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Digital Transformation in Libraries: Identifying the Main Components in a Knowledge Extraction System Based on Single Sign On

Mila Malekolkalami[1*] , Mohammad Hassanzadeh

[1] *PhD Candidate, Knowledge and Information Science-Knowledge Management, Management and Economics Faculty, Tarbiat Modares University, Tehran, Iran. malekolkalami@modares.ac.ir, 0000-0003-2831-9307*

[2] *Full-Prof., Knowledge and Information Science-Knowledge Management, Management and Economics faculty, Tarbiat Modares University, Tehran, Iran. hasanzadeh@modares.ac.ir, 0000-0002-6175-0855*

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ABSTRACT

This study aims to identify the main components in a Knowledge Extraction System based on Single Sign-On in libraries. This research is with a mixed approach and it is an exploration based on the Sandelusky and Bargo (2006) model. The studies from 2000 to 2022 were analyzed in ATLAS Ti software. In the quantitative phase, the statistical population is 12 experts in knowledge management and libraries who were selected by purposeful sampling. MICMAC software was used for the ISM method. 40 codes were categorized into 4 main themes of knowledge extraction based on SSO features including Infrastructural measures of knowledge extraction, Knowledge organization, Integration of knowledge, and Monitoring and updating knowledge. Access using unit code with the rank of 1 and frequency of 12 is one of the most important components in a knowledge extraction system based on SSO in libraries. According to the ISM, the knowledge extraction system based on SSO in libraries has four levels. Since SSO is one of the hot trends and high topics in the field of libraries, there can be a knowledge extraction system based on SSO features to help share and develop knowledge.

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Introduction

With the development of digital libraries and the application of technologies and artificial intelligence in them, extracting knowledge from databases is one of the challenges of knowledge management in this organization due to the great variety and large volume of data (Osman, Noah & Saad, 2022). To facilitate and accelerate the dissemination and accessibility of knowledge in libraries, databases are developed based on processes controlled by students, researchers, librarians, and experts in specialized fields (Daga, E., & Motta, 2019).

The use of new tools and the development of technology have made it possible to digitize information and analyze large volumes of data. Advanced information processing techniques are used to extract, digitize, retrieve, display, classify and integrate information. But a large amount of information is not structured and no special law is used to organize information. Therefore, there is a need for software tools to provide the possibility of separating and extracting new and useful knowledge from the multitude of online and offline documents and data sets (Giroux et al., 2008).

As service centers in society, libraries, like other service organizations, need the knowledge of their end users to choose and manage their development and marketing strategies.

considering the vital role libraries play in society, whether public or academic, in addition to creating easy access to resources for users and removing the physical walls of libraries, and increasing users' attention to the library, they need to extract knowledge from users' online and digital activities.

Single Sign-on is an authentication system designed to build trust between the user and the application, allowing users to authenticate to different applications and websites using only one set of passwords (Chowhan & Tanwar, 2019; Parmar et al., 2022). SSO defines the specific details of each user including email address or username. At the same time, the possibility of password insecurity also increases, and by disabling SSO, all access to relevant systems is lost (Parmar et al., 2022). There are various systems for storing user information, such as Enterprise Single Sign-On (Taneski, V., Heričko, M., & Brumen, 2019). In this paper, we tend to suggest a knowledge extraction system based on SSO in libraries. In this case, providing a database to store the data on SSO is required. By providing SSO service for users, in addition to creating privacy security and saving users' time, libraries can analyze the data obtained from users' search and reading which is stored on the user's user account and password, and provide relevant knowledge. meet their needs to determine strategies related to the library collection, marketing, and other services.

The integrated library system, as a reliable database, plays an important role in managing its community. The data includes names, contact details, and records of library users that are useful in identifying the strengths and weaknesses in collections and evaluating the effectiveness of marketing activities. Moreover, this system can have tools for scheduling, managing, and promoting library programs or events, online customer registration services, and validation (Breeding, 2022). This database can be used to find hidden knowledge of library users using algorithmic analysis. Furthermore, achieving the hidden knowledge of this collection can help to provide innovative library solutions such as improving access, increasing library visitors, designing and implementing programs needed by the community, and providing special services.

