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The prevalence of web browser extensions use in library services: an exploratory study

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Abstract

Purpose – The paper aims to present an outline how libraries are harnessing browser extensions to provide an easy and convenient access to library resources and services. Investigating the features, purposes of use and types of browser extensions prevalent among libraries in different regions, the paper seeks to measure the degree of implementation of browser extensions.

Design/methodology/approach – Stratified sampling method was followed to select academic libraries, and convenient sampling method was applied to select public libraries from four continents – Asia, Oceania, Europe and North America. Two-step web content analysis was applied to gather data along the select dimensions.

Findings – The study contributes to the recent advances in application of browser extension with numerous examples focussing on the relevance of different approaches adopted by the libraries. Providing a framework of proportionate implementation along checkpoints, the study also highlights degree of acceptance of browser extension among libraries in different regions.

Research limitations/implications – The investigation was restricted to libraries having English websites and confined to four continents only. This study aims at improving understanding among the librarians about the intended use and application of browser extension and helping them benchmark their effort in support of education, research and training. The current investigation expands the scope of future research on remaining regions and website whose contents are in non-English language to attain a broader perspective of its implementation.

Originality/value – The article may guide library professionals to use, develop and promote the implementation of browser extension in libraries. The checkpoints used here may serve as bedrock for framing questionnaire and interview schedule for conducting future research examining users' perception of browser extension in the context of library resources and usage pattern, to fully comprehend its practicability and usefulness.

Keywords Libraries, Web accessibility, Knowledge management, Web 2.0, Information science, Websites

Paper type Research paper

1. Introduction

The rapid development and expansion of web-based technologies has led to librarians developing innovative strategies to attract users through value-added services. The application of web browser extensions is an example of an innovative approach adopted by libraries to provide quicker access to resources. Web browser extensions are code snippets: "small applications that add new functionality to the core browser" (Bailey and Back, 2006, p. 291) which provide the user an improved browsing experience. Through introducing extensions, plug-ins and add-ons, one can expand the potentiality of the

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browser to a desired level and can perform a multiplicity of tasks in an online environment.

Many libraries have already incorporated a variety of web browser extensions into their websites; however, there is little research on the application of web browser extensions in library services. While a few recent publications point to web browser extensions in libraries, they either concentrate on a specific type of browser extension or limit the research to a local library context. There has been no study carried out to comprehensively describe how libraries across the continents are harnessing this specific class of software.

2. Literature review

2.1 General studies

Of the various web-based applications studied (Kroski, 2008; Harinarayana and Raju, 2010; Si *et al.*, 2011; Garoufallou and Charitopoulou, 2012; Mahmood and Richardson, 2013), web browser extensions are among the least examined areas. Research on the applications of web browser extensions in libraries carried out so far mostly concentrated on library toolbars (Jones, 2008; Wilson, 2009; Si *et al.*, 2012), plug-ins and add-ons, and to basically guide librarians in the implementation of specific types of applications (Brown, 2007; Huynh *et al.*, 2007; Wolf, 2008; Walker-Headon, 2010).

2.1.1 Library toolbar. Library toolbars are designed on the premise that the user will experience "pragmatic access" to resources, in sharp contrast to the conventional library approach to providing services. Looking at the effectiveness of library toolbars, Webster (2007) observed that the most valuable aspect of toolbars was to allow users to connect to a specific library tool/application without opening a new browser window and typing in a specific URL, thereby adding power and convenience to users' web explorations. Brown (2007) discussed at length the general construction of a toolbar and the various functionalities it offered, including content integration and providing real-time reference services with a chat box embedded in the library toolbar.

Si *et al.* (2011), in a study of Web 2.0 applications in 30 top Chinese university libraries, observed that a library toolbar was considered a popular application area under Web 2.0. Going beyond the general toolbar application, Wilson (2009) proposed a model for a subject-specific toolbar application that has the distinctive advantage of being designed for a specific group of researchers. He opined that, unlike a general toolbar, subject-specific toolbars limit the audience and thereby reduce the needed databases, resources and links, which in turn decreases the complexity of the tool. The main focus was on user-centred design approaches for a specific class of web applications.

2.1.2 Web browser plug-ins and add-ons. Many libraries have already implemented various plug-ins and add-ons that have received attention in recent research (Brown, 2007; Puckett, 2010). These studies identified the potential usage of scripting add-ons in a library setting that let users add scripts to any webpage and interact with the content. These scripts place a link to citations or commercial book sites that a user interacts with and are used to do lookups to library link resolvers to inform users if a book is available in the library (Webster, 2007).

Liu *et al.* (2009) opined that libraries should pay attention to the perspective of users when designing and delivering services. Hence, the need for librarians to formulate strategies to intuitively introduce users to library resources through interactive and

attractive plug-ins. Nicholas (2007) discussed the benefit of using OpenSearch plug-ins to bring online library resources right into the users' workflow. Fernandez (2011) described the unique features and advantage of Zotero, a Firefox plug-in, and a powerful citation management tool. Zotero provides an attractive alternative to proprietary citation tools, as it is "free, user-friendly, and Web 2.0-compatible" (Duong, 2010, p. 315), and also supports online catalogues and databases, as well as integrates functionality with many popular websites, which benefits researchers when generating citations for research articles (Trinoskey *et al.*, 2009; Fernandez, 2011). The above studies identified the advantage of using these small applications and advocated for the use of plug-ins and add-ons as new approaches to attract potential users.

2.1.3 Other forms of browser extensions. There are a few additional scattered areas of investigation relevant to the topic of browser extensions (West, 2008; Tsai *et al.*, 2009; Markey *et al.*, 2012; Zhang, 2012). Suhr (2009) documented the browser-specific modification of codes for bookmarklets, which is used to supplement browsers with helpful features. The bookmarklet acts as a resource discovery tool, letting users instantly check in-library availability of a book encountered online. Wilde (2008) opined that browser extensions support added functionality and allow greater flexibility in designing interfaces. While discussing the initiatives of libraries to embed access to library resources into users' browsers, Chang and Keil (2006) noted that a browser extension acts as a constant reminder to the users regarding library resources, if prominently displayed in the browser. Support for such views is implicitly expressed in the observations of Bainbridge *et al.* (2012), relating to the use of Java script-based browser extensions in reorganizing web content and in integrating remote data sources.

