging workload	Gaitanou *et al.* (2022)
Data enrichment/quality enhancement	Gaitanou *et al.* (2022) & Rasmussen Pennington and Cagnazzo (2019)
Seamless integration of library services on the internet	Moi (2020)

Improved visibility and discovery of library data on the web	Gaitanou *et al.* (2022) & Hallo *et al.* (2016)
Linkage of library resources with other online services e.g. Wikipedia	Hallo *et al.* (2016)
Easier communication with other professionals due to common standards	Gaitanou *et al.* (2022)
Use of more mainstream services and a broader range of vendors	W3C (2011)
Increased external interest in library services	Gaitanou *et al.* (2022)
Flexible and extensible data model	Danowski and Pohl (2013)
Integration and interoperability of different library systems	Byrne and Goddard (2010)
Modelling of data according to things of interest e.g. themes, peoples, locations, etc.	Hallo *et al.* (2016)

Figure 4. The Benefits of the Linked Data Approach (Thesis Author).

The Challenges of the Implementation Process

Whilst in previous literature and research linked (open) data is often praised for its immense potential, the implementation of linked data seems to also be accompanied by various challenges. Mitchell (2016) characterizes the linked data efforts of the library community as "existing in the startup phase of a technology adoption hype cycle" (p.6) due to the multitude of different standards, tools and approaches currently available in the field. In their study of Pakistani information professionals' perspectives on the application of linked data technologies in the library, Warraich and Rorissa (2020) also identify that, while many of the questioned library professionals possess a relatively good understanding of the theoretical concepts surrounding this new approach, the stage of its actual implementation can still be described as "embryonic" (p. 1048).

According to Moi (2020), one of the core problems and obstacles in the adoption of linked data technologies is the lack of expertise and knowledge when it comes to the implementation process of these new technologies as well as a general lack of awareness of the international library community when it comes to the application potential of linked data. Rasmussen Pennington and Cagnazzo (2019) suggest that the implementation of linked data is often more of a side-project involving only a small part of a library and not a development that is introduced to the whole of the library staff at once which can lead to uncertainty of the related terms and concepts of library professionals not directly involved in the project.

Moreover, Carlson *et al.* (2020) bring attention to the fact that while most librarians would agree that the current use of MARC is being pushed to its limit, most libraries still heavily rely on their MARC-platforms and are in no way ready to abandon them completely.

So far, there is not widespread culture of adoption, no common methods and workflows that facilitate the adoption of these 'foreign' technologies and a lack of successful examples showcasing the move from MARC to linked data (Moi, 2020). Since MARC is exclusively used by the library community, it may be hard for library professionals to articulate themselves to professionals outside this particular community who have the necessary knowledge on Semantic Web technologies (Schreur, 2012). In their online survey of information professionals concerning the implementation of linked data across European libraries, Rasmussen Pennington and Cagnazzo (2019) identified a significant need of the study participants for guidelines and step-by-step instructions to facilitate the implementation, a sentiment that is also reflected in McKenna's qualitative study (2017) which describes the wish of information professionals for LD resources and tools that target their own specific needs and help them to fully engage in the implementation process. Niu (2020) as well as Carlson *et al.* (2020) speak of the steep learning curve of linked data applications as the top barrier for many libraries starting their own projects. As the origin of linked data and the Semantic Web lies in the computer sciences, libraries need support from professionals in this field. Unfortunately, not every library has this kind of access and specifically smaller libraries might struggle finding people with sufficient LD expertise to transform their own systems. Raza *et al.* (2019) suggest that more conferences, seminars and workshops for librarians in the fields are necessary, to provide library professionals with the skillset to implement linked data technologies themselves.

Carlson *et al.* (2020), moreover, report a common assumption of librarians that linked data's benefits are so far largely theoretical. Despite the frequent conferences, presentations and articles on the topic, the library community at large is not 'doing' linked data which points to a need for more education as well as experiences regarding linked data in libraries. This sentiment is, moreover, supported by Warraich and Rorissa (2018) as they identify a lack of awareness of Pakistani university library professionals for the overall concepts of linked data and the Semantic Web as well as the problem of no common guidelines and best practices. They also bring forward the need for more in-depth and qualitative studies on this topic to explore the phenomenon further.

This lack of common standards, methods and practices also leads to another problem: the possible emergence of 'linked data silos'. Suominen and Hyvönen (2017) as well as Park and Kipp (2019) criticize the multitude of different approaches currently being taken in the library community when it comes to their linked data projects. If the goal of true interoperability wants to be realized, libraries need to stop defining their own data models for bibliographic data and work on creating a shared vision as well as data model. While it seems BIBFRAME has been taking huge strides in recent years of becoming this shared data model, Radio and

Kalwara (2022) also point to the problem of the various extensions to the BIBFRAME ontology which they view as a barrier to truly decentralized data hubs.

McKenna (2017) and Godby *et al.* (2019) , furthermore, highlight that most of linked data's benefits have so far not come to fruition, since the library community has not accomplished a wide-spread implementation of linked data technologies. Due to a lack of interlinking, the full potential of linked data has not yet been realized. While the library community has managed to provide machine-readable, structured data, the true promise of linked data has not been fulfilled so far and there still is a lot of progress to be made (Carlson *et al.*, 2020; Tillman, 2019).

> Innovation and change require vision and perseverance, two qualities the GLAM community has proved capable of mastering time and time again. The tide will begin to turn faster when librarians leave the confines of their comfort zones and begin learning about new ways to achieve our community's age-old goals. Regardless of the technology, the vision is clear: improved and enhanced access to information and cultural heritage resources through cataloging and metadata practices (Carlson *et al.*, 2020, p. 140).

The whole transformation process itself is, furthermore, identified as one big challenge by Danowski and Pohl (2013). The authors suggest that the process of mapping and converting old MARC21-data into the new RDF-format is a difficult task in itself. Furthermore, when integrating externally produced data sets into the library catalog, questions of provenance and synchronising data arise.

Another related challenge concerning the use of external data sources is the continuing challenge of openness as a standard for data publishing as well as a lack of open licenses for metadata (Danowski and Pohl, 2013). Mitchell (2016) argues that a core issue of the library community is that while less metadata is being created, more metadata is being licensed – when the LAM-community as a whole cannot find consensus on the topic of data openness, the benefits of linked data and collaborative resource description are heavily impacted.

The following table gives an overview of the challenges and obstacles that where mentioned in the studies and texts analysed in this sections:

The Challenges of the Linked Data Approach	**Key References**
Lack of awareness of library professionals towards the topic of linked data and its practical implementation	Warraich and Rorissa (2020)
Lack of expertise and knowledge on the implementation process and application of new technologies	Moi (2020) & Rasmussen Pennington and Cagnazzo (2019)
Steep learning-curve	Carlson *et al.* (2020), Godby *et al.* (2019) & Niu (2020)
Access to skilled professionals	Niu (2020)
Lack of practical examples	Carlson *et al.* (2020)
No agreed upon best practices, common guidelines or step-by-step guides	Rasmussen Pennington and Cagnazzo (2019)
No wide-spread implementation	Godby *et al.* (2019) & McKenna (2017)
Emergence of linked data silos due to different linked data approaches	Suominen and Hyvönen (2017)
Transformation and mapping of MARC to RDF	Danowski and Pohl (2013)
Incorporating external data sets – questions of provenance and synchronising data	Danowski and Pohl (2013)
Lack of openness as a standard for publishing data	Danowski and Pohl (2013) & Mitchell (2016)

Figure 5. The Challenges of the Linked Data Approach (Thesis Author).

Chapter 4: Theoretical Framework

This chapter describes the core concepts and theory that support the following analysis and discussion of the research results. Firstly, the shifting understanding of bibliographic data due to the introduction of Linked (Open) Data as a model for information organization and resource description in the library community will be illustrated. Secondly, practice theory will be introduced to discuss the changing nature of the practices of information organization and management due to the influence of linked data technologies.

The Datafication of Library Records

The following section will showcase that in previous literature the transformation in data format from MARC to linked data can also be understood as a shift in understanding bibliographic data based on a new theory for knowledge and information organization on the internet. As the literature review has shown, linked data is oftentimes described as a paradigm shift influencing the ways in which we think about information and information organization as a whole in-line with current developments in the knowledge organization community.

To understand the magnitude of the transformation in knowledge and information organization that is happening right now, it is essential to understand the long-prevailing reality of the MARC-format and its effect on information organization in the library community. MARC was developed long before the introduction of the World Wide Web with the aim of creating a format that is readable by humans as well as computers. Strongly referential of the traditional cataloging card, MARC is heavily based on the manifestation of an item. Furthermore, its machine-readability is mostly limited to the use of text-strings rather than links and, therefore, connections between different statements are only understandable to the human cataloger but mostly unclear for machines (Rasmussen Pennington and Cagnazzo, 2019).

As libraries are moving into the digital sphere, it becomes continuously more apparent how MARC is unable to rise to the challenge of presenting library resources adequately in this new environment and keep up with the enormous onslaught of information on the internet. In order to make better use of the structure of the web the International Federation of Library Associations (IFLA) introduced the FRBR-model[4], an entity-relationship model, that seeks to determine relevant

[4] The FRBR-model (*Functional Requirements for Bibliographic Records*) adopts an entity-relationship model for metadata instead of the single and flat record-structure most cataloging standards are based upon. It consists

elements of an information resource such as people, places, publications, etc., as well as the relationships between those elements (Frederick, 2017a). This perspective on knowledge organization is supported by Smiraglia (2009) who suggests

> the necessity of drilling down the taxonomy of knowledge elements to find core particles, which can be used to generate classes of structural knowledge elements, rather than universal concatenations of […] 'basic concepts'. We also suggest that faceted classification should embrace more than simple categorical aspects of complex concepts. Rather, facets should be used to represent multiple dimensions of concepts by temporal interfaces with instantiating information objects and semiotic interfaces insofar as possible to reveal the dynamic nature of concepts across otherwise distinctly different domains (p. 378).

This dynamic and entity-based framework for knowledge organization is further reflected by Ibekwe and Bowker (2017) who foreground the need for flexible and collaborative strategies for knowledge organization in the age of Big Data that are supported by automated processes.

Another related framework with the aim of bringing cataloging closer to the principles of the Semantic Web was introduced by the RDA Steering Committee: RDA[5] seeks to replace the Anglo-American Cataloging Rules (AACR2). Together with linked data, FRBR and RDA have provided libraries with a new framework for managing, organizing and describing bibliographic resources.

When reading previous literature on the introduction of linked data to the library community, it quickly becomes apparent that linked data is often perceived as more than simply a new format for bibliographic data. Marden *et al.* (2013) go as far as referring to linked data as a philosophy. Barbera (2013), furthermore, suggests that linked data brings about a radical cultural shift in how data is being produced, managed and shared within the library community and beyond. They point out, that one of the most significant changes introduced by linked data is the ability to make use of previously hidden information and unexpected links to gain new insights from data since one of the basic principles of linked data is known as AAA – *Anyone can say Anything, Anywhere*. This principle, moreover, leads to a paradigm shift in the library community as well as publishing and media industry, that have long been at the forefront of deciding which information is kept and shared in what ways.

