Metadata and Universal Access in Digital Library Environments

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Purpose- Accessibility metadata has been a recurring theme in recent efforts aimed at promoting accessibility of Information and Communication Technology (ICT) solutions to all regardless of their disabilities, cultural differences, language, etc. This paper explores the potential of accessibility metadata in improving knowledge discovery and access in digital library environments, discusses developments in creating accessibility terms for resource description, and attempts to relate those developments to the overall purpose of universal design to finally present some recommendations.

Design/Methodology/Approach –This is an exploratory study based on review of selected literature and documentations made available by metadata projects. Search for related literature was made via Google Scholar, EBSCO and Web of Science Databases using terms and combination of terms such as "universal design and metadata", "accessibility metadata", "inclusive design", and "metadata and digital libraries". Some documentations on metadata projects were obtained through email correspondences.

Findings: The overall discussion shows that accessibility metadata can be instrumental in exposing accessible resources to search engines and in augmenting library resource discovery tools for the benefit of users with disabilities. Accessibility metadata would help users to quickly discover materials that fit their needs. However, the notion of indexing resources by their accessibility attributes remains an area that needs further exploration.

Originality/Value- The paper gives emphasis to the importance of metadata research in universal design endeavors. It also provides recommendations for practical applications that would improve accessibility in digital library environments.

Keywords: universal design, universal access, inclusive design, accessibility metadata, digital library accessibility

Paper Type: Research Paper

1. Introduction

The overall aim of universal design, also known as inclusive design, is to make products and services accessible and usable to all regardless of their disability status, gender, language, etc. (Persson et al, 2015). Though it is much wider in scope than accessibility, the efforts for achieving its intention in the context of information systems could be broadly categorized as *designing for*

accessibility and *designing for adaptability* (Green et al, 2013; Kelly et al, 2009). The first approach sought to ensure accessibility through the use of guidelines and standards such as those developed by World Wide Web's Web Accessibility Initiative (W3C/WAI). The argument from the proponents of the latter, i.e., the adaptability approach, was that adherence to technical specifications has failed to bring significant impacts (Kelly et al, 2009). Their argument seems to be supported by studies which confirmed that reliance on guidelines won't necessarily ensure universal accessibility (Comeaux and Schmetzke, 2007; Stewart et al, 2005). There have been cases where websites evaluated as inaccessible were, in fact, judged accessible by the groups they were intended for and vice versa(Sloan et al, 2006). All in all, the lessons learned and conclusions reached (Vanderheiden and Treviranus, 2011; Vanderheiden et al, 2014; Kelly et al, 2009) could be summarized as:

- Designing for accessibility by itself will not be a panacea for solving the wide range of problems in the area.
- Assistive technologies are expensive, difficult to be accessed by everyone who needs them, and fail to meet the needs of many. Solutions targeting disabilities that affect fewer people become even more expensive.
- Therefore, we need to work on making accessibility cheaper and be within the reach of everyone, everywhere.

The shortcomings associated with the guidelines-based approach seem to have swayed the interest of newer generation endeavors towards the adaptive and auto-personalization approaches, which seek to improve accessibility by matching resources with users' needs and preferences. Koutkias et al (2014) discussed such projects like Clould4All[1] and GPII[2] , which aimed at creating cloud-based infrastructure for ensuring cheaper and ubiquitous accessibility solutions, and identified one "major gap": lack of common terminologies and models enabling the semantic description of both needs and preferences of users and available ICT artifacts. In other words, they indicated the need for standard procedures for resource description as well as user profiling.