2.2 Case studies

Despite its emerging potential, the application of browser extensions in libraries has received scant attention with regard to its wide array of implementation practices. Indeed, more generally, specific types of applications and related functional approaches are the main focus of library research.

Trainor (2010) discussed the use of OpenURL Referer, a browser extension that converts bibliographic citations on the web into direct links to a local library's full-text databases using OpenURL link resolver. Yi and Herlihy (2007) conducted an investigation to assess the impact of deploying an OpenURL link resolver on the use of scholarly e-resources by the students and faculty at California State University San Marcos. The study showed a sizeable increase in the use of electronic resources after the implementation of the link resolver. According to the results, the resolver technology enabled users to locate the full-text of an individual citation in one mouse click and thereby removed potential obstacles at the time of searching. Not only are those observations indicative of the inherent benefits of these applications but, indeed, of explicit advice for libraries to embrace technological innovations.

In their quest to discover a suitable alternative to web search engines that will guide users to resources which are carefully chosen, complete and authoritative, Bailey and Back (2006) developed Libx, a Firefox extension, and deployed it at the Newman Library at Virginia Tech. They outlined the multiple components of LibX, each intended to serve a specific set of functions. Functions included a toolbar component which allowed users to perform Online Public Access Catalogue (OPAC) searches directly from the browser toolbar; a context menu component which provided users the ability to conduct searches

from any text on a webpage; access to the library's OpenURL link resolver such as Special Effects (SFX) or Article Linker to easily find a copy of a resource being cited on any webpage; and an embedded cue component which places cues in webpages, alerting the user to library resources relating to the content of the page. The authors suggested that LibX will attract library non-users, who have become too reliant on the arbitrary Internet resources, back to the library environment, with a faster, easier and more convenient way of searching. Their views on the usefulness of Libx to extend traditional library service provision are echoed by others, including Goldbeck (2009) and Puckett (2010). Moreover, Goldbeck (2009) introduced several promotional tools and online learning options to inform and guide users on the use of Libx. Marcum *et al.* (2011, p. 101) observed that:

> […] additionally, by using the library's icon – or a component of the library's brand identity – LibX helps further the library's PR efforts by reminding users of who supplies access to those resources.

3. Research questions

The objective of the study is to investigate the prevalence and use of web browser extensions in library services. To implement the above research objective, the study seeks to address the following research questions:

RQ1. What are good practices to follow while introducing browser extensions?

RQ2. How does the use of browser extensions vary by region or type of library?

3.1 Research procedure

The present investigation used content analysis (Neuendorf, 2002; Krippendroff, 2004) of library websites as the research method.

3.1.1 Sampling method. In the absence of any single online directory having comprehensive coverage of library websites, a multifaceted approach for the sampling method was followed:

- *Stratified sampling method (non-proportionate)* was applied to draw academic libraries (ALs) (Table I) from the ranked lists of higher education institutes (Table II). The study purposely over-sampled Asian and Oceanian subgroups, as American and European universities predominate the ranked list, and to avoid under-representation of smaller strata.
- *Convenience sampling method* was followed public libraries (PLs) (Table III) were sampled in equal proportion to that of ALs from the online directories (Table IV).

3.1.2 Data collection method.

- Accessed selected websites and looked at the following hyperlinks: research tools, library tools, web services, tools and tips, apps and software, etc.
- When information was not found through those links, library site searches were conducted using the following terms: toolbar, toolbox, plug-in, add-on, bookmarklet and lookup. The terms widgets, gadgets, extension, browser and tool were also added to the above search terms as needed to make the searches meaningful.

Serial no.	North America	Europe
1	Arizona State University Library	Aarhus University Library
2	Baylor University Library	Durham University Library
3	Boston College Library	Ecole Polytechnique Federale De Lausanne Bibliotheque
4	Case Western Reserve University Library	ETH Zürich–Swiss Federal Institute of Technology Zürich Library
5	Colorado State University libraries	Karolinska Institutet, Universitets biblioteket
6	Columbia University Library	King's College London Library
7	Cornell University Library	KU Leuven Library
8	Drexel University Libraries	Leiden University Library
9	Eastern Kentucky University Libraries	Ludwig-Maximilians-Universitüt München Library
10	Fondren Library of Rice University	Lund University Library
11	Indiana University	National University of Ireland (Galway) Library
12	Massachusetts Institute of Technology Library	Royal Holloway University of London Library
13	McMaster University Library	Stockholm University Library
14	Montana State University Libraries	Trinity College Dublin Library
15	New York University Library	Universite Paris Diderot - Paris 7 Library
16	Princeton University Library	Universiteit van Amsterdam Bibliotheek
17	Rutgers, The State University of New Jersey Library	University College London Library
18	San Diego State University Library	University of Antwerp Library
19	Sheridan Library of Johns Hopkins University	University of Bedfordshire Library
20	Temple University Library	University of Birmingham Library
21	University of Alberta Library	University of Bristol Library
22	University of British Columbia Library	University of Cambridge Library
23	University of California, Irvine Library	University of Edinburgh Library
24	University of Chicago Library	University of Helsinki Library
25	University of Cincinnati Library	University of Leicester Library
26	University of Florida Library	University of Liverpool Library
27	University of Guelph Library	University of Minho Library
28	University of Illinois at Urbana-Campaign Library	University of Nottingham Library
29	University of Maryland, College Park Library	University of Oxford Library
30	University of Minnesota Library	University of Sheffield Library
31	University of Notre Dame Library	University of Strathclyde Library
32	University of Ottawa Library	University of Surrey Library
33	University of Prince Edward Island's Robertson Library	University of Sussex Library
34	University of Texas at Austin Library	University of Tartu Library
35	University of Victoria Library	University of Twente library
36	University of Waterloo Library	University of Vienna Library