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of four levels of representation: work, expression, manifestation and item to describe information resources (Online Computer Library Centre [OCLC], 2023).

[5] RDA (*Resource Description and Access*), similarly to the Semantic Web, is based on an entity relationship framework. It can be described as a set of cataloging guidelines and standards based on the FRBR-model and FRAD (*Functional Requirements for Authority Data*) to describe information resources in the digital world. The aim of RDA is to provide a more flexible and extensible framework for resource description in the environment of the web while still being compatible with earlier cataloging standards like AACR2 (Yang and Lee, 2013).

This decentralization is often described as an innate characteristic of the World Wide Web. Seeman and Goddard (2015), moreover, suggest that due to the distributed nature of the Web, libraries no longer have to store all their data locally but can exploit the use of links by connecting their data to related information all over the internet. Radio and Kalwara (2022) add that "[…] linked data's origins are rooted in a decentralized ethos, which are closely tied to the prevalence of using the network as an information organization model" (p. 598).

In an article of the *Data Deluge Column*, Frederick (2017b) talks about the reinvention of cataloging. The author suggests that society is headed towards the fourth industrial revolution and that the role of the library will be heavily impacted by this development – specifically in the ways of how data is organized and perceived within the library community. In the new information environment, libraries are no longer 'reusing' metadata but rather using data as it is found online and contribute to the new information ecosystem by enriching it with their own data and expertise.

The theoretical underpinnings of linked data are, therefore, defined in this thesis as:

- Structuring information according to an entity-based model that clearly reveals the relationships between the entities, moving the focus from a document-level to the level of entities;
- Foregrounding the importance of flexibility and extensibility when it comes to knowledge organization systems, as knowledge is temporally bound and ever-evolving and changing with time;
- Highlighting the importance of collaborative knowledge production and incorporating data produced from a multitude of different sources.

Practice Theory

Another essential framework for this study is a practice-based approach to the analysis of information organization in the library community. There is no unified or singular practice theory, rather, the practice-based approach can be described as a "broad intellectual landscape" (Feldman and Orlikowski, 2011, p. 1240). Nicolini (2013) defines this theoretical framework as a perspective that identifies the social world as a multitude of actions that are perpetuated and made durable through their interconnectedness with bodies, minds, objects and texts, where one action constitutes the resources for another. An action or practice herein is

> a routinized type of behaviour which consists of several elements, interconnected to one other: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding,

> know-how, states of emotion and motivational knowledge (Reckwitz, 2002, p. 249).

Reckwitz (2002), identifies a number of ‘elements’ that are an integral part of most practices. Firstly, a practice can be defined as a set of routinized bodily activities, meaning it usually is connected to the movements of the body. Secondly, next to bodily activities a practice further involves a set of mental activities, a routinized way of understanding the world, knowing-how to do something or desiring something. Thirdly, a practice usually involves some sort of object or ‘thing’ which is used within the practice and, thus, present a necessary component for successfully carrying out the practice. Nicolini (2013), furthermore, adds that these objects have the potential of making practices durable as well as connecting different practices throughout time and space.

Social practices, furthermore, incorporate particular forms of knowledge, meaning different ways of understanding, wanting, feeling and knowing how to. This knowledge is largely implicit and inherently connected to the historical and cultural circumstances of the practice. The practice employs a certain “routinized mode of intentionality” (Reckwitz, 2002, p. 254) which not only belongs to the individual involved in the action but to the practice as a whole.

As the previous statements showcase, practices can also be described as routines in the sense that they have some structure that is continuously repeated. Social structure is based on the routinization of practices and, therefore, tied in its temporality to social reproduction (Reckwitz, 2002). This means, social structures are temporal effects which can collapse and break apart. This shifting of social structures is intrinsically tied to the shifting and transformation of practices (Nicolini, 2013).

Lastly, practices are carried and carried out by agents, which are neither autonomous nor completely dependent but rather are able to employ their understanding of the world and their knowledge according to a specific practice (Reckwitz, 2002). The *homo practicus* is provided with space for innovation, creativity as well as individual performance (Nicolini, 2013). Traditionally, practices and the concept of the agent are strictly tied to human agency, but through the rise of post-humanist studies the role of non-humans gains importance and, for example, natural objects and technological artefacts can be foregrounded in producing social life as well (Feldman and Orlikowski, 2011).

Feldman and Orlikowski (2011), furthermore, constitute three basic principles that are shared by many practice-based approaches:

1. The relationship between the social world and situated practices infers that the structures of social life are produced by everyday actions and, thus, practices.

2. Dualism is generally rejected, for example, the conceptual opposites of body and mind, structure and agency, free will and determinism.
3. The relations between different phenomena are mutually constitutive, meaning no single phenomenon exists completely independent from another. This implies that social structures cannot be fully understood without acknowledging the role of individual agency but agency as human action is also intrinsically shaped by the structural conditions of the social world.

To employ practice theory as a theoretical framework, Nicolini (2013) recommends a toolkit approach which seeks to provide a more comprehensive as well as nuanced understanding of the world than following one singular understanding of practice theory. They, furthermore, suggest an alternation of lenses to the study of practices, switching between zooming in on the accomplishments of a practice and zooming out on the relationships of the practice in time and space.

Zooming in can either foreground the bodily actions as well as the objects used to accomplish the practice or focus on the orientation and concerned nature of the practice, the intentionality of the practice by analysing the desires, concerns and worries of the agents carrying out the practice.

> […] this zooming in does not try to access the values, beliefs, or presumed inner motives which supposedly guide the conduct of the practitioners. The aim of the zooming in is, on the contrary, to surface the practical concerns which govern and affect all participants, and a way to appreciate that from the perspective of the members, practice unfolds in terms of an often pre-verbally experienced, and yet collectively upheld, sense of 'what needs to be done' (Nicolini, 2013, p. 225).

The zooming in can, furthermore, focus on the durability and legitimacy of a practice, i.e. how the practice achieves durability over time. In relation to this, Nicolini (2013) highlights the four key areas of learning, mediation, other people and other practices.

The act of zooming out is then described as following the relationships that extend the practices across time and space as well as the connections to other practices – answering questions such as, how is the practice connected to prior practices, what does it contribute to the 'wider picture' and how did we arrive at the current state of practice? (Nicolini, 2013).

Application of Theories to the Study

The following analysis considers linked data as more than a technological framework, but rather as a new way of understanding the process of bibliographic resource description that leads to a transformation in how data is perceived in the library community. A practice-based approach is chosen to analyse the work of information management and organization as a practice at the library. Through the act of zooming in, the study seeks to identify the relevant elements of library practice, specifically its oriented and concerned nature (the mind). The act of zooming out aims to put these practices in relation to other practices as well as its connection to time and space.

Chapter 5: Methodology

To research the impact, the implementation of linked data has had on the work practices of library professionals, a case study at the National Library of Sweden is conducted. As the literature review has showcased, there has been a lack of research on the perceptions and attitudes of library professionals on the topic so far which is why this study aims to analyse the perspective of library professionals focusing specifically on library staff working at the National Library of Sweden. For the data collection, the qualitative approach of semi-structured interviews was chosen. This chapter presents the selection of material as well as the research method and highlights the ethical considerations of conducting the data collection.

Material and Methods

The Case of the National Library of Sweden

The National Library of Sweden will act as a case of investigating how libraries have been affected by the transformation to linked data. As Choemprayong and Wildemuth (2017) propose, when conducting a case study, it is important to strategically select the study case. The National Library of Sweden presents a unique and extreme case since it was the first and still is one of the only libraries in the world that has adopted linked data as its core data model. Furthermore, as Hagerlid (2011) discusses, a national library takes on a special role in the information ecosystem of a country since it is in a unique position to "advanc[e] an open access agenda and develop[…] a digital research information infrastructure (p. 118). The national library works in close approximation of national policy-making and the contributions it makes can lead to downstream benefits of other libraries as, for example, the availability of cataloging records, resource-sharing opportunities as well as the incorporation and development of new technologies (Savenije, 2017). This is also the case with the National Library of Sweden, as it provides and develops the Swedish Union Catalog LIBRIS, which will be a main point of analysis for this thesis and which contains titles from about 500 libraries around Sweden (National Library of Sweden, 2023).

The choice of analysing only one specific National Library was made because the study aims to explore the topic in a qualitative way and gaining an in-depth understanding of how the transformation to linked data has shaped one particular workplace. Moreover, since the adoption of linked data as well as the overall stage of adoption of these new technologies varies greatly between different libraries worldwide, choosing only one library for the study was perceived to yield the most comparable results. All study participants work with the same system, as it was implemented at KB, meaning they have more common ground and have a shared relation to one specific library and its cataloging system.

Data Collection

To achieve insights into the perceptions and attitudes of library professionals on the implementation of linked data at the National Library of Sweden, a series of interviews was conducted. A semi-structured approach was chosen for the interviews as defined in Luo and Wildemuth (2017) as a set of predetermined questions that can be modified throughout the interview based on the participants and what the interviewer perceives as most appropriate for the specific conversation. The advantage of semi-structured interviews is the freedom for the interviewer to adjust questions as well as to probe deeper into certain topics the interviewee brings up in their answers.

The interviewing process took place online through the use of the video platform Zoom. Some of the interviews were further complemented by additional answers provided via email in advance to the interviews or as later additions by the participants. In general, the semi-structured Zoom interviews were set up with the goal of having a 45 to 60-minute one-on-one conversation with library professionals, giving the participants the chance to share their own feelings and perceptions and letting them guide the overall direction of the interview. The interviews were recorded and saved on an external hard-drive for the purpose of transcribing and analysing the data. When contacted, the participants received an interview guide explaining the purpose of the study as well as the method of data collection and possible interview questions in addition to their interview invitation.[6]

The interview process was structured by referring to a five step sequence introduced by Robson (2002):

1. Introduction – Before the start of the interviews, the purpose of the study as well as the practicalities surrounding the data collection were explained to the participants. This included explaining the later use of data, the process employed to ensure the anonymity of the participants as well as the later publication of the thesis. Lastly, the interviewees were asked for their permission to record the interview.
2. Warm-up – This second step included asking the participants a more general question to ease them into the interviewing process.
3. Main body of the interview – Here, the interview participants were asked the interview questions, loosely following the structure of the interview guide but letting the conversation develop more organically according to the topics the participants focused on themselves.

[6] The interview guide provided to the participants can be found in the Appendix section at the end of the thesis.

4. Cool-off – To end off the interviews, the participants were thanked for the input as well as their participation in the research project and asked if they themselves wanted to share anything further that had not come up in the interviews until that point.
5. Closure – To close up the interviews the interview participants were thanked again and the interview was ended after some parting words.