Libraries also need to provide access to their organizational services through an SSO based on Google Authentication API to provide excellent services to their users. This service leads to greater effectiveness and efficiency (Purwinarko, Hardyanto & Adhi, 2021).

By considering the importance of knowledge extraction for libraries and applying new technology as SSO, we are particularly interested in identifying and extracting the essential components and the key themes used in a knowledge extraction system based on SSO in libraries. By identifying the main themes in this field we can initiate the first knowledge extraction system in libraries which is not limited to a single database and a wide recognition of users' needs can be obtained for the managing and marketing strategies**.**

Literature review

The review of studies shows the use of SSO in libraries. NSLHD libraries made changes in the way of providing services by implementing the SSO in the library's workflow system. Due to the spread of the coronavirus and the change in the workplace of library staff, and the access necessity, they implemented an improved remote service for library staff and doctors. Therefore, by providing immediate access to articles, the time of employees and doctors was significantly saved. This process of finding new articles does not require additional passwords and logins (Edwards McKnight & Nunn, 2022). The Paul Meek Library at the University of Tennessee at Martin (UTM) has also

provided a web-based module for transparent and easy authentication of its users using the OpenAthens platform. Through this platform, it is possible to access EBSCO articles outside the university (Li, Holly & Goodrich, 2022). In order to increase access, usability, personalization, and security for end users, libraries are looking to use SSO instead of IP authentication (Arsenault et al., 2019; Claffey & Ellis-King, 2022). In Purwinarko et al. (2021)'s study, a framework called Google Oauth 2 has been presented for using SSO services in libraries to provide better services to users and easier access to resources. Online public access catalog search, library collection scanning, patron accounts, patrons' personal book collections, circulation, librarian chat, QR codes for book borrowing, social media integration, and notifications of library activities and events are some features studied using in-house open source system, Koha to develop a mobile application in library services. The results showed that this library application was useful and practical (Mohideen, Sheikh & Kaur, 2021). TECH DEPT is an integrated platform that helps improve curricula and teacher preparation and professional development using SSO. This platform is used by a teacher librarian to better respond to the needs of students in a digital environment, and the teacher-librarians of a district can strengthen their performance in this way, and administrators can provide more powerful solutions to support the school community. To use this platform, students had devices to ensure easy access to digital resources. TECH DEPT created a SSO for all digital resources in the region and collaborated with TLs to access these resources. (Moen, 2022). Singh & Margam (2018) in a study, with the aim of investigating information, physical, organizational, and technological security measures in Jawaharlal Nehru University (JNU), Delhi University (DU), and Jamia Millia Islamia (JMI) in Delhi, stated that all the university libraries studied in physical security measures are left behind These libraries use SSO to control data access, but to maintain security, all cables and security equipment are located in JNU. The results of this study can help to improve information security gaps in the studied libraries. The findings of this study not only guide academic librarians to improve their information security practices but also open doors to improve information security in a rapidly changing technological world to overcome the limitations librarians face. Muhindi (2021), in his article, points out the importance of SSO to ensure the security of the user's identity. This article presents an approach for extracting knowledge using Bayes algorithms, which is based on client-based technique and can visually compare spy emails from legitimate emails and provide the necessary information to the user. Calvillo-Arbizu, Román-Martínez & Reina-Tosina (2021) state that in the health care field of a smart city and the importance of data protection in the application of the Internet of Things, authentication and SSO service are among the main and important needs of this distributed environment. Common standards and authorizations such as SAML, OAuth and XACML are defined for users to access resources. Barasti et al. (2022), focusing on the deployment of innovative services in seaports, proposed the use of SSO service for authentication and integration of distributed architecture. This integrated software provides regular access to data sets for the purpose of data aggregation and knowledge extraction for end users.