Table I.
List of academic libraries studied

(*continued*)

Serial no.	North America	Europe
37	University of Wisconsin-Madison-Health Sciences Library	University of Vigo Library
38	Vanderbilt University Library	University of Warsaw Library
39	Virginia Polytechnic Institute and State University Library	Univsitatsbibliothek Heidelberg
40	Western University Library	Uppsala Universitetsbibliotek

Serial no.	Oceania	Asia
1	Adelaide University Library	Beijing Normal University Library
2	Bond University Library	Bilkent University Library
3	Charles Darwin University Library	Chinese University of Hong Kong Library
4	Curtin University Library	City University of Hong Kong Library
5	Deakin University Library	Fudan University Library
6	Fiji National University Library	Hokkaido University Library
7	Flinders University Library	Hong Kong University of Science and Technology Library
8	Griffith University Library	Hongkong Polytechnique University Library
9	La Trobe University Library	Indian Institute of Technology, Kharagpur Library
10	Macquarie University Library	Istanbul Technical University Library
11	Massey University Library	King Saud University Library
12	Monash University Library	Korea Advanced Institute of Science and Technology Library
13	Murdoch University Library	Middle East Technical University Library
14	Queensland University of Technology Library	Nanyang Technological University
15	The University of Newcastle Library	National Cheng Kung University Library
16	University of Canterbury Library	National Taiwan University Library
17	University of New South Wales Library	National Taiwan University of Science and Technology Library
18	University of Otago Library	National Tsing Hua University Library
19	University of South Australia Library	National University of Singapore Library
20	University of Sydney Library	Peking University Library
21	University of Tasmania library	Shanghai Jiao Tong University Library
22	University of Waikato Library	Tel Aviv University Library
23	University of Western Australia Library	Tokyo Institute of Technology Library
24	University of Wollongong Library	Universiti Sains Malaysia Library
25	Victoria University of Wellington Library	University of Science and Technology of China Library

Table I.

- If no results were retrieved, a library website-specific search was performed in Google following the same strategies as above.
- Once an application was identified, a second step was followed to determine the nature and intent of the implementation of the application (Figure 1 and Table V).

Two research scholars of library science, who have knowledge of web-based applications, were selected and trained for data collection using the model in Figure 2.

3.2 Analysis of data

The degree of implementation of browser extensions in library websites was measured using "application index" introduced by Linh (2008, p. 640):

$$\text{Application index (AI)} = \frac{\text{Total of "yes" answers in a library}}{\text{Total of checkpoints}} \times 100$$

The application index (AI) measures the degree of adoption of browser extensions in a specific library. A library with a high score of AI corresponding to the increased number of checkpoints having "yes" answers indicates high implementation and adoption of browser extensions.

4. Findings

4.1 Good practices for implementation of browser extensions

Data were collected with three checklists denoting characteristic features, purposes of use and types of browser extension, as shown in Table V, and the findings are summarized below.

4.1.1 Characteristic features of browser extensions. Many libraries (57 per cent, 83 of 145) provide links to browser extensions from the library's home page directly (Wellington City Libraries) or through drilled-down pages (University of Waterloo Library) or via blogs (Seattle Public Library) or wikis (University College London Library). Moreover, access points to browser extensions are presented under different assumed appearances across libraries. For example, browser extensions offered by the Western University Libraries are linked to "research plugins", while the one from the Evanston Public Library is accessible through the "EPL Catalog Book Lookup". However, browser extensions not directly linked on the home page or labelled under

Table II.
List of online directories used to draw academic libraries

Serial no.	Online higher education directory	URL
1	The *Times Higher Education World University Rankings*	www.timeshighereducation.co.uk/world-university-rankings/2012-13/world-ranking
2	Academic Ranking of World Universities	www.shanghairanking.com/ARWU2012.html
3	Ranking Web of Universities	www.webometrics.info/en/world
4	International Colleges & Universities	www.4icu.org
5	Quacquarelli Symonds (QS) Top University Rankings	www.topuniversities.com/university-rankings

Serial no.	North America	Europe
1	Alliance Public Library	Bavarian State Library
2	Bangor Public Library	Biblioteca Nacional de Portugal
3	Bartlesville Public Library	Bibliotheque Nationale de France
4	Belen Public Library	Buckinghamshire County Council Library
5	Biblioteca Nacional de Mexico	Cambridgeshire County Council Library
6	Bibliothèque et Archives Canada	Derbyshire County Council Library
7	Bibliothèque et Archives Nationales du Quebec	Dublin City Public Library and Archives
8	Cheney Public Library	Durham County Council Library
9	Chicago Public Library	Edinburgh City Council Library
10	Cranford Public Library	Essex County Council Library
11	Cuyahoga County Public Library	Galway Public Library
12	Evanston Public Library	German National Library
13	Evansville Vanderburgh Public Library	Hampshire County Council Library
14	Harris County Public Library	Hertfordshire County Council Library
15	Hawaii State Public Library System	Kent County Council Library
16	Hennepin County Library	Lancashire County Council Library
17	Hockessin Public Library	Limerick City Council Library
18	Howard County Library	Lincolnshire County Council Library
19	Knox County Public Library	National Central Library of Rome
20	Lansing Public Library	National Library of Belarus
21	Library of Congress	National Library of Estonia
22	Merrimack Public Library	National Library of Poland
23	Milton Public Library	National Library of Scotland
24	Montgomery County Public Libraries	National Library of Sweden
25	Nashville Public Library	Norfolk County Council Library
26	National Library of Jamaica	Northamptonshire County Council Library
27	National Library of Nicaragua Ruben Dario	Oxfordshire County Council library
28	New York Public Library	Cumbria County Council Library
29	Pawtucket Public Library	Portsmouth City Council Libraries
30	Public Library Of Charlotte Mecklenburg County	Somerset County Council library
31	Regina Public library	Staffordshire County Council Library
32	San Jose Public Library	Surrey County Council Library
33	Seattle Public Library	Swiss National Library
34	Skokie Public Library	The British Library
35	Somerset County Library System	The National Library of Russia
36	Startford Public Library	The National Library of Wales
37	Vancouver Public Library	Vienna City Library
38	West Hartford Public Library	Warwickshire County Council Library
39	Westlake Porter Public Library	West Sussex County Council Library
40	Wyoming State Library	Wiltshire Council Library