Regarding the selection of the informants, a prior internship at the National Library provided a good starting point. During the internship, the thesis author was able to identify and engage with a couple of key actors involved in the linked data project at KB that were then in turn contacted for the possibility of interviews for this study. Furthermore, with the help of her former internship supervisors, other possible participants were selected and contacted.

The following table gives some insights into the study participants and their professional backgrounds. The overall aim during the selection process was talking to library professionals with a wider range of expertise, giving a more comprehensive picture of which areas the implementation of linked data technologies has touched so far and how people from different backgrounds have embraced the ensuing changes. In total, a number of seven library professionals participated in the study with the interviews lasting between 33 minutes for the shortest interview and 65 minutes for the longest interview. The table below presents the different participants as well as the specific area of expertise. To keep the participants as anonymous as possible, a general term for the professional background was chosen:

Participant	**Professional Background**
A	Librarian
B	Data Scientist
C	Developer
D	Data Scientist
E	Developer
F	Developer
G	Metadata Strategist

Figure 6. Interview Participants (Thesis Author).

Choice of Methods

A qualitative research design was employed since previous research suggests a lack of qualitative studies on the perceptions and attitudes of library professionals concerning the topic of linked data and its implementation in the library community. While there have been some studies researching the perspectives of information professionals on linked data, most have collected quantitative data while less attention has been focused on qualitative data (Warraich and Rorissa, 2018).

The interviews were chosen as the data collection method since it best fits the aims of the study in exploring the perspectives of library staff working at the National Library of Sweden. The semi-structured interview approach allows the researcher to gain comprehensive insights into the viewpoints of library professionals and let them truly share their own perceptions and experiences while still ensuring that the interview focuses on the main issues relevant to the study. A semi-structured approach to the interviews, furthermore, is construed more as a conversation or discourse between the researcher and the respondent, giving the participants more freedom and control to share their own voice and creating the data in a more collaborative way (Williamson, 2018).

The choice of conducting the interviews through the use of online video technology was made, since the interview participants and the researcher were separated by great geographical distances and, therefore, considerable travel costs. Furthermore, de Villiers *et al.* (2021) suggest that,

> depending on the specific research design adopted (including the scope, level of analysis and the research objectives/questions), video interviews offer qualitative researchers a sound data collection device (p. 1778).

The interview participants were considered to have sufficient experience and digital literacy for participating in an online video call. Furthermore, due to the Covid19-pandemic, online meetings via different video platforms have become relatively normal and throughout her internship at the National Library, the researcher herself participated in multiple online meetings and conferences via the platform Zoom. Therefore, the choice of conducting the interviews via Zoom was considered to not cause any problems or issues for the participants. Based on the large geographical distance between the interview participants and the researcher, the online interviews furthermore added the advantage of giving the participants more flexibility in arranging the interviews according to their schedules, which resulted in more library professionals being able to participate in the study. Lastly, since the thesis focuses less on the actual work environment but rather on the perspectives and attitudes of the library professionals concerning the research topic, the location of the interviews was considered to be of little consequence for the study.

Ethical Considerations

As Creswell (2013) suggests, ethical considerations need to be part of the entire process of planning and designing a qualitative study – specifically but not limited to the data collection process. As the study, furthermore, is engaged in internet research, defined by Markham and Buchanan (2012) as an inquiry that "utilizes the internet to collect data or information, e.g. through online interviews, surveys, archiving, or automated means of data scraping" (p. 3), ethical considerations must accompany every step of the study and issues of privacy and anonymity must be treated with the necessary care as well as in alignment with the expectations of the study participants.

Before the data collection started, study participants were informed about the aims as well as the scope of the thesis project via email. In addition to their interview invitation, they were provided with further information on the researcher, supervisor, thesis topic and interview process as well as the later publication of the thesis. These terms were, furthermore, repeated at the beginning of the Zoom interviews ensuring the respondents are completely aware of the scope of the study and their participation in it. Thus, the participants were able to give their informed consent as defined by Sieber (2009) as an "adequate understanding of what they will experience, so that they can judge for themselves whether they want to 'go ther' or would rather be left alone" (p. 117).

As the study is not engaged in collecting any sensitive personal data as defined by the Swedish Research Council as information regarding race, ethnic origin, political or religious views, and, in agreement with university guidelines, no official consent form was sent to the participants but spoken consent was obtained at the start of the interviews (Swedish Research Council, 2017). The participants were informed that their participation is completely voluntary and they are able to withdraw any information from the study at any point before the thesis is published.

Another major concern when conducting research involving other people is to ensure the appropriate treatment of the study participants' privacy. When the identity of the study participants is irrelevant for the overall study, for example when attitudes or perceptions towards a certain phenomenon are researched, anonymity can be promised to the participants (Swedish Research Council, 2017). The participants were informed that their anonymity and privacy would be safeguarded as best as possible in the reporting of the research results and that their participation would be anonymized by default in the resulting thesis. The author of the thesis commits to protecting the participants' privacy and anonymity as best as possible but due to the circumstances and research design of the thesis this protection can never be absolute. Since the study focuses on the National Library of Sweden specifically, the participants' relation to the library is mentioned but their specific job position is kept private. This will ensure that the interview answers cannot directly be traced back to the particular participant once the thesis is published.

When evaluating the potential risks as well as ensuing benefits of this study, as Markham and Buchanan (2012) suggest to consider, the risks are perceived to be relatively minor because no sensitive information as defined by the Swedish Research Council (2017) is collected. Furthermore, since the participants are informed about the scope of their involvement on various occasions and their participation is completely voluntary, they can make an informed decision on it and later on have the opportunity to withdraw their consent once the interviews are completed.

In comparison, the benefits of the thesis are considered to be quite substantial as this thesis aims at giving insights into a current gap in research and further seeks to help library professionals at KB and the library and linked data community as a whole to understand the implementation process further from the perspective of active practitioners – giving the interview participants the opportunity to express their genuine viewpoints on the topic.

Limitations

The research design and approach of this thesis naturally brings along certain limitations which will be discussed in the following section. Firstly, the strict timeframe and scope of this study as a Master's thesis limited the study significantly in the selection and number of participants as well as in choosing to do a case study on the singular case of the National Library of Sweden. Conducting a case study, furthermore, brings with it the limitation or weakness of providing no strong basis for generalizing the findings later on in the research process beyond the boundaries of the research setting. As of such, it is difficult to apply the findings of this thesis to public or university libraries, which, furthermore, often have a completely different agenda than national libraries, and also libraries outside of Sweden.

But as Choemprayong and Wildemuth (2017) suggests the limited research setting is also one of the greatest strengths of the case study design since it allows the researcher to get rich and comprehensive insights into one particular setting. As described in the choice of research material, this is particularly relevant as the circumstances and stage of the implementation of linked data vary greatly between different libraries and in the library community as a whole.

Regarding the interview process, one limitation is the choice of doing the interviews via video instead of conducting them in-person at the National Library of Sweden. Video calls and online communication in general naturally come with a number of limitations such as bad internet connection, delayed voices and struggles with the functionalities of the chosen platform which was Zoom in this case. These are all elements that are hard to control for the researcher as they are mostly dependent on the technology used and the knowledge of the participants engaged in the study. Nevertheless, to keep these obstacles as small as possible, the equipment as well as the internet connection were tested before the data collection started through a test interview and the researcher ensured that the interviews were conducted in locations with a stable and secure internet connection. Other than that, the online video interviews are considered to provide the same results as an in-person interview would have done.

Lastly, another consideration is conducting the interviews in English since it is not the native language of most people working at the National Library of Sweden nor the first language of the researcher herself which could cause some difficulties in expressing one's viewpoint as accurately as possible. Since the researcher had already spent some time at the National Library of Sweden, this risk was considered relatively small, as during her time there, conversations in English presented no problem at all. Furthermore, the email conversations leading up to the interviews gave a first impression of the extensive understanding of the English language all participants possessed. Since the interview participants were provided with an interview guide containing the possible interview questions beforehand, they were also given the chance to prepare for the interview as they saw fit.

Chapter 6: Study and Analysis

In the following chapter, the data gathered through the semi-structured interviews with library professionals at the National Library of Sweden is presented. The chapter is divided into four sections which correspond to the four main research questions that guide the thesis. Firstly, the attitudes and perceptions of the library staff at KB concerning linked data and its effects on their work practices will be presented. Secondly, the ways in which the transformation to linked data technologies has affected work practices at the library will be shown. Thirdly, the major benefits as well as challenges of 'doing' linked data in practice are discussed from the perspective of library professionals. Lastly, the broader implications linked data holds for library practices and their relation to the future development of the information environment as a whole will be analysed.

Impact of Linked Data on Library Practice

Linked Data as the Default Way of Thinking About Information

To analyse the attitudes and perceptions of library professionals concerning the implementation of linked data, the interview participants were asked to identify their general knowledge and understanding of linked data. All participants describe a general knowledge and understanding of the concept of linked data since it has impacted their positions at the library to various degrees. Participant B is the only one that describes their knowledge as limited but acknowledges that most of their work seems to refer back to linked data in some way in the end. "It is always some indirect link to linked open data", (Participant B) even though the connection might not be apparent from the beginning. They, furthermore, describe linked data as "the system in the background that connects everything".

The other participants express a great familiarity with working with linked data technologies in their everyday work practices. Participant D refers to linked data as a sort of mindset for thinking about information and information organization:

> For me [linked data] is a default way of thinking about information. So in that sense it is always linked data for me. […] It is a mode of working rather than something that I do specifically (Participant D).

Participant G, moreover, describes linked data as primarily a new model and technique for organizing metadata, different in structure than models the library systems were based upon before with the great benefit of reusing data between the library's in-house systems.

Linked data has become an integral part of the everyday work practices of many of the participants which is in line with the goal of the National Library to move towards a completely linked data system. Participant E and G add that the library is currently aiming at establishing linked data as the common practice for handling the coordination of data within the library as well as in-between libraries and other organizations. The National Library has already drawn up a policy for metadata work which includes the aim of using linked data as a method for handling data as far as possible in all their systems. The policy, furthermore, highlights the importance of reusing metadata from external sources, the automation of processes to make them more efficient, and focusing on user requirements, openness and transparency which all connect back to linked data as a core pillar, says Participant G.

Regarding the coordination of library data within the National Library, Participant C, moreover, states:

> […] there are so many systems and legacy systems still on KB that require a lot of work to figure out what their roles should be in the future and if they can be folded into existing systems or need to be transitioned into other systems, so there's a big like shift in where we're going but most of the systems have an aim for linked data. It's a long-term engagement I would say.