As the literature review shows, SSO is used in libraries to increase access and authentication. Knowledge extraction is also important as a way to acquire the knowledge of library users for decision-making and management of the library and determining marketing strategies. In this paper, we are trying to suggest the critical components of the knowledge extraction system in libraries based on the features and benefits of the SSO service. That is, the user can access resources from different libraries using SSO, and search formulas, resource downloads, online reading, and other user activities are stored on his password. By analyzing the data from the user activity, can be followed by the search for information and knowledge needs and offers the necessary suggestions for the future. As far as we know, such a framework has not been studied in libraries before. The results of this study can help library managers determine library management strategies such as library collection and identifying users' knowledge needs in an area. Also, libraries are linked regional, national, and even internationally, and the user can access the resources they need using system suggestions without restricting time and location.

Method

This research is with a mixed approach and it is an exploration based on the Sandelowski & Barroso (2006) model. The studies from 2000 to 2022 were analyzed in ATLAS Ti software. The quantitative step is based on the interpretive structural method. The statistical population is 12 experts and experts

of knowledge management and libraries who were selected by purposseful sampling. This technique is done in MICMAC software.

In the present research, in the first step, to achieve the goal of identifying the categories of the knowledge extraction system based on SSO in libraries the meta-synthesis method has been used according to the model of Sandelowski & Barroso (2007).

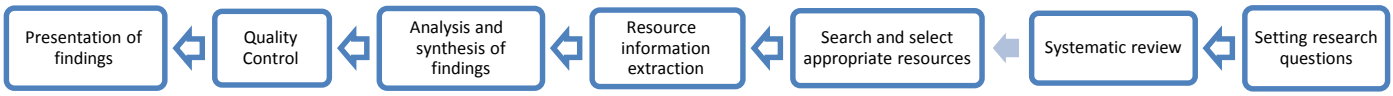

Figure 1. *The seven-stage meta-synthesis model (Sandelowski & Barroso, 2007)*

Findings

Step1: Set the purpose of the study

The first step in the meta-synthesis method is to set the research questions. These questions can generally be set based on four parameters: what, who, when, and how (Williams et al, 2020). In order to group and identify the dimensions of the knowledge extraction system based on SSO in libraries, these questions have been answered based on Table 1.

Table1. *Research Questions*

Parameter	Research Question
What?	Identifying the components of knowledge extraction system based on SSO in libraries
Who? When?	Various works such as books, articles, reports in the field of knowledge extraction system based on SSO in libraries from 2000 to 2022
How?	Thematic review, identification and note-taking, key points, analysis of concepts

Step2: A systematic review of the literature

A total of 183 studies were found by reviewing and identifying research through the National Library and other libraries search system, research institutes, and international databases such as Science Direct, Google Scholar, Springer, Emerald, Researchgate, Worldscientific etc. with related keywords. In this study, the keywords used to identify the articles are shown in Table 2.

Table2. *Research Keywords*

Keywords
Knowledge extraction system
Verification of integrated quality
Single sign out in libraries
Knowledge management based on SSO
Librar*
SSO in libraries

Step3: Search and select appropriate resources

In the meta-synthesis method, there must be certain criteria for the searched studies. The setting of these criteria will be done with the opinion of researchers and experts, and in this field, there are no specific and fixed criteria for conducting the research. The setting of the criteria should be such that it includes all the findings that have been selected in line with the topic of the researcher.

The entry criteria are:

The first criterion: The published articles and studies in the chosen field.

Second Criterion: Since the meta-synthesis method only deals with qualitative data, therefore, articles and studies that use appropriate qualitative methods such as interviews, observation and systematic library review, and other qualitative methods, as well as quantitative articles, including survey and experimental, and correlation articles, which had qualitative results and investigated the subject of this research, are examined.

Third criterion: The research should have reported sufficient data and information related to the research objectives.