(*continued*)

Table III.
List of public libraries examined

Serial no.	Oceania	Asia
1	Adelaide City Council Library	Chai Wan Public Library, Hong Kong
2	Alice Springs Public Library	Dewan Bahasa dan Pustaka Library, Brunei
3	Auckland City Libraries	Hong Kong Central library
4	Campbelltown City Council Library	King Fahad National Library
5	Canterbury City Library	National Central Library, Taiwan
6	Christchurch City Library	National Diet Library
7	Darwin Public Library	National Library & Archives of IR of Iran
8	Dunedin Public Library	National library and Documentation Services Board, Sri Lanka
9	Hamilton City Library	National Library Board Singapore
10	Katherine Public Library	National Library of Bangladesh
11	Latrobe City Library	National Library of China
12	Marion City Library	National Library of India
13	Monash Public Library	National Library of Indonesia
14	Napier Public Library	National Library of Korea
15	National Library of Australia	National Library of Kuwait
16	National Library of New Zealand	National Library of Maldives
17	National Library of Vanuatu	National Library of Nepal
18	State Library of Queensland	National Library of Pakistan
19	State Library of South Australia	National Library of Philippines
20	State Library of Tasmania	National Library of Thailand
21	State Library of Victoria	National Library of Turkey
22	State Library of Western Australia	National Library of United Arab Emirates
23	Sutherland Shire Council Library	Perpustakaan Negara Malaysia
24	Wellington City Library	Quatar National Library
25	Wollongong City Library	The National Library of Israel

Table III.

Serial no.	Online directories for public libraries	URL
1	Hennen's American Public Library Ratings, 2010 edition	www.haplr-index.com/HAPLR100.htm
2	Libdex (directory of libraries across the world)	www.libdex.com/country.html
3	PublicLibraries.Com (public libraries across the United States)	www.publiclibraries.com
4	UK Public Libraries	dialspace.dial.pipex.com/town/square/ac940/weblibs.html
5	Everyone's Library Friend (ELF): List of libraries	www.libraryelf.com/Libraries.aspx#intl
6	Wikipedia: List of national and state libraries	en.wikipedia.org/wiki/List_of_national_and_state_libraries

Table IV.
List of online directories used to gather public libraries

unusual guises are difficult to locate, such as for the Griffith University Library and the Chicago Public Library.

As the concept of browser extensions is relatively new, users need to be properly introduced to their functionalities. Therefore, many libraries (56 per cent, 81 of 145) of

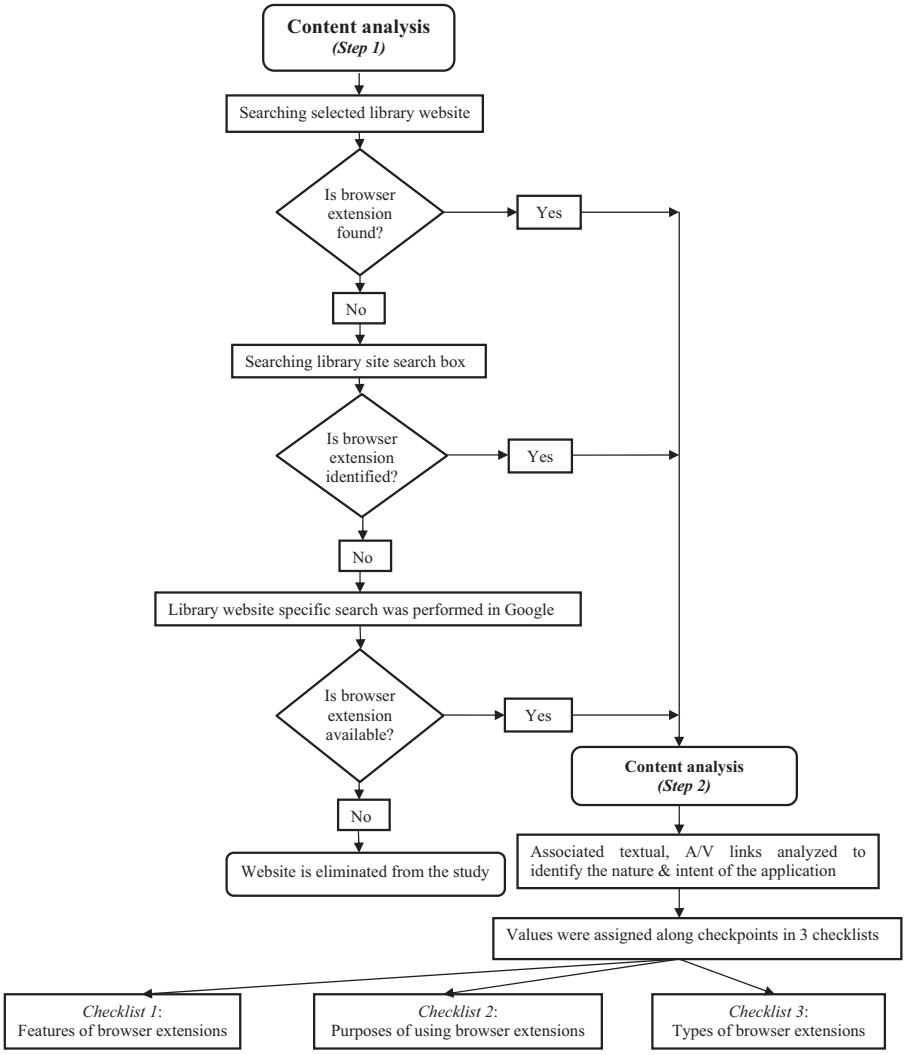

Figure 1.
Content analysis to identify the existence of browser extensions and to determine the nature and intent of their use

those using browser extensions provide clear instruction on its use. Fondren Library of Rice University provides step-by-step guidance with screenshots and a podcast on the use of a browser plug-in to directly search the library catalogue for any documents identified while searching the Internet. Moreover, different types of applications need different installation requirements. Accordingly, 62 per cent of libraries (90 of 145) provide sufficient installation instruction, such as the Flinders University Library.