They, moreover, explain that so far the LIBRIS catalog, data.kb.se and SWEPUB (Swedish Scientific Publications) have been able to adapt to linked data at the core. Currently, the library is working on transforming the newspaper collections at tidninger.kb.se to linked data as well. Participant F describes linked data as the fundament for collaborating more in-between the different teams and departments within the National Library of Sweden as well as in-between systems and platforms used at KB.

Moving in the Right Direction

All participants share a very positive feeling towards the implementation of linked data technologies at the library. Multiple participants see the transformation of the data model to linked data as the right thing to do (Participant C, D, E and G).

> I still think linked data will be the way we do things, especially when we work with […] very complex information models because I haven't seen anything that is better. It is still the best technology for information modelling (Participant D).

Participant G, furthermore, explains how the implementation of linked data is not only a choice but rather a necessity for fulfilling the National Library's most central task of managing and organizing the immense inflow of media they receive according to the Swedish Legal Deposit Act. Due to the digitization of society this inflow has increased drastically and the ways media is being produced are significantly impacted. Moreover, the end-user demands for KB's library services are continually becoming more advanced. Linked data provides part of the solution to making these vast amounts of heterogeneous materials searchable and findable.

When talking about the transformation process the participants agree that it was a hard and challenging time and there are still many challenges ahead of them but their hardships are accompanied by a sense of pride of moving in the right direction. When looking back at how the data was before, Participant F points out how they can really see how far KB has come and how much better the data has become.

Participant A explains that one of the most frustrating and challenging things was launching the catalog while the format was still unfinished, which created many difficulties for the production and creation of metadata. Furthermore, a lack of resources and a knowledge gap between people directly involved in the implementation and people outside of the development team presented further challenges. Participant F also adds that it can sometimes feel as if the switch to linked data is currently causing more work for catalogers rather than less which can at times be a bit disconcerting. Nevertheless, all participants are optimistic about the future success of linked data.

> I still have had and have a positive feeling again towards the goal. It is just that the process of it is and has been hard. […] It will be easier and easier and we are moving from something to something better. So yes, it is hard but we have to do it (Participant A).

Participant E states, that "once people start to see beyond the technical change, something positive happens" and that the notions in linked data can further act as a bridge between technology and the domain of the library.

A Paradigm Shift

When asked if linked data could be perceived as a paradigm shift for the way information is organized and managed at the library, most participants agree to this sentiment. Participant C defines linked data as a big generational shift in how library data is perceived and looked at. Participant A adds that through the adoption of linked data within the library catalog, they have learned to think more in terms of triples and entities that relate to each other, working with "data pieces" rather than with records. Participant B states that linked data has, furthermore, introduced a new way of thinking about the storage of data and how information is extracted from it. Participant F points to the new ways of collaborating with other institutions like the Library of Congress, Wikidata, etc. that are enabled through linked data, which create innovative ways of publishing, retrieving and reusing data at the library.

Nevertheless, Participant A explains that in terms of cataloging the concept of linked data is not something completely foreign in the library community. “Linked data is about control, usage […] – we are used to that like with authority records. So it is not that new” (Participant A). Linked data is described as a continuation from data sharing practices like, for example, authority records or copying MARC records within the library community. Participant G suggests that linked data is only one part in a paradigm shift happening in relation to information organization and metadata production as a practice. For instance, the practices of reusing external data and opening up data developed separately from the linked data conversation and linked data is just one method that supports these practices.

Changing Work Practices

Current State of Linked Data at the National Library of Sweden

Participant D explains the development of linked data at KB as a process consisting of three main steps:

> The first step is to expose linked data. The second step is to […] have linked data at the core. Then, perhaps, the third step is to be able to consume linked data, so that your library catalog can interact […] with data that exists elsewhere. […] When LIBRIS XL went into production, we were basically at step two. And, now we are working with step three (Participant D).

After accomplishing the first two steps, the National Library of Sweden is now working on the third step by starting to think about ways to use external data. LIBRIS has been completely transformed to linked data and other library systems are following as development continues.

Participant E explains that, while linked data has been known in the library community for quite a long while, practice has not really reflected that too much this far. They describe the practical implementations of linked data within the library world as a “very prolonged experiment”. A few of the participants (Participant C, D and E) see the more wide-spread adoption of BIBFRAME outside the National Library, that is currently happening, as an indicator for the broader library community making active progress in their linked data efforts. Participant D and E are, moreover, suggest that linked data is currently moving into a new stage of its implementation – a “second wave” that is more about actually doing and less about talking and further extending beyond the library community to other cultural heritage institutions like archives and museums (Participant D).

> The time for experimentation and learning has sort of [passed]. We cannot continue doing just that. So, now we have to deal with the harder questions, the actual sort of day-to-day practice (Participant E).

Effect on the Daily Work Practices of Library Professionals

Concerning the day-to-day work practices, most participants speak of an up-skilling due to their use of linked data technologies. Regarding the appearance of new job positions, the participants agree that the current focus has been on raising the competences of library professionals already working at the library rather than on hiring new people or creating new job positions like a 'Linked Data Librarian'. Nevertheless, the development team has paid special attention to linked data skills and experience when hiring new employees. Participant E and F state that they think their knowledge on linked data was an important factor when getting hired at the National Library.

As linked data is being introduced in more and more areas of the library, it becomes apparent that it is impacting the work practices in manifold ways. Participant C expresses their uncertainty of how things will look like in the future: "I think it is an interesting time but it is also, I guess, very scary for people working in different areas – what their jobs are going to be going forward" (Participant C). Participant A suggests that they already see the role of the cataloger shifting more from creating data towards being responsible for curating and choosing what is being said. Participant E brings up the term "catalinking[7]" instead of cataloging:

> You might not even say catalogers in the same way because you can do much more. You can capture meaning much more precisely using this technology. So we can get away from just transforming structures without capturing the meaning in those structures properly (Participant E).

Participants C and F, moreover, explain how the transformation to linked data has led to new constellations of working together at the library. The implementation process has required a variety of people from different areas of expertise, e.g. developers, metadata professionals and domain experts, to work together. Nevertheless, Participant F adds that this change is mostly apparent in development teams that are already actively working with linked data but that some parts of the library that are still working with old systems have not changed that much thus far.

Beyond the borders of the National Library of Sweden, there also has been active communication and contact with other implementers around the world concerning linked data technologies as many early implementers are sharing the same problems and challenges as KB, shares Participant C.

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[7] The term was first brought up by Wallis (2013) in a presentation called *Linked Data for Libraries: Great Progress but What is the benefit?* during the SWIB 2013 conference.

The Benefits and Challenges of 'Doing' Linked Data

Benefits and Opportunities of the Implementation

Through the analysis of the interview data a number of benefits and challenges of linked data technologies for the work practices at the National Library of Sweden could be identified.

One key benefit that is mentioned by most of the interview participants (Participants A, C, D, E and F) is the higher quality of bibliographic data that is now being achieved due to the switch from MARC21 to RDF and BIBFRAME. The use of links instead of text-based strings has the advantage of preventing spelling mistakes and differences in spelling within the catalog data. Participant F, moreover, states that the switch from strings to links creates more stability within the data. Participant C mentions that through the use of links it gets much more obvious for catalogers if something is wrong, whereas in MARC little mistakes were not that easily recognizable which could result in many different variations of the same word.

> […] the problem with the information model being very precise and being very good is that you cannot hide. In MARC21 you can just put anything in and it looks like you have good data but you actually don't. It is just noise but it looks like you have a lot of information and if a person reads one record then maybe they can sort of decipher what was actually meant but a computer cannot (Participant D).

Participant A, furthermore, adds that the use of links creates more clarity for catalogers what to refer to in certain metadata fields. Using links also makes the data more precise and disambiguation gets easier as the links clearly point to one specific entity. Overall, the data structure of linked data provides the library with the ability to create more concrete, correct and uniform metadata which raises the overall data quality.

Participant C and E also point out that the transformation process has allowed them to rethink how they look at data. The MARC-ecosystem allowed a decent amount of vagueness which can make it hard to identify relationships between data.

> [We] start to understand where things in MARC maybe have gone a little bit wrong when we try to convert it and look at it in linked data. So, […] it is a way to maybe correct some wrongs in the process and start to talk about […], what are the things we are looking at? And what are the relationships between them? (Participant C).

They, furthermore, add that linked data has benefited the catalog because the data format reveals what problems actually exist within the data. It has specifically highlighted the problem of the identification of an entity (Participant E).

Another benefit of the data model is its machine-usability. Apart from the human users of the catalog, the computer is able to engage with the catalog much better. Even though the MARC-format was developed for its machine-readability, Participant C points out how it really just creates a digitized catalog card. Linked data lays the ground-work for computers to actually ‘understand’ the bibliographic data in the catalog. This becomes especially valuable when looking at the number of transactions that are actually performed by machines in comparison to human catalogers. Participant D estimates that almost 90 percent of all transactions in LIBRIS are done by the computer.

> So, the LIBRIS system could be […] better and more useful without it being better and useful for manual cataloging. It could still be better. […] The people that were experts in MARC21 […] of course now have a harder time. They would need to learn all the vocabulary that is in kb.se. They would need to learn all of that to have sort of the same level of competence in cataloging. And that is tough. […] It’s very easy to focus on that particular situation. But, the rest of the system is much better now than it was before (Participant D).

The fact that everything is machine-readable also makes it easier to extract data from LIBRIS. This is especially important with regard to future developments such as the application of more automated processes in the cataloging workflow. While the MARC-environment has made it difficult to effectively extract data, the information in linked data is made much more accessible and it becomes explicit how the data is connected rather than implicit as it was before. Participant F, furthermore, adds that through the linking of data, discovery has become better because it is easier to find related information. Many participants argue that overall linked data creates a much better ecosystem for information.

Participant F states that beside the benefits for the catalog, linked data has also benefited the library overall in creating a shared data format that is easily useable for many different applications. When building new platforms and systems, the use of a common data model makes the data more accessible and integration goes smoother. The use of a more widely used data model, moreover, creates the opportunity to engage with other professionals outside the library community. While the MARC-format enjoyed little to no understanding outside the library community, linked data is more widely known. This also makes it possible for libraries to use a wider range of vendors and tools for their system than before.

> JSON-LD is one of those syntaxes for linked data that makes it easier for regular web-developers and back-end developers to work with a set of things they are used to, unless otherwise you have to learn to understand MARC to be able to use it and that is a very hard threshold (Participant C).

Furthermore, the adoption of a common data model leads to a greater availability of library data outside the library community and presents other institutions with the possibility of reusing the data created by libraries and in turn gives the library the chance to make use of data from other sources.

> I think the real promise of linked data is not to be needing to be responsible for all your data and be able to use other's data and combine that into something more and better (Participant C).