Fourth criterion: The studies that go through the expert review process and are published in the form of full articles online or in full.

The fifth criterion: The articles and studies published in the chosen field between 2000 and 2022.

Sixth criterion: Articles and studies that investigated the subject of this research with scientific methods and showed suitable solutions for its analysis.

The exit criteria are:

First criterion: The studies which did not report enough information about the goals of this research.

The second criterion: The studies that were conducted with the same titles and goals.

The third criterion: The studies that lacked a suitable methodological model.

Fourth criterion: The studies that did not report enough information about the goals of this research.

The fifth criterion: The studies that lacked the necessary scientific quality because they were published in low-quality journals.

In this step, 183 studies found in the previous step were carefully reviewed in several steps to exclude studies that do not fit the research questions, and finally to identify the most relevant studies to extract the answers to the questions. The review process includes reviewing the title, abstract, and content of the research along with the research methodology. The steps of the review process in this research are as follows:

1. At this stage, the reviewed studies whose titles were not related to the research questions were excluded. By reviewing the title of the study, 78 studies were discarded due to the lack of relevance of their title to the research questions and 105 studies entered the next stage for further review.
2. At this stage, the reviewed studies that their abstract were not related to the research questions were excluded. By studying the abstracts, 52 studies were discarded due to the lack of connection between the abstract and the research questions, and 53 studies entered the next stage for further study.
3. At this stage, the content of the studies was reviewed, and studies that were not related to the research questions were excluded. By reviewing the content of the studies, 12 studies unrelated to the research questions were discarded and 41 studies were taken to the next stage for further investigation.
4. At this stage, according to the final evaluation of the articles, and their relationship with the subject of intelligent extraction of knowledge, 9 other studies were deleted due to lack of communication.

The researcher excluded some articles in each review, which are not studied in the meta-synthesis process. This process is shown in Fig 2 (Ridder & Lensvelt, 2018).