The organization scheme for browser extensions varies from library to library. While some libraries organize applications under specific functional features, other libraries prefer displaying browser extensions in one place under a common heading. For example, the University of Texas at Austin Libraries utilize the requirement-oriented

Serial no.	Checkpoints (on features)	Score (1/0)
Checklist 1: Features of browser extensions		
f_1	Brief description about browser extensions	
f_2	Guidance to use browser extensions	
f_3	Adequacy of instruction on how to install browser extensions	
f_4	Browser extensions are linked through homepage	
f_5	Browser extensions are displayed at one place	
f_6	Browser extensions are categorized	
f_7	FAQ on browser extensions	
f_8	Feedback on browser extensions	
Serial no.	Checkpoints (on purposes)	Score (1/0)
Checklist 2: Purposes of using browser extensions		
p_1	Searching the library catalogue	
p_2	Scholarly journal articles	
p_3	Databases	
p_4	Used as subject guide/course guide	
p_5	Providing reference service	
p_6	Offering research tools	
p_7	Disseminating news and events	
p_8	Providing personalized information on lending status	
Serial no.	Checkpoints (on types)	Score (1/0)
Checklist 3: Types of browser extensions		
t_1	Library toolbar	
t_2	Catalogue search bookmarklet	
t_3	Bibliographic information gathering bookmarklet	
t_4	Remote access bookmarklet	
t_5	Library search user script	
t_6	Academic search plug-in	
t_7	Citation management add-ons	
t_8	Other kinds of browser extensions	

Table V.
Data collected with the three checklists – characteristic features, purposes of use and types of browser extensions

categorization, accommodating browser extensions under search widgets, information organizing widgets and collaboration widgets. The San Jose Public Library displays browser extensions under "Library widgets & web tools" and the San Diego State University Library lists extensions under "Library widgets & tools". Ecole Polytechnique Federale De Lausanne Bibliothèque presents comprehensive coverage of browser extensions in one location. This type of A-Z display using common headings provides exhaustive coverage of all sorts of browser extensions, and the libraries using this method generally do not opt for any further division. On the contrary, a decentralizing trend was also noticed among some libraries, displaying topic-based browser extensions at their respective topical pages, such as the lookup tool of Hennepin County Library being linked to the library catalogue to make searching the catalogue convenient.

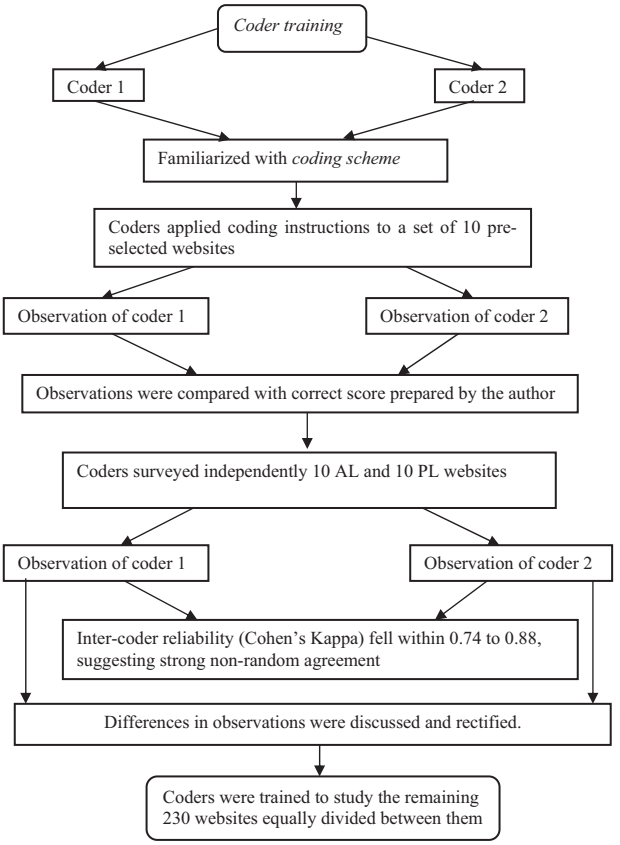

Figure 2.
Coder training to familiarize coders with coding scheme and to develop a sense of standard interpretation of data collection

As some libraries are using extensions experimentally, it is pertinent to receive user's feedback about their experience and use this to modify the functionalities to make the applications more effective for the users. Accordingly, 36 per cent (52 of 145) of the libraries seek user comments through online comment links, as shown by McMaster University Library and Montgomery County Public Libraries.

4.1.2 Purposes of using browser extensions. Figure 3 shows that browser extensions are mainly used for searching library catalogues (69 per cent, 100 of 145), and its application for providing personalized information on lending status is the least observed (18 per cent, 26 of 145) among the libraries studied.

Many libraries offer built-in search boxes which can be added to the web browser as a plug-in to search the library's catalogue from anywhere and are intended to bring resources close to the user's preferred site. Examples include the Universiteit van Amsterdam Bibliotheek and the Nashville Public Library. Interestingly, Temple University Library provides database-specific search plug-ins to support independent topic-based research from any webpage.