The focus of this paper is limited to resource descriptions, or metadata, to explore how they can facilitate accessibility of information resources. Metadata, particularly about the accessibility features, capabilities, and adaptability of resources has the potential to remove significant barriers to access (Cheetham et al, 2014). Therefore, this paper singles out a group of metadata called *accessibility metadata* and explores developments in the area. It asks questions such as, "what should constitute accessibility metadata?", "How can it be utilized to maximize accessibility in digital library environments?", "what is its practical contribution in facilitating access to information?", "What has been done so far and what needs to be considered for future improvements?" To answer the questions, the paper adopted the exploratory research approach, as the aim was to gain as much insight as possible into the area. It was based on review of related literature and documentations made available by metadata projects. Some documentations were obtained via email correspondence with people working on accessibility metadata project. The literature reviewed was collected through Google Scholar, EBSCO database and Web of Science using terms and combination of terms such as "universal design and metadata", "accessibility metadata", "inclusive design", and "metadata and digital libraries". Finally, the resources were analyzed to seek answers to the research questions. In the context of this paper, the term *accessible resource* refers to a resource annotated with accessibility metadata and designed to be accessible to a wide range of users with and without assistive technology.

The rest of the paper is organized as follows: section 2 provides an overview on the role of metadata in universal design and accessibility. Section 3 discusses functions and types of metadata with emphasized focus on accessibility metadata. Section 4 continues the discussion on accessibility metadata, setting the focus on terms that should be included as part of accessibility metadata. Section 5 deals with application of accessibility metadata in digital libraries and provides some examples. Section 6 presents few points that can be considered for further research and finally section 7 closes the paper with conclusion.

2. Metadata and Universal Design

Metadata is an integral component of the new generation approaches that promote accessibility by matching user needs and preferences with available accessibility solutions. Cheetham et al (2014) described metadata as essential component of projects such as GPII/Cloud4All and Floe (Flexible learning for open education)[3] and stressed its significance stating that without it, it would be very difficult for those projects to appropriately reach their goals[4]. As explained in the project documentation [5], GPII is believed to create a cloud-based platform where users can register their needs and preferences and accessibility developers create and upload tools that address those needs. In addition to user needs, the GPII is supposed to contain information about assistive technologies, devices, and uses (Koutkias et al, 2014). The intention is to invoke accessibility features in any device the user may use anywhere and adapt the interface automatically (e.g., screen would change to large print, high-contrast, etc. depending on the stored user profile information). Metadata is thus the fabric that holds together components of the newer generation accessibility solutions.

Another explanation for the importance of metadata in the realm of universal design is the role it can play in bridging accessibility and usability, an ideal outcome desired by experts in the field. Medina et al (2010) criticized works in the scientific community for being limited to accessibility and failing to extend to usability. They provided an example of an instance where a web page can fulfill the maximum AAA level of accessibility according to Web Content Accessibility Guidelines (WCAG 2.0), be usable for a sighted person, but be *only* accessible for a blind user. They argued that accessibility and usability go hand in hand, and so recommended changing the term "Web accessibility" to "usable Web accessibility" or "universal usability". Ding et al (2013) mentioned the 'gap' between the user experience of disabled people and technical accessibility guidelines and argued that "personalized usability" is a significant approach for enhancing accessibility. From a metadata perspective, the usability of a digital library or an equivalent web based system is the function of its metadata quality (Stvilia et al, 2004). Raman (1994) in Turró (2013, p. 26) even defined accessibility of digital documents as *"*the amount of structural information captured by the encoding, the degree to which this structural information is available for processing by other applications, and the availability of the appropriate software needed to process this structure". Turró (2013) also added that such information could be used by assistive technologies to summarize the content of a document, facilitate navigation and provide structural information about the content. Takagi et al (2008) described metadata authoring as an important step in transcoding for Web accessibility, a technique designed to make webpages accessible on the fly.

Metadata can also be instrumental for automated accessibility checking. For instance, the research by Brady et al (2015) has used PDF Accessibility Checker[6], a tool that utilizes metadata/tags for

evaluating accessibility. Looking at the results of tests done with tools such as WAVE (Southwell and Slater, 2013), one can see error reports such as "Missing alternative text", "Missing or uninformative page title", "Image map area missing alternative text" which are clearly related to resource description issues.