Current Challenges of the Implementation

While the reuse is identified by almost all participants (Participant A, B, C, D, F and G) as one of the great promises of linked data, it also quickly becomes apparent that it is one of the current key challenges of the use of linked data at the National Library of Sweden. Participant A and G describe the reuse of data outside of KB as one of the ultimate goals and promises of linked data but state that the National Library has so far not been able to fully make use of this opportunity. Multiple participants mention that most of the data used in the cataloging system is still produced by KB itself. Only fairly recently, they were able to introduce one of their first external data sets for a subject headings scheme. Furthermore, KB has started working with caching externally published records and is collaborating with QUEERLIT[8] to incorporate another linked data subject headings scheme focused on LGBTQIA+ terms into their catalog.

Participant A states that, so far, there is a lack of official guidelines or linked data policy that facilitates the reuse of data which makes it hard for librarians to decide which data sets to use and trust. Participant C adds that not only trust but furthermore, the overall stability of data sets is a major point of concern when reusing external data sets. After all, linked data is a long-term engagement and for relying on others' data, it needs to promise stability.

Another major challenge mentioned by almost all of the participants (Participant A, C, D, E, F and G) was the lingering legacy of the MARC-ecosystem. As the National Library of Sweden is the first and still one of the only libraries within Sweden that has adopted linked data technologies as its core data model, many vendors, libraries and other cultural heritage institutions are currently not in the same place as KB. "We want to work with linked data and we still have to convert all our data back into a non-linked format", complains Participant A. Many library systems within KB, like the public search interface or the ILS as well as systems used by other Swedish libraries, are still dependent on receiving their data in the MARC-format. "It turns out that MARC21 is fairly hard to kill", states Participant D. This prevalence of MARC21 has the consequence that a lot of efforts are still necessary

[8] QUEERLIT is a joined effort by the Gothenburg Research Infrastructure in Digital Humanities, KvinnSam and the National Library of Sweden with the aim of developing a database for LGBTQIA+ fiction and a thesaurus for indexing related themes (Bergenmar, 2023; Queerlit, n.d.).

to transform the data in its linked data format back into MARC for import and export processes. This is further complicated as other libraries often depend on their own special ‘flavour’ of MARC which means there are large amounts of tuning necessary to develop export profiles for each library (Participant D). This additional work-load has resulted in taking away time and resources that could be invested in other developments surrounding the linked data implementation. Participant E points out that cohesive and committed efforts on an organizational level are necessary to change this situation. It is, furthermore, important to showcase the value of linked data and why its implementation is effective and the necessary next step for the development of new systems. Participant C states that, so far, many vendors are still playing the waiting-game and not taking active and committed efforts to develop systems to accommodate and make use of linked data.

Since linked data formats are still fairly new for the library community, many of the participants describe RDF and BIBFRAME as unfinished or incomplete which brings with it a new set of problems. MARC has established itself as a reliable and stable format within the library community, whereas “when it comes to RDF, then there is still a lot that needs to be decided and expressed and that […] can be hard” (Participant D). Participant E describes the current linked data systems as immature, unstable and lacking adequate experience when applied in difficult circumstances. There are still a lot of things in the linked data world that need to be vetted and discussed before it can establish itself in the same way MARC has been able to.

> […] there are a lot of questions of how linked data should be employed and also the interoperability – which people and libraries have been able to share MARC records and how should we share linked data records going forward. So there’s a lot of questions coming with the new technology that need to be figured out and communicated with the parties that are doing the development at this point (Participant C).

This problem also comes up in relation to the emergence of linked data silos. To realize the vision of the Semantic Web, the concept of semantics has to be at the forefront. Otherwise, it will result in a larger linked data web that within it has points of disconnect, so-called linked data silos, explains Participant E.

Participant A, furthermore, highlights that within the LIBRIS-catalog a lot still needs to be transformed to linked data, e.g. the agents and works, which also requires a lot of resources that are currently lacking. “It is not magically turning into linked data by like pushing a button. It is still so much work to do” (Participant A). Participant C adds that there is also a lot more work necessary when it comes to the different materials at the library as well; for example, musical works are presenting a whole new challenge, especially since BIBFRAME is still too focused on text publications and it is unclear how to extend the format to other materials.

Another challenge, brought up by Participant E, is the large gap between academic notions surrounding linked data and their technological feasibility. While academic literature on RDF is going very deep into ontology and semantics, so far very little implementation is living up to it in reality. As a consequence, much of this literature is not very useful for librarians working in the field. "[There are] many things that are still so obscure in terms of practice. I mean it is very hard to see where that fits into the daily job of a librarian" (Participant E).

In general, the learning-curve for linked data is described as relatively steep by some of the participants (Participant B, D and F).

> I think it is more or less a learning curve. So, for now we have a lot of existing services and systems and […] in many ways it is easier to just keep the description of the metadata in their own system and they can describe it as they want to do and update it. So, I think it is a learning curve and a development curve to start using it but when you do it, you get the benefits (Participant F).

Participant B mentions that the concept can be quite hard to understand for people who lack in-depth knowledge of linked data and the Semantic Web. As Participant F points out, keeping the old systems is often the easier way to go and many developers that are still working with the non-linked data format may not see the benefits of going through the difficult and resources-consuming transformation when the benefits of linked data are not instantly visible. Participant D adds that there still are not that many people available that have a deeper understanding of linked data but who are a key factor when it comes to a successful implementation of these new technologies. They attribute KB's success with implementing linked data to the expertise of the people involved in the transformation process, without whom the project would not have been achievable.

The Unfulfilled Promise of Linked Data

When asked if the promises of linked data have come true thus far, most participants answer no or at least not fully (Participant A, C, D and G). While some positive benefits of the transformation have already become apparent, the true potential of linked data has yet to be realized. Participant C states that one major obstacle is the current lack of a public search interface based on linked data at KB. Participant F adds that this would be the next big step for the National Library on their linked data journey. Furthermore, more advantages might become apparent once KB's data sets are connected to a larger variety of other data sources.

Participant E is the only one that answers the question with yes. They describe that the promises of linked data have come true in those areas where the library has put their minds to first.

> It’s not a fulfilled promise but we see that we can do so using linked data. So, as a technology and as a platform using that technology it is fulfilled but then it’s up to us to actually do it (Participant E).

Overall, all participants have a positive outlook on the fact that the promises of linked data will come true in time if they continue working on implementing linked data in more systems and areas of the library.

The Implications of Linked Data for Future Library Practices

The Future of Linked Data at the National Library of Sweden

When it comes to the future of linked data at the National Library of Sweden, four topics are brought up by the interview participants: the use of external data, the development of a stable and reliable format, the integration of library systems and, lastly, the interplay of linked data and artificial intelligence (AI).

Participant A expresses a strong need for stricter guidelines regarding reusing external data sets and the necessity of a linked data policy on an organizational level. As mentioned above, one of the current key challenges is reusing external data within the library catalog. To streamline this process, the development of a linked data policy would help in creating more clarity and trust when it comes to incorporating external data sets into the catalog.

Another point that is brought up by Participant A is a renewed focus on finishing the current linked data format since it is very allowable at the moment. There is still a lot of cleaning up that needs to be done before the format can be considered stable and reliable which requires a lot of manual work. Participant C adds:

> For linked data to be successful […], it needs to have stability, it needs to have proper funding for years to come. […] We work a lot for links not to break because that is probably the most common thing for things that are published on the web […] – they have vanished with time (Participant C).

Thirdly, multiple participants bring up the point of extending linked data to more and more library systems. Participant C states that with the underlying ambition of all the library systems to be linked, a lot more work is necessary as well as a fundamental shift in how different parts of the library think about data currently. Participant F describes the different systems and platforms that are currently used at the National Library as silos. Linked data offers the opportunity of integrating them in different ways, removing redundant data and, moreover, linking them to other sources which could further contribute to research. In relation to this, Participant E brings up the aim of normalizing notions surrounding genres and forms as they permeate all of the library and its structure currently.

> We can use the semantics of linked data to coordinate these much better and build less specialized systems and just work together within the same linked catalog (Participant E).

Reducing the number of disparate systems and combining current systems into one requires a lot of communication and collaboration between the different departments at KB. Participant C points out the need for transparency and "seeing the benefit together, why you're doing it." The various development teams at the National Library are at different stages of working with linked data and sometimes it can be hard to see the benefits in making the transition if the current systems are working. Participant D, furthermore, reports on current efforts of extending linked data to other parts of the library, for example, the archives.

Lastly, the combination of linked data and AI is brought up by multiple participants (Participant A, C, D and G). Participant D explains that linked data lays the groundwork for many automated processes and the more wide-spread application of AI technologies within the catalog. Through the use of AI, it is possible to extract much more information from digital objects than is usually described in metadata, for example, the locations mentioned in a novel. Linked data creates the possibility of connecting this information to the digital object. Participant G, furthermore, adds that with the help of linked data and AI, previously inaccessible or hard-to-access collections like KB's video and audio collections, the newspaper collections, postcard collections and everyday-print collections could be made much more searchable and accessible.

Current Grey Areas

Talking about the future directions of linked data at the National Library also brings up some grey areas that the library professionals see as necessary to discuss and/or research further. Specifically, the use of external data sets brings up a lot of uncertainty for many of the participants (Participant A, B, C, E and F). Participant A sees the handling of multiple data sets as a problematic area:

> How do we know what the best data set is? And are we going to link all of these different kinds of data sets that describe almost the same thing together? That is something that I see as a little bit of a problem (Participant A).

When dealing with multiple data sets it can be hard for librarians to discern between the different data sets and once the public search interface is transformed to linked data, this problem extends to the end-users as well. Participant A, moreover, suggests that a linked data policy could help in answering some of these questions. Participant F adds that such a policy would also reduce the steep learning curve regarding the implementation of linked data.

The reuse of external data also brings up questions on data provenance. When linking to others’ data and merging different sources of data, Participants C and E point to the importance of understanding where information is coming from. This also connects back to trusting the information and being able to back-track the data to its original source.

Participant D also brings up a lack of clarity regarding the end-user effects of linked data. Since the end-user is currently not interacting with linked data at the National Library of Sweden, research in this area is hard to accomplish. The usefulness of the systems for end-users becomes even more interesting once linked data is combined with automated methods for organizing the data.

Linked Data and the Digital Information Environment

The participants share various ideas on how they see linked data affecting future practices beyond the library and its impact on the information environment as a whole. Participant F suggests that, due to the implementation of linked data, the position of the library in today’s information environment could be impacted greatly as library data is becoming more open externally. As a consequence, library data is made much more accessible not only via coming to the library or accessing the catalog online but by finding library data through other online resources, for example, Google or other search engines. Thus, linked data might impact practices of information discovery as a whole. Furthermore, linked data is impacting the way library data is used in new and different ways, offering unprecedented ways of engaging with library materials.

Participant B suggests, that linked data is turning the library into an aggregator and “trustworthy central source where anyone can link sources of data together”, highlighting how linked data can infuse more trust into the practice of information collection and management at the library. Participant G describes how linked data helps the library to become a more reliable and stable source of data that other institutions and people can use. These ideas are also reflected in Participant A’s perspectives, as they identify library practices shifting from creating data to curating data, i.e. picking the most trustworthy data sets and developing the linkages between them. According to Participant E, linked data, moreover, provides libraries with the means of semantic precision, moving them away from the issues of data transformation to the problem of identification.