Libraries also use browser extensions as a novel means to provide reference tools; for instance, the Columbia University Libraries offer the Britannica widgets and the Oxford

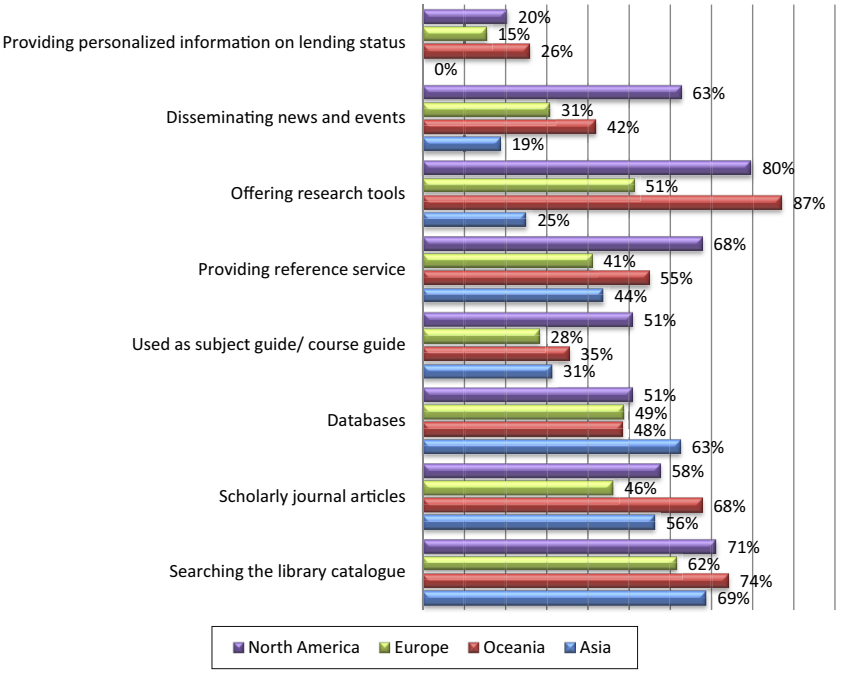

Figure 3.
Application index for browser extensions, highlighting the prevalence of the catalogue search function, and heavy adoption of tools supporting education and research

English Dictionary (OED) browser lookup tool. An online reference tools button on the browser toolbar of the Merrimack Public Library not only guides users to various databases but also serves as an information literacy tool for elementary, middle and high school students. Extending libraries provides patrons the facility to get real-time online reference service from any website by adding links to the browser toolbar. Examples include: Ask A Librarian (Curtin University Library), AskAway (Lansing Public Library) and Ask SPL (Startford Public Library). The above examples enhance user experience and incorporate more value into the existing service provision.

As research tools, browser extensions help scholars by tracking resources a bit faster and easier. For instance, Montana State University Library provides a long list of search plug-ins intending to make library research more convenient by allowing users to narrow the search down to specific resources. Colorado State University Library's Plugins by Research tools table comprehensively illustrates which plug-ins support which research applications or data sources, reflecting the way the library envisioned the potentiality of browser extensions to support research activities.

Another interesting purpose of using browser extensions is to inform users about their personalized lending status. Users can obtain borrower information directly from the *library information* drop-down list (Curtin University Library), *check your library account* link (Skokie Public Library) and *my account* button (Cuyahoga County Public Library) attached to the library toolbar from anywhere on the web. The library toolbar of Karolinska Institutet, Universitetsbiblioteket offers a *my loans* button as a shortcut for users to renew items or view items borrowed and to track items put under reservations directly from any website.

4.1.3 Types of browser extensions. Toolbars from the Wyoming State Library and Regina Public Library allow users to access the library catalogue and search Google Scholar which provides "access to relevant and quality articles" (Cothran, 2011, p. 293). The library search bookmarklets of the University of Minnesota Library, Bartlesville Public Library and Christchurch City Libraries allow users to verify whether the library has a copy of a book that was found on worldcat.org or any bookseller's site, such as amazon.com, barnesandnoble.com, borders.com and powells.com,. Remote access bookmarklets from the National University of Singapore Library and Howard County Library offer users off-campus access to licensed library resources, thereby supporting research activities of distant learners. Bibliographic information gathering bookmarklets, such as *RefGrab-It* offered by the Istanbul Technical University Library and Drexel University Libraries, allow users to save online references instantly, as it lets users collect bibliographic data directly from websites and import them into the user's RefWorks account.

Another noticeable feature is that libraries are offering citation converters such as *OpenURL Referer*, which is a web-browser plug-in that can grab bibliographic citations from the web and convert them into URLs, as demonstrated by the example of the University of Prince Edward Island's Robertson Library. The *EndNote Web Plugin* of the Ebling Library of the University of Wisconsin-Madison-Health Sciences lets users import online references directly to their EndNote account.

Interestingly, the MIT Library offers *Instapaper*, a bookmarklet which allows users to save a whole article for later reading on an iPhone or iPad. *Cooliris*, a browser plug-in from the Christchurch City Libraries provides a full-screen photo viewer for users to experience an interactive slideshow of online images.

4.2 Implementation of browser extensions in different regions and in different types of libraries

The study revealed that libraries adopt browser extensions differently. The overall comparative degree among the continents (Figure 4) showed that the implementation of browser extensions is considerably higher in North America (ALs 60 per cent and PLs 57 per cent) compared to the other continents – Oceania (ALs 54 per cent and PLs 44 per cent), Europe (ALs 42 per cent and PLs 28 per cent) and Asia (ALs 39 per cent and PLs 28 per cent).

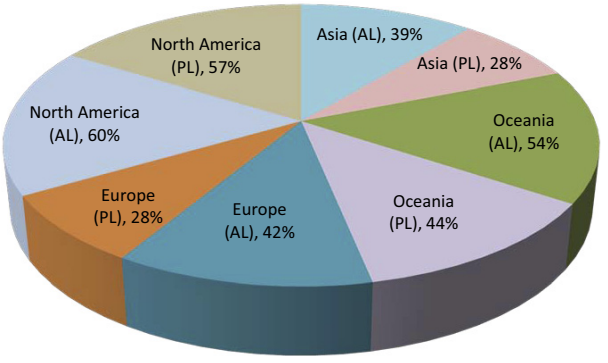

Figure 4. Application index for browser extensions, showing its prevalence in ALs and in North America

A notable difference was observed between the ALs and PLs as to the acceptance of browser extensions. ALs assimilate the applications to a relatively greater extent compared to PLs.