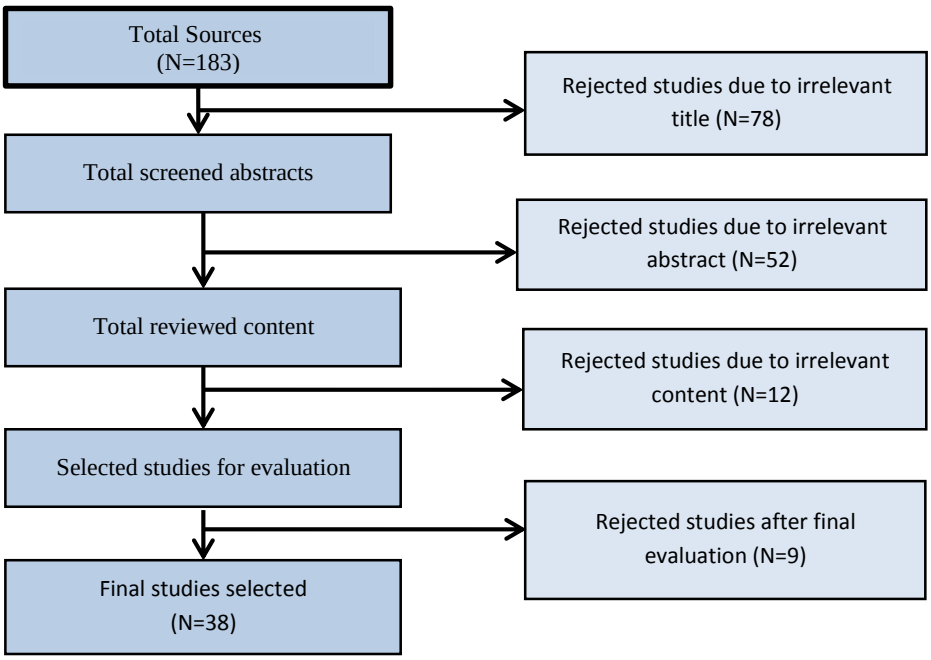

Fig2. *Review and selection process*

After eliminating studies that are disproportionate to the goals and questions of the research, the researcher should evaluate the methodological quality of the research. The purpose of this step is to eliminate research in which the researcher does not trust the findings. The most commonly used tool for assessing the quality of initial qualitative research studies is the Critical Assessment Skills Program, which helps determine the accuracy, validity, and importance of qualitative research studies by asking ten questions. These questions focus on the following: 1. Research Objectives. 2. Methodological logic, 3. Research plan, 4. Sampling method, 5. Data collection, 6. Reflexivity (which refers to the relationship between the researcher and the participants), 7. Ethical considerations, 8. Accuracy of data analysis, 9. Clear expression of findings, 10. The value of research.

To use this tool, all studies are examined and each research is assigned a score between 1 and 5 in terms of having the above characteristics. Based on the 50-point scale of the Critical Appraisal Skills Program, the researcher proposes the following scoring system and categorizes the studies based on their degree of methodological quality: Very good (50-41), Good (40-31), Medium (30-21), Poor (20-11), Very poor (11-0).

Based on the Critical Assessment Skills Program, the researcher performs the above scoring system and removes any research that is below a good score (below 31) (Chenail, 2011).

Table3. *Outcome of the Critical Assessment Skills Program*

Criteria / Article	Research Methods	Clear statement of findings	Accuracy of data analysis	Ethical considerations	Reflectivity	Data collection	Sampling method	research plan	Methodological logic	Research purposes	Total points
S01	4	3	3	5	4	4	4	3	4	4	**38**
S02	2	2	3	5	2	3	3	4	4	3	**31**
S03	4	5	4	5	3	4	2	4	3	3	**37**
S04	4	4	4	5	4	3	4	5	4	3	**40**
S05	3	4	3	5	4	4	3	4	4	5	**39**
S06	4	4	4	5	5	4	4	5	4	5	**44**
S07	5	5	4	4	2	2	2	4	3	2	**32**
S08	3	4	5	5	4	3	4	3	3	3	**32**
S09	2	3	4	5	2	3	4	4	3	2	**32**
S10	3	4	4	5	3	4	4	3	4	3	**37**
S11	2	2	3	5	2	3	3	4	4	3	**31**
S12	3	4	3	5	4	3	4	2	3	2	**33**
S13	2	3	4	5	2	3	4	4	3	2	**32**
S14	3	4	3	5	4	3	2	4	2	3	**33**
S15	4	3	3	5	4	4	4	3	4	4	**38**
S16	3	4	3	5	4	4	3	4	4	5	**39**
S17	3	4	4	5	3	4	4	3	4	3	**37**
S18	4	4	4	5	4	4	4	4	4	4	**41**
S19	4	4	4	5	4	3	4	5	4	3	**40**
S20	3	4	4	5	3	4	4	3	4	3	**37**
S21	3	4	4	5	3	4	4	3	4	3	**37**
S22	3	3	3	5	4	4	4	3	3	3	**35**
S23	4	4	5	5	4	4	5	4	5	5	**45**
S24	3	4	3	5	4	3	4	2	3	2	**33**
S25	4	3	4	5	4	4	3	4	4	4	**39**
S26	3	3	4	5	3	4	4	3	3	2	**34**
S27	3	4	3	5	4	3	4	2	3	2	**33**
S28	4	4	4	5	4	4	4	4	4	4	**41**
S29	4	4	5	5	4	4	5	4	5	5	**45**
S30	5	5	3	3	4	4	4	4	4	4	**41**
S31	4	4	4	5	4	4	4	4	5	5	**43**
S32	3	3	3	5	4	4	4	3	3	3	**35**
S33	3	4	3	5	4	4	3	4	4	5	**39**
S34	4	4	4	5	4	4	4	4	4	4	**41**
S35	3	4	3	5	4	3	4	2	3	2	**33**
S36	3	3	3	5	4	4	4	3	3	3	**35**
S37	3	4	4	5	3	4	4	3	4	3	**37**
S38	3	4	4	5	4	3	4	4	4	5	**40**

As the result of table 4 shows no studies have been omitted from the evaluation process. Table shows the details of studies in this paper.