On the other hand, metadata can be an indirect reminder to digital resources producers on the features they need to incorporate while designing their products. If there is a scenario where libraries, eLearning centers and digital publishers use a standardized accessibility metadata schema, that would serve as a reminder of the features publishers have to include for making their products accessible at libraries or eLearning facilities. One important development that can be related to this is the formation of the Digital Learning Metadata Alliance (DLMS) in October 2014 by IMS Global Learning Consortium, Dublin Core Metadata Initiative and International Digital Publishing Forum (IMS Global, 2014). The goal of the collaboration was stated as ensuring "the adequacy and consistency of metadata across a wide variety of consuming applications such as library systems, learning platforms and internet search engines". This could be considered as a step towards realizing an across-the-board solution to accessibility of digital resources.

To sum up, metadata is important but quality and richness matter. In relation to universal accessibility, it has the potential for simplifying discovery of accessible resources and thus saving time of users; add efficiency to assistive technologies in processing information resources, assist in automated accessibility checking, bridge accessibility and usability , and thus weave the foundation where users' needs and preferences can be mapped to available accessible solutions. The next sections narrow the discussion to accessibility metadata and ask what it should consist of.

3. What is Accessibility Metadata?

Metadata is commonly defined as "data about data"; important for resource description, representation, and discovery (Caplan, 2003; Good, 2002). The term is said to have originated from the field of computer science (Caplan, 2003), and used as "the modern term for bibliographic information libraries have traditionally kept in their catalogs" to guarantee discovery, use, management and preservation of digital resources(Peñalvo et al, 2010, p. 16). Literature shows different interpretations of metadata depending on the context and community where it is used. Caplan (2003) mentioned inconsistency in its usage even in the library community where some use it to refer to the description of digital as well as non-digital resources while others restrict it to the digital ones. There also seems no single agreed-upon classification of metadata by types or functions (Greenberg , 2009). For instance, according to the National Information Standards Organization (NISO), there are three main types of metadata namely descriptive metadata, administrative metadata, and structural metadata. Administrative metadata is further subdivided as rights management and preservation metadata (NISO, 2004). Greenberg (2009)presented them as descriptive metadata, preservation metadata, provenance metadata, contextual metadata, technical metadata, and rights management metadata. Corrado and Moulaison (2014) said that there are four main types of metadata used in standard digital libraries such as descriptive metadata, administrative metadata, technical metadata and structural metadata. Table 1 presents summary of metadata types and their functions as discussed in the papers mentioned above.

Table 1 *Types of Metadata*

Type of metadata	**Function/purpose**
Descriptive Metadata	Resource discovery, identification and access. E.g. *Author, title, abstract, keywords*
Structural metadata	Describe how objects are put together, how pages are organized to form chapters
Technical metadata	Describe file format and size of digital objects. E.g. Font information for text files; *resolution, camera model, shutter speed,* etc. for digital photographs
Provenance metadata	Management of record lifecycle, attribution, version history, etc. e.g. *Creator, Date created, date modified*,
Rights management metadata	Information related to intellectual property rights. Eg. Access, reproduction, use/reuse, etc.
Preservation metadata	Deals with information necessary to preserve and archive resources.
Contextual Metadata	Information on arrangement of resources in relation to other resources. context includes provenance information to indicate the source of the data, descriptive metadata to define attributes for data and structural metadata to define data formats

As can be noted from the above discussion, accessibility metadata is not yet treated as a separate category. It is , however, considered as a type of technical metadata and defined as "the degree to which the institution allows access to people with disabilities" (Corrado and Moulaison, 2014, p. 115). Nevile (2011) also said that it describes resources by their accessibility attributes, helping people with disabilities discover resources that accommodate their accessibility needs. Here, accessibility metadata plays the role of descriptive metadata, helping in resource discovery and access. Thus, it defies metadata categorizations serving as descriptive, technical, or administrative metadata. Advances in universal design have raised the profile of accessibility metadata, which would also invite exploration of its potential for ensuring universal access of information in digital libraries.