However, a study comparing the number of libraries adopted browser extensions with those not having applied browser extensions (Figure 5), revealed that acceptance of browser extensions is more common in North American libraries (74 per cent i.e. 59/80), followed by libraries in Oceania (62 per cent i.e. 31/50), Europe (49 per cent i.e. 39/80) and Asia (32 per cent i.e. 16/50).

5. Discussion and conclusion

The investigation presents an overall picture of the implementation of browser extensions among the libraries across continents. Following data collection and calculation of category scores with the checklists of the selected libraries, it was found that 56 per cent (145 of 260) of libraries use browser extensions, although the features, purposes of use and types of browser extensions adopted by libraries vary greatly. The study also indicates that a browser extension is primarily used to:

- gain quick access to library resources;
- provide guidance to use resources;
- enhance research skills; and
- keep users up to date with the latest news and upcoming events.

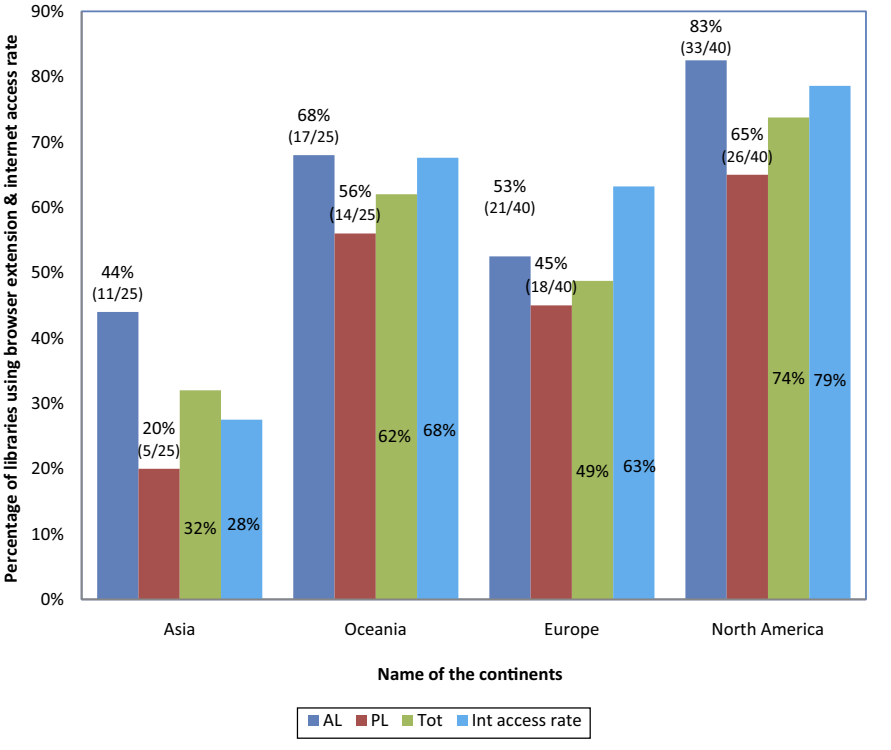

Figure 5.
Percentage of libraries using browser extensions, indicating its wider acceptance in North America and far less acceptance in Asia; regional adoption of browser extensions corresponds to the rate of Internet access in respective continents

The study reveals a general trend among various libraries to adopt browser extensions and steer users directly to the library environment in a "fun way" from their preferred site, making them more "immersive and integrative", which mirrors the research of Si *et al.* (2012) who claimed that libraries may use new applications to integrate information services into students' academic life and thereby extend library services into the users' own community.

5.1 Good practices

The following good practices are recommended to be considered during the adoption of browser extensions:

- *Set a clear purpose*: Librarians need to follow the standard norms and establish a clear purpose before introducing a browser extension. This will help one determine which type of application to use and how to apply it in the best way for the intended user group.
- *Make the application prominently visible*: Libraries need to determine whether the browser extension is transparent or prominently located and easily accessible to the users. Consideration should be taken to have a direct link on the home page with access points, to release users from clicking on several links or entering terms into a site search box, which may frustrate users and reduce interaction.
- *Provide annotations*: Libraries should provide adequate annotation on browser extensions to the desired user community. A generalized brief description on individual browser extensions is helpful, particularly to the new user, to gain an idea about the potentiality of this new web-based application. As an example, the Massachusetts Institute of Technology Library and Westlake Porter Public Library provide short descriptions of browser extensions along with a video presentation to acquaint new users with the tool in a lively and attractive way. This step will improve the accessibility of the application.
- *Remember the target group*: Determine the target audience and let this decide the kinds of services and programmes which will be integrated with the browser extension. For instance, scholars often desire quick access to articles and research tools, teens are interested in library news and events, newcomers usually look for library information, general students seek subject guides and so forth. A closer look at the target group will enable librarians to effectively determine user requirements.
- *Offer multiple application options*: Some users want the library toolbar to get quick access to library resources, while others want individual search plug-ins to conduct specific database searches, or prefer to search bookmarklets to verify whether the library has a copy of a book that was found on any bookseller's site. Provision of different application options will ensure a wider approach to maximize user involvement.
- *Encourage participation*: Browser extensions can foster the learning process; therefore, user support and participation is crucial to the success of browser extensions. Encourage users to make comments and provide feedback on the application. Seeking users' opinions and suggestions will help librarians gain insight into how to enhance library services with the new application.