Participant D, F and G explain how the use of explicit identifiers and the ability to directly connect information to its source will, furthermore, make it easier for libraries to be considered sources of truth in an ever-changing information environment and the continued rise of fake news.

Regarding the future of library practices, all participants bring up the implementation of AI and machine-learning as a more impactful factor for library practices in the future than the implementation of linked data currently is. “AI, that is what is going to make the library world shake a little bit – more than linked data” (Participant A).

Chapter 7: Discussion

In this chapter, the results are analysed on the basis of the four main research questions, key themes are identified and the findings are brought into the context of previous research and the theoretical framework of the thesis. The four guiding research questions are: How do the library professionals perceive linked data and the effects of its implementation on their work practices? How and to what extend has the transformation to linked data technologies affected the work practices of library professionals? What are the major challenges as well as benefits of ‘doing’ linked data in practice and has the transformation been worth it so far? And lastly, what broader implications does linked data hold for library practices in relation to the future development of the digital information environment?

Library Professionals’ Perceptions of Linked Data

The interviews showcase a general to great familiarity with linked data and related concepts of the library professionals at the National Library of Sweden, supporting the findings in previous studies like Mitchell (2016) and Warraich and Rorissa (2020) who proposed a high degree of visibility of linked data in the library community as well as a good understanding of related concepts by library professionals in the field. This result can be related to the specific library professionals interviewed for this study since many of them have been intensely involved in the implementation process of linked data at KB. Furthermore, since many of the study participants possess a more technical background in data science or systems’ development, they might have had an easier time grasping concepts like linked data and the Semantic Web than less tech-savvy library professionals would. Nevertheless, the fact that the thesis author had a hard time at arranging interviews with more catalogers and librarians at KB might indicate that library professionals from these departments were less comfortable with discussing linked data than professionals working in the areas of data science and development.

The interview participants showcase two distinct understandings of linked data – while many of the participants with a background in data science or development define linked data as a new mindset or a way of thinking, the interviewed professionals with a background more related to cataloging and metadata see linked data more as a natural development in format for the practice of cataloging, simply a new method or technique. Regardless of how they specifically understand linked data, all participants perceive linked data as an integral part of their daily work practices and view LD as a long-term engagement for the library as a whole. They, furthermore, share a positive attitude on the transformation towards linked data technologies as a whole, reflecting attitudes in previous literature foregrounding the immense potential and power of linked data for the library community in today's information environment (e.g. Schreur, 2012). The participants portray linked data not only as the right thing to do but further as a necessity to fulfil the mission of the National Library of Sweden and the Legal Deposit Act.

As mentioned in previous literature, linked data is often perceived as a paradigm shift for understanding the practice of information management within the library community. Throughout the interviews it becomes apparent that most of the interviewed library professionals agree with authors like Jin (2021) and Schreur (2012) in portraying linked data as a 'paradigm shift'. Nevertheless, as some of the participants point out, this new understanding of knowledge and information organization is not necessarily connected singularly to the emergence of linked data. Rather, linked data is understood as one part of a paradigm-changing shift currently happening in the field of knowledge and information organization that is connected to the emergence of the rapidly growing amounts of information available on the internet. The necessity of adapting to this new reality of Big Data and the consequences of the vast amounts of information online, was already brought up by Ibekwe and Bowker (2017) independent of the emergence of linked data and the Semantic Web as well. Moreover, some of the interview participants highlight that linked data can also be perceived as an almost natural progression of data sharing practices that have been happening in libraries for years, for example, the copying of MARC-records and the use of authority records.

Nonetheless, as the results of this study indicate, linked data is going far beyond a mere switch in data format and the application of new technologies. This is especially evident in the participants' perspective on the connection of linked data and open data. A considerable amount of the interviews revolved around the topic of (re)using external data sources and opening up KB's data to others. This focus suggests that linked data is foregrounding a discussion on opening up information that is also reflected in other spaces of the information environment, for example, the rise of open access publishing models and creative commons licensing.

Regarding the perceptions of library professionals towards the impact of linked data on their work practices, LD is perceived as a big shift when it comes to the storage of data, extracting information from library data, collaborating with other institutions as well as the practices of publishing, retrieving and reusing data. But, as previous studies have already established, library practice as a whole is still awaiting a full transformation to linked data technologies (Mitchell, 2016). Furthermore, as Frederick (2017a) already pointed out, the National Library of Sweden joins many other libraries around the world in existing in an in-between stage of transformation, unhappily caught in the clutches of MARC21 and unable to entirely grasp the full potential of linked data yet.

The Effects of Linked Data on Library Practice

By applying a practice-based approach to study how linked data is influencing library practice at the National Library of Sweden, the following section highlights how the application of linked data principles has impacted how library professionals carry out their work, engage with library resources and collaborate with others. The interviews suggest that linked data is moving into a new stage of its adoption in the library community, transforming from a prolonged experiment to a framework affecting the everyday work practices of library professionals. Specifically, the emergence of BIBFRAME and its more wide-spread application in libraries is identified as indicative for a turning point of the linked data implementation in the library community by the interview participants.

Library professionals acting as agents in this context, have adapted their work practices responding to and interacting with the benefits as well as challenges linked data has exposed. The interview participants describe an up-skilling in terms of linked data knowledge of current library professionals leading to new competencies in interacting with library data rather than the hiring of outside professionals to transform their systems and practices. But, the results of this study also suggest that prior linked data knowledge has been beneficial for some of the interviewed professionals that got hired more recently at KB, supporting the results of Frederick's (2022) study where linked data knowledge is identified as a valuable and preferred skill in job listings.

Referring back to the guiding principles of the National Library as they were introduced in the Background-chapter of this thesis, the main functions of the library are defined as collecting, describing, giving access to and preserving the library's collections (National Library of Sweden, 2022a). Furthermore, these basic principles are later extended to providing a well-functioning national infrastructure, strengthening collaboration within the Swedish library sector, contributing to the development of digital library services, creating accessibility and relevance for everyone and keeping up with the developments in society (National Library of Sweden, 2022b). All of these principles are connected to certain library practices that have been influenced by the implementation of linked data to various degrees as will be discussed in more detail below. The focus of the National Library, when implementing linked data principles at their institution, has so far been foremost directed towards transforming the Swedish Union Catalog LIBRIS to linked data as its core data model. Therefore, the core library practices of collecting, describing, giving access to and preserving the collections have already been profoundly impacted by the switch in data format.

Data Collection: Linked data is impacting the way information is collected, specifically what information is being collected, in which ways and by whom the practice is carried out. As some of the participants point out in the interviews, linked data enables a lot of computational processes, automation and the use of AI, which creates a novel and unprecedented level of engagement with library materials. Specifically, since the library is collecting a rapidly growing number of digital materials and it becomes impossible for human catalogers to keep up with the onslaught of digital information being produced every day, machine-supported processes for collecting and describing information become increasingly necessary, foregrounding the importance of machines as non-human agents in this practice. As linked data is affecting the way machines can understand library resources, it has the potential to be an important pillar in facilitating the automation of such processes.

Data Description: For the participants, the most palpable area of change has been the way library data is structured and described as the library is moving away from the string-based input-format of MARC towards incorporating more and more links through the use of URIs into their cataloging system. The participants describe a change in thinking, moving from records to thinking in terms of data that was already brought up by Sprochi (2016) which showcases how the mental activities and especially the way information organization is understood by library professionals is changing due to the application of linked data as a framework for knowledge and information management. For catalogers, the use of links, moreover, creates more clarity on what to input in specific metadata fields which suggests that it perhaps gets easier to know what to do. Multiple of the study participants also suggest that the role of the cataloger as the main agent in this practices is shifting from creating data towards curating data, a sentiment that was also brought up in previous literature (e.g. Schreur, 2012).

The developers also bring up the enormous rise in data quality connected to the concreteness of linked data as it eliminates many mistakes previously inherent in the data – a development that is also discussed in previous literature (e.g. Rasmussen Pennington and Cagnazzo, 2019). Moreover, through the introduction of more external data sources for the description of library resources, many participants point to the library giving up a certain degree of control and responsibility in the practice of data description which implies that more and diverse agents are invited into the practice.

Nevertheless, since the implementation is still in its early stages, the overall practice of cataloging can still cause some uncertainty in catalogers while they are adopting this new mindset, and since the format is still unfinished, there is a lot more work to do to establish RDF and BIBFRAME as a stable and reliable format for cataloging all of KB's diverse materials. Some of the participants also bring up that contrary to previous studies, stating the reduced workload as a great benefit of linked data (Gaitanou *et al.*, 2022; Pace, 2018), the transformation to linked data has so far often caused more rather than less work for catalogers at the National Library of Sweden. This supports previous results of Wennerlund and Berggren

(2019) who bring attention to the drop in productivity in cataloging practices that accompanied the launch of linked data at the National Library.

Data Sharing: The impact of linked data on accessing library materials and making them more easily discoverable and available on the Web, is a point often brought up in previous studies (e.g. Rasmussen Pennington and Cagnazzo (2019) and Schreur (2012)). At the National Library of Sweden, the implementation of linked data in this practice is best described as an ongoing work-in-progress.

The lingering legacy of MARC21 as a vital 'object' or 'thing' for carrying out the practices is still very prevalent in most other libraries in Sweden and many library professionals still lack the required linked data knowledge necessary to transform their systems to linked data. Therefore, most of the data at KB has to be transformed back to MARC for importing as well as exporting purposes while other Swedish libraries as users of the National Union Catalog are still reliable on MARC as a format for library data.

When it comes to the accessibility of library data to end-users, the public search interface of KB is still based on MARC21 and, thus, the library end-user does not directly come into contact with the linked data aspects of the catalog. Nevertheless, due to the adoption of a more widely-used data model, the interview participants share a positive attitude that linked data will enable a much easier accessibility of their data to other institutions in the cultural heritage community and beyond. Looking at the future, the National Library of Sweden is focusing on the third step of their LD implementation journey and making their data more accessible outside the library by developing end-user services based on linked data and integrating their data better on the web. This will most certainly affect the accessibility of as well as the engagement with library services by end-users and other institutions.

Data Preservation: The preservation of library collections in its digital form is brought up in relation to the switch in data format. MARC is described by many of the interviewed professionals as a reliable, stable and trusted format which linked data and RDF/BIBFRAME, so far, are not able to compete with. Since linked data is still in its earlier stages within the library community, there is a lot more work to do before it can be considered a mature, stable and battle-tested solution that the library community will trust in preserving their data in the long-term. Referring back to Nicolini (2013), these data formats can act as 'objects' used within in the practice that have the potential to make a practice durable throughout time. While the MARC-format has established itself as a reliable 'object' in library practice, RDF and BIBFRAME so far lack the same kind of durability.