4. What Should Constitute Accessibility Metadata?

Kawanaka et al (2008) acknowledged the existence of metadata created by different research projects and individuals, but isolated in separate tools due to the disconnection between the projects. They recommended the establishment of the *Accessibility Commons*, a common infrastructure to integrate, store and share metadata to improve web accessibility including assistive technologies such as screen readers and others. Takagi et al (2008) also discussed the idea of *Social Accessibility*, which is a more user-centered collaborative metadata authoring. As explained by them, the traditional responsibility of making websites accessible rests on the shoulders of the site owners. However, there may be instances where users find inaccessible contents and ask the site owners for help. Therefore, they proposed allowing volunteers anywhere to improve the content by providing "external metadata" (Takagi et al, 2008). Though such user-inclusive approach might sound appealing for generating the much-sought accessibility attributes in large amount, other works on metadata have recognized the need for a standard or model for ensuring reusable and interoperable metadata sets (Zheng et al, 2008). There have been works in this regard by the Benetech[7]-led Accessibility Metadata Project[8], which registered an important milestone in 2014 when their recommendation was accepted by schema.org -- an initiative founded by Google, Bing, Yahoo! and Yandex to enhance discoverability of content on the Internet (Cheetham et al, 2014).

As shown at W3C's Web Schema's page[9], there are four accessibility properties such as *accessibilityFeature*, *accessibilityHazard*, *accessibilityAPI*, and *accessibilityControl*, which are incorporated as part of schema.org. For each property, there is a list of "expected values" or "supported values" which are driven from IMS Global Access for All (A*f*A) Information Model Data Element Specification. The property *accessibilityFeature* describes features a resource may possess to enhance its accessibility to users .It is supposed to include values such as *alternativeText, annotations, audioDescription, bookmarks, braille, captions, largePrint, taggedPDF, tactileGraphic, tactileObject,* etc. The property *AccessibilityHazard* describes characteristics of a resource which might be physiologically dangerous for some groups of users. List of values it supports include *flashing, noFlashingHazard, motionSimulation, noMotionSimulationHazard, sound,* and *noSoundHazard.* The property *AccessibilityAPI* describes resources' compatibility with accessibility APIs and the values it is supposed to support include *androidAccessibility, iOS accessibility, JavaAccessibility,* etc. The *accessibilityControl* property describes the input methods available for accessing the resource and the values it supports are specified as *fullKeyboardControl, fullMouseControl, fullSwitchControl, fullTouchControl, fullVideoControl, and fullVoiceControl*.

As noticed by Batanero et al (2014), there seems to be a relationship between WCAG 2.0 guidelines and those accessibility terms discussed above. It appears that those terms could be keywords for the intentions of some or most of the WCAG 2.0 principles. For instance, WCAG 2.0 Guideline 1.1 states that alternative text should be provided for any non-text content and goes on specifying non-text elements such as input controls, time-based media, sensory, etc. On the other hand, the accessibility metadata property *accessibilityFeature* includes *alternativeText* among list of "expected values" such as *annotations, tactileObject, captions, timingControl*, etc. Table 2 tries to illustrate the relationship.

Table 2. WCAG 2.0 Guidelines and Accessibility Metadata Terms

WAI/WCAG (summarized)	Accessibility Property (Schema.org) version 1.0	Accessibility Metadata Values(Examples)
Principle 1 : perceivable		
Guideline 1.1: Textual Alternatives	accessibilityFeature	alternativeText,
Guideline 1.2: Time-based media	accessibilityFeature	Captions, audioDescription highContrastAudio
Guideline 1.3: content adaptability	accessibilityFeature	
Guideline 1. 4: color perception, audio control, contrast, visual presentation, images of text	accessibilityFeature	audioDescription highContrastAudio highContrastDisplay tactileGraphic, tactileObject
Principle 2: Operable		
Guideline 2.1: Information Control with a keyboard	accessibilityControl	fullKeyboardControl
Guideline 2.2: timing adjustable, pause, stop, hide	accessibilityFeature	timingControl
Guideline 2.3: identify elements that cause seizure	accessibilityHazard	Flashing, noFlashingHazard motionSimulation noMotionSimulationHazard sound, noSoundHazard
Guideline 2.4: Navigation	accessibilityFeature	readingOrder structuralNavigation
Principle 3: Understandable		
Guideline 3.1: readability of the content	accessibilityFeature	readingOrder, signLanguage, Braille
Guideline 3.2: predictability of functioning	accessibilityFeature	displayTransformability readingOrder
Guideline 3.3: user support and error prevention		
Principle 4: Robust		
Guideline 4.1: maximize compatibility with current and future user agents, including assistive technologies	accessibilityAPI	AndroidAccessibility ARIA ATK AT-SPI BlackberryAccessibility iAccessible2 iOSAccessibility JavaAccessibility MacOSXAccessibility MSAA UIAutomation