- *Offer a FAQ link*: An frequently asked questions (FAQ) link should be provided to answer various queries relating to browser extensions. Many people are still unfamiliar with browser extensions; therefore, one may explain what browser extensions are, the types of applications being offered, the different purposes of its use, how to install applications, browser requirements, setting preferences, etc. This may also relieve librarians from answering repeated and redundant queries.
- *Make it attractive*: Use audio and video clips of the application to introduce browser extensions in a more attractive way to the user; for instance, follow the example of the YouTube presentation of the Murdoch University Library describing the use of Libx to gain access to library resources. Displaying the application at an eye-catching location will attract users and maximize its use. Engage users in regular consultation to find out whether the application is effective for their uses or to identify what improvements they need on the existing service provision.
- *Organise by levels*: Applications need to be displayed in one location and organized by types, programmes and resources. By organizing applications under specific headings, libraries can minimize information overload and enhance accessibility. Moreover, by displaying browser extensions in one location, libraries make it convenient for the users to be easily introduced to the types of extensions being offered. This will enable users to choose a specific application from a comprehensive list. This step saves the time of the user and ensures maximum exposure of the applications.
- *Popularise the endeavour*: Promote browser extensions through posters, leaflets, flyer campaigns, announcements on library blogs and sharing on social networking sites such as Facebook, Twitter, etc. Moreover, PLs, having various user segments with each group requiring different awareness techniques, may warrant a stronger marketing and promotional strategy. Interestingly, the Lancing Public Library toolbar itself offers podcasts of news and events for off-campus students, adding value to the marketing and promotional efforts of the library.
- *Provide experimental services*: Design experiments to find out how exactly a new application works. Many libraries release beta or pre-release versions at the beginning to a limited audience to check out its performance. A few trial-and-error approaches at the initial stage will help decide what works best for the users.

5.2 Variation in implementation

A look at the outcomes of this exploratory study points to two key findings. First, there is a noticeable regional variation in adoption of applications.

5.2.1 Regional variation. Browser extensions are widely used among libraries in North America. This suggests that the popularity of browser extensions is relatively high in North America, which may indicate a preference for application-based access to resources among user communities. The result perhaps echoes the findings from the Pew Research Center's Internet Project which shows a sizable range of the user community in America, ages 16 and older, have strong (35 per cent) to medium (28 per cent) levels of interest in applications to access library resources (Zickuhr *et al.*, 2013a). Moreover, North American library websites are better equipped with relevant browser

extension features that promote the use of the application which further suggests a higher rate of adoption.

The differential level of implementation of browser extensions among libraries in different regions may well be a reflection of disparate Internet access rates among the regions. Data on world Internet usage and population statistics, 30 June 2012, derived from Internet World Stats (www.internetworldstats.com/stats.htm), which is the latest at the time of writing the article, revealed that Internet access rates are very high in North America (78.6 per cent), followed by that of in Oceania (67.6 per cent) and Europe (63.2 per cent); however, Asia (27.5 per cent) presented an extremely low penetration rate. EDUCAUSE reported that 75 per cent of North American students strongly believe that technology is critical to their academic success, with library websites being the most preferred institutional technology resource (Dahlstrom, 2012). A subsequent study by the Pew Research Center confirmed the growing technology preference among American students, noting that 98 per cent of American students aged 18-29 use the Internet and 80 per cent have a broadband connection at home, and exhibit a fascinating mix of habits and preferences while using libraries and technology (Zickuhr *et al.*, 2013b). Meanwhile, CNN reported that 90 per cent of Americans own some form of computerized tool (Gahran, 2011). The high Internet access rate in North America and the growing familiarity with computerized gadgets in every sphere of life might have raised the strongest interest among the users towards application-based library services. This should encourage librarians to embrace browser extensions as a part of the implementation of new technology in libraries.

The adoption of browser extensions in Oceania, Europe and Asia corresponds to the rate of Internet access from the respective continents. The findings suggest that the acceptance of browser extensions is not widespread among Asian libraries and the implementation is noticeable in some fragmentary isolated pockets only. The poor Internet access rate, as well as infrastructural limitations in Asia, might have discouraged librarians and decision-makers from considering browser extensions as an agreed component to library provision.

5.2.2 Variation among the types of libraries. The second result of the study is that the acceptance of browser extensions is relatively common in ALs compared to PLs and the underlying reason likely relates to the disparate profiles of users using different types of libraries. Usually, public library users are more heterogeneous, belonging to different age groups, coming from different strata of the social ladder, presumably having diverse levels of understanding towards technological advancements, and have variable and different user needs and preferences. In contrast, academic library users are easily identifiable and are relatively captive, mostly constituting students, scholars and teachers, who, with a few minor differences, broadly share common subject areas of interest and prefer new modes of learning, receiving instruction and guidance, and are conceivably more conversant with new technology and its application. The differences between attitudes and preferences of the two user communities might be a reason for ALs intensely accepting browser extensions in many regions. The findings corroborate the observations of Chew (2009) and Ashcroft (2010) that ALs are the early adopters of new technologies.

The study also reveals that several PLs typically lack focus on guidance and instructional features on their website that would attract and encourage users to make use of library resources with the help of browser extensions. The result echoes the

findings of Ashcroft's (2010) study that reiterated that PLs need improved marketing and advocacy, at both strategic and patron levels. This finding also emphasizes that the implementation of browser extensions does not depend on technology proficiency alone but on a user-centric approach in terms of library service provision. An improved understanding of user expectations and views regarding technology adoption in service provision, may guide librarians to reorient technical infrastructure, and to frame appropriate and progressive policies on the implementation of browser extensions.

5.3 Limitation and future scope

The present investigation had some inherent limitations. The study was confined to selected libraries among four continents only. Libraries having non-English websites and restricted or limited access were outside the purview of the research. The convenient sampling method was used for data collection from the PLs. Furthermore, data gathered from the Internet remains susceptible to alterations and modifications. Hence, the current investigation expands the scope of future research on the remaining regions and websites whose content is in a non-English language to attain a broader perspective of its implementation. Moreover, web content analysis, employed in the present study, depends on subjective judgement to some extent, highlighting the researcher's views and observations concerning the implementation of browser extensions from the unique perspective of his or her academic discipline. However, the checklists used here may serve as a bedrock for framing questionnaire and interview questions when conducting future research examining users' perception of browser extensions in the context of effective resource utilization, to fully comprehend its practicability and usefulness.

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