The results of this study also indicate that trusting in the reliability and stability of data sets grows ever more important in an environment where external data sets are incorporated in one's own systems. As mentioned above, the more wide-spread adoption of BIBFRAME could be a sign that the format becomes more established and permanent as an object within the practice.

Providing a National Infrastructure: Regarding the development of a national infrastructure, linked data enables greater interoperability of library data with other systems and services outside the library community. But, since many other Swedish libraries have still not been able to switch to linked data as their core data format – lacking the necessary know-how and resources to make the transition – KB has had to take huge efforts in supporting the diverse needs of these libraries. Many interview participants mention that the practice of developing export-profiles which convert their linked data to the specific version of MARC21-format each library needs, is taking a lot of effort, time and resources which could otherwise be invested into making more progress regarding developing other linked data services.

Strengthening Collaboration: The interview participants described a restructuring in teams and departments due to the interdisciplinary knowledge the implementation of linked data requires. This implies that linked data has led to new constellations of agents involved in carrying out different library practices. Furthermore, collaboration is extending beyond the borders of the National Library of Sweden as KB is collaborating with other implementers around the world. Thus, it seems as if linked data as a shared understanding of information organization on the web is facilitating communication across different institutions in the LAM-community and beyond, a point also brought up by Gaitanou *et al.* (2022).

Development of Digital Library Services: By implementing linked data, the National Library of Sweden is also significantly impacting the development of digital library services. The results of this study indicate that KB is aiming at using linked data as the underlying data model for all future library services, therefore, integrating these services better into the information environment of the internet. Through the adoption of linked data technologies in more and more library services and system, the library, moreover, creates greater interoperability of their own systems and has the chance to consolidate old and redundant systems, overall, reducing the number of separate systems. This showcases how RDF and BIBFRAME as linked data formats become important 'objects' in this practice.

Conforming to Societal Developments: As mentioned above, the topic of opening up data is frequently brought up during the interviews which indicates that linked data plays an important factor in opening up library data, thereby conforming to the broader societal trend of Open Data. Furthermore, as the end-user is turning to the internet in their search for information, linked data's potential of improved discoverability and visibility on the web is mentioned by some of the participants, suggesting that many library professionals have high hopes for linked data in this regard. Linked data is perceived as the right step to take in order to keep up with societal developments. This sentiment highlights how linked data has already significantly impacted mental activities involved in library practice.

Overall, when reflecting on the influence linked data has so far had on different work practices, it becomes apparent that while linked data has influenced the knowledge as well as aspirations of the interviewed library professionals, there perhaps is a lack of ‘objects’ or ‘things’ as well as the more wide-spread know-how and particular understanding of knowledge organization, making the related practices durable at the moment. The interview participants themselves suggest that, for example, common guidelines as well as a more wide-spread availability of linked data systems by outside vendors can solidify the use of linked data technologies in the library community. Moreover, linked data is not the only current development the interviewed library professionals bring up regarding the transformation happening in library practice. Most participants suggest that AI and machine-learning will bring along a much more palpable shift in library practices.

The Challenging Reality of ‘Doing’ Linked Data

The interview participants identified a number of benefits as well as challenges that were also mentioned in previously published studies. Starting with the benefits of the linked data implementation, Figure 7 showcases the benefits of linked data that have already become apparent at the National Library of Sweden in relation to the benefits that were brought up in previous studies. The checkmark signals that the benefit mentioned in previous literature, is also apparent in the interviews with the library professionals at KB.

The Benefits of the Linked Data Approach	**Key References**	
Greater interoperability of library data	Gaitanou et al. (2022) & Rasmussen Pennington and Cagnazzo (2019)	✓
Creation of a shared knowledge base for cultural heritage institutions	Byrne and Goddard (2010)	
Cloud-based approach as a cost-effective storage solution	W3C (2011)	
Collaborative resource description	W3C (2011)	✓
Sharing diverse perspectives on information resources	Alemu *et al.* (2012), Fan (2022) & Schreur and Carlson (2020)	
Reuse of resource description and multilingualism	Rasmussen Pennington and Cagnazzo (2019) & W3C (2011)	✓

Reduced cataloging workload	Gaitanou *et al.* (2022)	
Data enrichment/quality enhancement	Gaitanou *et al.* (2022) & Rasmussen Pennington and Cagnazzo (2019)	✓
Seamless integration of library services on the internet	Moi (2020)	
Improved visibility and discovery of library data on the web	Gaitanou *et al.* (2022) & Hallo *et al.* (2016)	
Linkage of library resources with other online services e.g. Wikipedia	Hallo *et al.* (2016)	
Easier communication with other professionals due to common standards	Gaitanou *et al.* (2022)	✓
Use of more mainstream services and a broader range of vendors	W3C (2011)	✓
Increased external interest in library services	Gaitanou *et al.* (2022)	
Flexible and extensible data model	Danowski and Pohl (2013)	✓
Integration and interoperability of different library systems	Byrne and Goddard (2010)	✓
Modelling of data according to things of interest e.g. themes, peoples, locations, etc.	Hallo *et al.* (2016)	

Figure 7. The Benefits of Linked Data at the National Library of Sweden (Thesis Author).

The rise in data quality was clearly identified as one of the most palpable benefits as it was mentioned by almost all of the interview participants. This can be linked to the reality of linked data efforts at KB being foremost focused on the Swedish Union Catalog LIBRIS XL and its transformation to linked data as its core data model so far. A relating benefit, that was not mentioned specifically in previous literature, was the chance linked data provided for the library to rethink their data and take a closer look at how the data was structured as well as what relationships existed between the data when it was still in the MARC-format. Multiple participants described the transformation in formats as an opportunity and chance to right some wrongs and improve the data overall which also showcases how the transformation to linked data is not merely treated as a switch in format but has the potential to revolutionize the understanding and structuring of bibliographic data as a whole. The interviews suggest that linked data played a significant role in making KB's data more precise and uniform and has led to less mistakes in the cataloging process. Furthermore, the use of links within the catalog has made relationships between the data much more obvious, leading to an improved discovery of related data within the libraries in-house systems.

Another often identified benefit that was also mentioned in previous studies was the access to professionals as well as vendors and systems outside the library community due to the adoption of a more commonly used data model (W3C, 2011).

Regarding library systems, the interview participants, furthermore, portrayed linked data as an opportunity to rethink current systems as well as a chance to consolidate old systems and reduce the total number of systems in use – a benefit that is also touched upon by Byrne and Goddard (2010). This can be linked to the flexibility and extensibility linked data as a data format offers.

The greater interoperability of library data was mentioned only briefly in the interviews but relates to many of the mentioned benefits. Some participants highlighted the fact that while linked data might not be as easily understood by catalogers as MARC was – since MARC had centuries to establish itself and for catalogers to gain extensive knowledge of the format – linked data has the clear advantage of being understood much better by computers. This benefit was further foregrounded since most of the transactions done in LIBRIS are executed by a computer anyway. Specifically, in today's digital information environment where vast amounts of information are produced every day and it is most certainly impossible to process and organize all of this information through manual cataloging, using machine-supported processes and automation becomes continuously more relevant. Moreover, the rapid development of AI, that was also mentioned by many of the participants as a development potentially affecting the library community quite drastically, requires computers to be able to understand bibliographic data on a deeper level than through the mere 'reading' of strings.

Lastly, the opportunity of reusing externally produced data was mentioned by many of the participants as a great benefit and one of the core promises of linked data. Since KB has only just started using external data in their own catalog and is still putting a lot of effort into making their own data available outside the library, this part of the linked data adoption still seems like an ongoing progress accompanied by many obstacles and challenges that still need to be solved. Nevertheless, the participants perceive their data to be more available to people outside of the library community.

The benefits of portraying multiple perspectives that was mentioned by Alemu *et al.* (2012), Fan (2022) and Schreur and Carlson (2020) was not directly brought up during the interviews. But, the involvement of the National Library in the QUEERLIT-project suggests that the library is finding new ways of incorporating diverse perspectives on their materials into their catalog. Another benefit brought up in previous studies was the creation of a shared knowledge base for cultural heritage (Byrne and Goddard, 2010). The participants did not directly make mention of this as a benefit of linked data but some of the participants bring up the idea of connecting the data from different cultural heritage institutions together, clearly seeing the value in sharing data in this way. Since both of these benefits are related to the successful sharing of data and use of external data and the National Library of Sweden is only just starting development in this area, the interview participants might not have identified these points as realised benefits yet. Nevertheless, the interviews suggest that the participants have a positive mindset that linked data will bring further advantages in this area as well.

The better integration of library data into the catalog, improved discoverability of data on the web as well as linkage of library services to other online services was not really brought up during the interviews. This again might relate to the current stage of the linked data implementation at the National Library. Since the library end-user is so far not able to engage with the linked data aspects of the catalog, many of the described benefits are not yet able to be experienced by library professionals at KB. But, the development of a public interface is portrayed by multiple participants as one of the next steps in KB's linked data journey.

Now turning to the challenges of implementing linked data at the National Library of Sweden, Figure 8 showcases the challenges the interview participants brought up during the interviews in relation to the challenges that were stated in previous studies. The checkmark signifies that the challenge mentioned in previous literature, is also apparent in the interviews with the library professionals at KB.

The Challenges of the Linked Data Approach	**Key References**	
Lack of awareness of library professionals towards the topic of linked data and its practical implementation	Warraich and Rorissa (2020)	
Lack of expertise and knowledge on the implementation process and application of new technologies	Moi (2020) & Rasmussen Pennington and Cagnazzo (2019)	✓
Steep learning-curve	Carlson *et al.* (2020), Godby *et al.* (2019) & Niu (2020)	✓
Access to skilled professionals	Niu (2020)	✓
Lack of practical examples	Carlson *et al.* (2020)	✓
No agreed upon best practices, common guidelines or step-by-step guides	Rasmussen Pennington and Cagnazzo (2019)	✓
No wide-spread implementation	Godby *et al.* (2019) & McKenna (2017)	✓
Emergence of linked data silos due to different linked data approaches	Suominen and Hyvönen (2017)	✓
Transformation and mapping of MARC to RDF	Danowski and Pohl (2013)	✓
Incorporating external data sets – questions of provenance and synchronising data	Danowski and Pohl (2013)	✓
Lack of openness as a standard for publishing data	Danowski and Pohl (2013) & Mitchell (2016)	✓

Figure 8. The Challenges of Linked Data at the National Library of Sweden (Thesis Author).