Though not dealt with the level of granularity shown at schema.org, accessibility metadata is not a new concept to libraries. Information related to intellectual property, access restrictions, and some types of technical attributes relate to accessibility metadata (see Section 3). Library metadata

schemas do carry elements that help to describe accessibility qualities. For instance, Morozumi, Nevile and Sugimoto (2007) noted that Dublin Core (DC)'s *audience* and MARC 21's *reading level* could be used to describe resources suitable for users with dyslexia or other forms of impairment. DC's *Format* could be used to indicate whether a resource is in braille, audio, video or text formats, which could be important information for some people who have difficulties in reading printed text. However, it must be noted that describing a resource in that manner might not yield enough information. For example, as shown by Nganji and Brayshaw (2015) , resources would need to be described as *text*, *audio*, *audio with captions*, *video*, *video with captions*, *braille* etc. to design a system that matches resources to people with dyslexia, visual impairment, and hearing impairment. This requires efforts to exploit developments like those in schema.org.

4.1. Application Profiles

There is no metadata schema that can be considered "complete" or perfect, and there is nothing like "one size fits all" in metadata as the metadata needs of applications and communities are so diverse (Coyle and Baker, 2016). As the result, Information professionals can use mix of available metadata schema to annotate their collections based on the needs of their communities or the nature of their collections (Corrado and Moulaison, 2014). Therefore, there could be a potential for accessibility metadata elements in schema.org to be used in conjunction with other library metadata schemas in a way that enhances findability of accessible resources. It is also recommended that institutions maintain *application profile* : a document showing the metadata schemas they use, set of metadata elements, policies, guidelines, and the reasons behind their choices of the schemas (Corrado and Moulaison, 2014). The most commonly used metadata schemas in digital libraries such as the DC (Coyle, 2005) provide frameworks for building application profiles which may be consulted when the need arises. According to Coyle and Baker(2016) , the Dublin Core Application Profile (DCAP) describes what a community seeks to accomplish with its application (Functional Requirements), describes the types of things annotated by the metadata and their relationships (Domain Model), lists metadata terms to be used and rule for their use (Description Set Profile and Usage Guidelines), and defines the machine syntax that will be used to encode the data (Syntax Guidelines and Data Formats). Digital libraries using Dublin Core can use the DCAP as a template to define the needs of their communities, their metadata needs, and other issues as specified in the framework. The work on schema.org is not yet stabilized [9]. However, libraries may need to explore ways of harnessing it as they build their application profiles.

In conclusion, accessibility metadata can be used to describe resources by their accessibility features and expose them to their potential users. Recent developments in relation to universal design have contributed input that can be considered for use among other library metadata. The following section presents examples for application of accessibility metadata in digital libraries and discusses issues that need to be addressed in the future.

5. Application of Accessibility Metadata in Digital Libraries

The accessibility metadata properties incorporated into schema.org are said to have been picked up by the Internet Archive's Open Library initiative [10], Hathi Trust Digital Library[11], and the Learning Registry[12](Rothberg, 2014). It has also been revealed that Bookshare[13], an online library of accessible eBooks for people with print disabilities, has added accessibility metadata to its full collection of over 150,000 titles (Myers, 2013b). The motive for incorporating the metadata

recommendations, for Hathi Trust Digital Library for instance, was to "to improve the way search engines index our content in order to make it possible for users to find accessible content" (Zaytsev.2015, personal communication, November 17). The metadata for an item in their collection can be viewed through their page-viewing application. For example, the markup code on the page viewing application shows the following accessibility metadata for an item entitled *Universal Design Book:*

```
<div itemscope="" itemtype="http://schema.org/Book" style="display:none">
  <meta itemprop="accessibilityFeature" content="alternativeText" />
  <meta itemprop="accessibilityFeature" content="bookmarks" />
  <meta itemprop="accessibilityFeature" content="index" />
  <meta itemprop="accessibilityFeature" content="longDescription" />
  <meta itemprop="accessibilityFeature" content="readingOrder" />
  <meta itemprop="accessibilityAPI" content="ARIA" />
  <meta itemprop="accessibilityControl" content="fullKeyboardControl" />
  <meta itemprop="accessibilityControl" content="fullMouseControl" />
  <span itemprop="name">Universal design book, containing official price lists.,  </span>
  <span itemprop="author"></span>
  <span itemprop="url">http://hdl.handle.net/2027/uiug.30112024501352</span>
</div>
```

Figure 1. Example of accessibility metadata annotation for a book

The other example is the Teacher's Domain media library (PBS Learning Media) -- a library with over a 100,000 games, videos, and interactive resources "that span all subject areas"[14]. As shown in a video presentation (Myers, 2013a), the search tool of the media library has added a functionality for faceted search by accessibility features. It also lets users specify their accessibility preferences. A user can log in to the system, set his access preferences, and perform search. Then resources annotated with accessibility metadata will be listed with more information as per the specifications made by the user. The user may see labels such as "accessible" and "inaccessible" along the titles in the search result. This way, he/she can learn which resources are accessible and which are not, right from the result list.

Such examples of consolidation of the metadata properties into practical solutions invite closer examination to see how well they support universal design goals and what should be considered for the next round of improvements. Some observations, questions, and recommendations are presented next.

5.1. Augmenting Resource Discovery Tools

Search interfaces are the first things users expect to see while trying to access electronic information services. They are gateways for users to get what they want. They are the prime tools libraries and other information-oriented systems use to make their resources findable and accessible to their patrons. Breeding (2015) discussed a variety of commercial and open source resource discovery tools (RDTs) and the features they include. As he explained, modern resource discovery interfaces would provide relevancy-based search, faceted navigation, social and community-oriented features, cloud of search terms, etc. to navigate through resources managed and accessed by library systems. The ideal scenario from accessibility point of view could be that a user searches for a resource, the search tool provides information on the accessibility status of the resource, filter

out only resources accessible to that particular user, or rank results based on their accessibility status (WCAG 2.0 requires metadata to locate both accessible and inaccessible resources[15]). The current discovery tools do offer the possibility for filtering search results by media type such as braille, audio, video, etc. However, this can be taken a step further for filtering audio with alternative text, video with captions, text-to-speech enabled eBooks, etc. That could help people with disability to quickly discover and access resources suitable for their needs.

The examples discussed in the preceding section show how accessibility metadata elements could be employed to improve the search ecosystem. First, they help to provide faceted navigation and give users the freedom of limiting search results to the materials accessible to them. Second, they help to expose those resources to search engines. The overall understanding that can be taken from the overall discussion is that accessibility of RDTs depends not only on the design of their interfaces, but also on the metadata of resources, they discover. Augmenting RDTs for accessibility would entail extending the already existing library metadata to include accessibility attributes.

Augmenting discovery tools would also mean expanding their ability to incorporate tools or widgets developed anywhere. For instance, a tool for searching videos with closed captions and another tool for crowdsourcing description of YouTube videos have been discussed in the final report of the Benetech led Accessibility Metadata project (Rothberg, 2014). It is also mentioned that Cloud4All is developing metadata generating tools that can be incorporated to any authoring environment [see footnote 4]. Would there be a way for these and other related tools to be integrated in library search systems? This too could be a practical contribution to ensure universal access in information services.