The interview participants identified most of the core obstacles mentioned in previous studies as well. Only the lack of awareness concerning linked data in the library community (Warraich and Rorissa, 2020) was not brought up at all by the participants. This might relate to the long-term attention many of the interviewed library professionals and the National Library overall, have paid to the linked data development throughout the years. Moreover, many of the participants have been deeply involved in the transformation process of LIBRIS to linked data which has required them to be more involved with the overall topic of linked data as well. As mentioned above, most of the interviewed participants are working in the areas of development and data science and might therefore have greater knowledge and understanding concerning linked data than library professionals with other areas of expertise. As some of the participants mentioned, linked data has also been receiving more and more attention in the cultural heritage space over the years, and successful implementations of the connected technologies are emerging more frequently which might have caused a more wide-spread knowledge of related terms and concepts in recent years.

Regardless of the growing awareness for linked data, the participants also identified the steep learning curve as well as the lack of skilled professionals in this field as an ongoing challenge (Carlson *et al.*, 2020; Godby *et al.*, 2019; Niu, 2020). This becomes particularly apparent when one participant mentioned that, without the skills and dedication of the involved team, the successful implementation of linked data at KB would not have been possible. Another challenge that was brought up in relation to this, was the large gap between academic notions on linked data and the actual reality of linked data in practice which Seeman and Goddard (2015) have already brought up.

One of the core challenges that was identified by almost all participants – but rarely touched upon directly in previous literature – was the lingering prevalence of the MARC-format and how the wide-spread and long-term use of this data format has made the process of moving on particularly difficult. The participants described various difficulties in relation to this, like the great amounts of manual work necessary to make the transformation, convincing other library professionals of the switch in data format when their library systems based on MARC21 are still working perfectly and especially transforming from a stable and trusted format to an incomplete, immature and unstable format like RDF and BIBFRAME. The lingering legacy of MARC seems to be one of the key actors in delaying further development and the wide-spread adoption of linked data outside the National Library of Sweden. Moreover, it has caused an in-between stage of formats for KB since LIBRIS still has to be able to import and export MARC-data to fulfil its role as the National Union Catalog useable by libraries all around Sweden. Since many of the previously published literature focuses on linked data from a more theoretical perspective or is specifically highlighting the end-product of a linked data implementation, the transformation process from MARC to RDF seems to have been neglected in other studies.

Regarding the newness of linked data and KB being one of the first libraries in the world to adapt to linked data at the core, the lack of common guidelines (Rasmussen Pennington and Cagnazzo, 2019) as well as the possibility of linked data silos (Suominen and Hyvönen, 2017) were identified as important challenges by the interview participants as well. In relation to the previously published literature on this topic, this seems to be one of the most pressing issues when it comes to a successful implementation of linked data in the cultural heritage community as a whole. To truly make use of the 'semantic' part of the Semantic Web, semantic interoperability must be at the forefront when adopting linked data technologies.

Concerning the promise of linked data that is mentioned in many of the previously published theoretical papers on the topic, the library professionals all seem to be confident about it eventually becoming a reality. But, since the National Library of Sweden is still in the middle of transforming all of their systems to linked data, specifically the end-user related systems and platforms, most of the promises have not come true thus far. As this section showcases, the interviews with library professionals confirmed many of the previously mentioned benefits as well as obstacles but, furthermore, foreground some novel points as well.

Implications of Linked Data for the Future Information Environment

Regarding the broader implications of linked data for future library practice as well as the digital information environment as a whole, this study foregrounds a number of key factors playing a significant part in an information environment structured by linked data: control, responsibility, trust, truth, stability, openness and collaboration. As Rasmussen Pennington and Cagnazzo (2019) already proposed, linked data is shifting the relationships between the different actors in the information and knowledge community. As the interview participants suggest, due to adopting linked data and incorporating external data into their catalog to achieve the fifth stage of the 5-Star scheme for Publishing Linked Open Data, that was introduced by Berners-Lee (2010), the National Library of Sweden has to give up a certain amount of control as well as responsibility for their data. Thus, trust in external data sources, the truth in their information as well as their long-term stability become important factors in this new digital information environment.

Furthermore, the results of this study support Schreur's (2012) suggestion that the openness of data becomes a significant factor in the transformation of the library community to linked data. The switch to linked data highlights the necessity of adopting a standard of openness when it comes to making one's data available online. As one participants points out, when institutions want to make their data available on the web, linked data is already the established cause of action. Libraries now have to get clear on how they position themselves regarding opening up their data on the internet which might come at the cost of losing control over their data.

The interviews further highlight the importance of collaboration in the digital information environment – collaboration not only within the library between different library professionals working on the successful implementation of linked data but reaching far beyond its borders to other institutions and LD implementers. The participants bring up collaboration with other libraries in finding solutions for common problems during the transformation journey as well as collaboration with other cultural heritage institutions when it comes to describing information resources.

All of these factors are significantly impacting current library practice and as the information professionals propose might change how the library as a whole is perceived. While linked data might enable libraries to become a better recognized source of information in the digital sphere, the practice of cataloging is radically transformed when implementing linked data technologies. As the participants suggest, catalogers are moving from creating records to linking data within their catalogs to other sources, therefore curating data instead of merely creating it. The implications this holds for library practice as a whole are yet to be seen but the interviewed library professionals expect the role of the library in the digital information environment to be shifting considerably. As linked data enables libraries to better integrate themselves in the information environment of the internet, the interviewed library professionals, furthermore, propose that library data as whole will become more open externally and unprecedented ways of engaging with library materials will be enabled.

Chapter 8: Conclusion

By studying the National Library of Sweden as one of the first successful implementers of linked data technologies in the library community, this thesis has provided deeper insights into how linked data has impacted library practice as well as how its broader implications within the digital information environment are perceived by library professionals actively working in the field. As this study highlights, the transition from MARC21 to linked data is more than just a transformation in data format and can rather be identified as part of a mindset shift in the field of information and knowledge organization which comes at the cost of reframing the related practices on the web. While linked data is often perceived as a paradigm shift for the library community in previous studies, this thesis proposes that linked data is only part of a paradigm-shifting development happening in the field of information organization as a whole, part of a bigger process in a library practice that is adapting to the novel requirements of the digital information environment characterized by its openness, vast amounts of information in diverse forms and from a multitude of different sources – some big, some small, some known for centuries and some yet unknown or previously neglected – and the necessity of leaning more and more on the advantages as well as the affordances of digital technologies to adequately adapt to the challenges of this new environment.

Regardless, of how linked data is perceived by the individual library professionals, this thesis further showcases how linked data is impacting many areas of library practice significantly, transforming the basic functions of the National Library in a multitude of ways. While the collection and description of library data have already been impacted substantially, the practice of sharing data and making it available online have yet to be transformed thoroughly as the National Library of Sweden is still working on implementing linked data in their end-user systems. The difficult transformation from MARC21 to RDF and BIBFRAME has, furthermore, caused KB to be stuck in an in-between stage of transformation where linked data is the aspiration and end-goal but MARC still governs many areas of day-to-day practice. Thus, the National Library of Sweden has not been able to realize the full potential of linked data yet and is still awaiting the so-called promise of linked data to fully come to fruition.

KB has faced many of the already established challenges stated in previous literature and has been able to recognize multiple of the benefits linked data is supposed to realize according to previous studies as well. So far the most palpable benefits of linked data are related to the practices of information description, specifically the rise in data quality as well as the reimagining of data structure. Furthermore, the flexibility of linked data has allowed the library to begin to integrate different in-house systems with each other. Adopting a more wide-spread data model has, moreover, allowed for easier communication with other information professionals and for collaborations to extend outside the borders of the library community. The benefits concerning end-user services and data sharing practices have yet to be realized, as the National Library of Sweden is expanding linked data principles to all their systems and services. Regarding challenges of the LD implementation, the most significant challenges currently are related to the incorporation of external data into the library systems, dealing with an unfinished data format, and being one of the first libraries world-wide to implement linked data into their systems. The library professionals hope for more guidelines concerning the use of linked data and incorporating external data into their catalog. Furthermore, a lack of resources, skilled professionals and practical examples hinders the more widespread adoption of linked data technologies in the Swedish library community according to the interview participants. Despite the obstacles the full transformation to linked data still encompasses, the library professionals share a hopeful and incredibly positive attitude towards the goal of linked data as it is perceived as the right direction to move towards and the future of information organization in the library community.

While linked data might not be the only development impacting library practice in the digital sphere, it provides the pillars for future technological developments, like the use of AI, to build upon and takes on an active role in further spreading the 'ideal' of sharing, reusing and opening up information resources on the internet. It, moreover, plays an important part in highlighting the importance of control, responsibility, trust, truth, stability, openness and collaboration as key factors and areas of consideration in this new information environment. When linked data becomes the standard, the sharing of responsibility, giving up of control, collaboration with others and sharing of data have to become the standard as well to make proper use of the benefits linked data promises. As linked data continues to impact library practice in a multitude of ways, libraries are provided with the opportunity to position themselves anew in the digital information environment, shedding old practices and adopting new ones, better aligned with the shifting end-user needs and societal expectations.

To better understand the implications of this study, future research should address the interconnectedness of linked data and other technologies as for example AI and machine-learning and how their combined impact is affecting library practices. Furthermore, future studies should turn an eye to the end-user effects of linked data, how it is affecting their use of library data and what expectations end-users have for digital library services as well as how they make use of linked data particularly. Lastly, an area of great uncertainty in library practice seems to be the practice of using external data sets and connected issues of data provenance which should be investigated further in future studies as well.

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Appendix

Interview Guide

Background

1) What is your role at KB?

2) How familiar are you with Linked Data? To what extend do you engage with it every day?

3) How long have you been engaged with working with linked data technologies?

Implementation of Linked Data at KB

4) To what extend has your library/catalog benefited from implementing linked data technologies? How has it benefited?

5) What are the current key challenges for the development of linked data at KB?

6) How has the switch to linked data affected different aspects of the information environment at KB e.g. creation/production of metadata, discovery process, use of the catalog by end-users etc.?

7) To what extend have your work practices been affected? Was it easy/hard to change your workflows?

8) Do you think your role within the library will change due to the implementation of linked data e.g. loose/gain meaning/importance, evolve into something new? To what extend is this affecting the overall structure of the library?

9) Have new job positions/additional skills and requirements emerged due to the implementation of linked data e.g. a Linked Data Librarian?

10) Is the overall work happening at KB changing fundamentally due to the adoption of linked data?

Sentiment towards Linked Data

11) What are your general feelings when it comes to the implementation of linked data in the catalog? How did you perceive the transformation process?

12) What is your general attitude concerning the future of linked data within the library community? To what extend has it changed due to its implementation at KB?

13) Do you feel like the promises of linked data have come true so far?

The Future of the Library

14) To what extend do you think the role of the library will be shifting due to linked data and the Semantic Web? Why?

15) Where do you see the future of linked data at KB heading towards? Are there any institutional plans and what are your own hopes for future developments?

16) Are there any grey areas with regards to linked data that you think require future research/need to be discussed further?

Concluding Thoughts

17) Would you like to add any further comment/reflection on the topic?