5.2. More Work on Accessibility Metadata Vocabularies

Examination of accessibility metadata terms used in schema.org and library metadata schemas such as DC shows the need for more work on the vocabularies. For instance in schema.org, the term *unlocked* is presented to indicate that there is no Digital Rights Management (DRM) restriction applied to a resource. DRM tools could prevent assistive devices from proper rendering of content (Ellis and Kent, 2011). However, there are different accessibility issues related them. For instance, one can download DRM protected eBook on his/her computer but may not be able to read it on Kindle or Pocket PCs[16]. Reading DRM protected eBooks on different devices and platforms might require installation of third-party applications[17]. Therefore, the term could be made clearer. For example, terms like *text-to-speech enabled*, *text to speech disabled* could be more informative for users of screen reader technologies. It was discussed earlier that DC's *audience* could be used as accessibility descriptor to describe the intended users of a resource. However, a resource might be suitable for more than one user group. Moreover, the group it was intended for may actually have different preferences. The argument here could be whether we need to set up a mechanism for users to choose whatever they want instead of us prescribing resources to them. These simple examples could show the need for further work for specifying or tweaking accessibility metadata terms.

5.3. Who Should Do the Resource Description?

One of the challenges in annotating resources for accessibility could relate to the manpower that should do the job. Cheetham et al (2014) discussed the potential of automatic metadata generation

tools and their limitations in describing some properties, such as in telling whether a video contains flashing lights that might cause seizures for some viewers. The researchers highlighted the need for cooperation from content creators in providing information to facilitate proper annotation of their works. The other question to ask in the face of massive digitization projects being undertaken by libraries is whether such annotations could be done by librarians or digital content system managers. It would require training librarians or hiring accessibility experts in libraries.

6. Further Challenges

The work on accessibility metadata seems not yet stabilized, as there is an admission that the work is still going on. As discussed in section 5, those new additions to schema.org are being utilized by some information systems but it seems too early to measure their impact at this moment. They would need to be countered by studies from the end user's side to see problems users are facing, for instance, in using resource discovery tools, and to what extent the results reflect the need for those metadata properties; whether there is a need for adding more of their kind, or in what manner they could be employed to enhance user experience. On the other hand, it is important to note that it is not only human users but also programs like Application User Interface (API) that benefit from rich and quality metadata. This would require bringing user-generated metadata into the mix. As cloud-based accessibility solutions get traction, the significance of metadata would also increase in order to exploit emerging accessibility services in the cloud[18]. These would initiate issues such as reusability, interoperability and resource sharing which in turn encourage exploitation of technologies such as the semantic web and linked data.

7. Conclusion

The goal of realizing inclusive libraries will not be achieved merely by designing their websites or search interfaces according to WCAG 2.0 or other guidelines. It also requires making their resources discoverable and accessible to the wider mass. That in turn requires resources to be properly annotated so that they can be exposed to search engines or resource discovery tools.

This paper discussed developments related to accessibility metadata to explore how it can be employed to improve accessibility in digital library environments. It started by asking what accessibility metadata is, what it should consist of, what contributions it can make to maximize accessibility in digital library environments, what has been done so far in developing accessibility metadata, and what needs to be considered for future improvements. The paper attempted to review developments in the area to get the answers and forward few recommendations.

Accessibility metadata can be used to annotate resources by their accessibility features and match the resources with their users. Accessibility metadata is not a new concept to libraries. However, the reinvigorated attention it got in projects related to universal design invites exploration of its applicability for enhancing usability and accessibility in digital library environments. Though the work on schema.org's accessibility metadata terms is ongoing, there is a potential for libraries to explore ways of including them in their application profiles to enhance their users' experience. Discussion of digital libraries which picked up those recommendations has revealed the potential accessibility metadata can have: exposing accessible resources to search engines and augmenting resource discovery tools for faceted search. The overall discussion shows that accessibility

metadata can be instrumental in ensuring universal accessibility but much work remains to be done. Development and refinement of accessibility terms, ways for using them together with other metadata schemas, and other related issues could form part of further work. Moreover, such works would need to be supported by user studies to see the extent of the need for accessibility metadata.

Notes

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