Table4. *Outcome of the Critical Assessment Skills Program*

Author(s)	Year	Title	Code
Edwards et al	2022	Just in time: integrating library services for literature searches in a hospital library setting	**S01**
Valero et al	2021	AIoTES: Setting the principles for semantic interoperable and modern IoT-enabled reference architecture for Active and Healthy Ageing ecosystems	**S02**
Muhindi et al	2021	Detection of Visual Similarity Snooping Attacks in Emails using an Extended Client Based Technique	**S03**
Barasti et al	2022	An ICT Prototyping Framework for the "Port of the Future"	**S04**
Pagano et al	2021	C-Ports: A proposal for a comprehensive standardization and implementation plan of digital services offered by the "Port of the Future"	**S05**
Jayakanth et al	2021	Off-campus Access to Licensed Online Resources through Shibboleth	**S06**
Mir et al	2022	Decentralized, Privacy-Preserving, Single Sign-On	**S07**
Norta et al	2021	A Blockchain Implementation for Configurable Multi-Factor Challenge-Set Self-Sovereign Identity Authentication	**S08**
Ning et al	2016	Cybermatics: Cyber–physical–social–thinking hyperspace based science and technology	**S09**
Deshpande et al	2019	DiiS: A Biomedical Data Access Framework for Aiding Data Driven Research Supporting FAIR Principles	**S10**
Siqueira	2019	Footstep: An Approach to Track Web Usage in Real Time.	**S11**
Pecori	2018	A Virtual Learning Architecture Enhanced by Fog Computing and Big Data Streams	**S12**
Shree et al	2016	Enhancing access of archives and ranking in websearch	**S13**
Purwinarko et al	2021	Implementation of google single sign On (SSO) in the library management system	**S14**
Frontoni et al	2017	HDOMO: Smart Sensor Integration for an Active and Independent Longevity of the Elderly	**S15**
Rauwerda et al.	2015	The promise of a Virtual Lab in Drug Discovery	**S16**
Ryan et al	2017	On composability and security of gamebased password-authenticated key exchange	**S17**
Lukác et al	2017	A process-oriented service infrastructure for networked enterprises	**S18**
GIROUX et al	2008	WebLab: An integration infrastructure to ease the development of multimedia processing applications	**S19**
Kaiser et al	2004	Seamless, Intelligent Grid Services for e-Science	**S20**
Jakel et al	2012	Interactive Information Extraction based on Distributed Data Management for German Grid Projects	**S21**
DARWISH et al	2018	Fog Based Intelligent Transportation Big Data Analytics in The Internet of Vehicles Environment: Motivations, Architecture, Challenges, and Critical Issues	**S22**
Frischmuth et al	2012	Linked Data in Enterprise Information Integration	**S23**
Jing et al	2010	SSO based Security Management in Cloud Computing Environment	**S24**
Ghasemisharif et al	2018	O Single Sign-Off, Where Art Thou? An Empirical Analysis of Single Sign-On Account Hijacking and Session Management on the Web	**S25**
Bazaz et al	2016	A Review on Single Sign on Enabling Technologies and Protocols	**S26**
Pashalidis et al	2013	A Taxonomy of Single Sign-On Systems	**S27**
Pratama et al	2022	Security awareness of single sign-on account in the academic community: the roles of demographics, privacy concerns, and Big-Five personality	**S28**
Chinitz	2000	Single sign-on: is it really possible?	**S29**
Aleisa et al	2020	The privacy paradox applies to IoT devices too: a Saudi Arabian study.	**S30**
Barth et al.	2019	Putting the privacy paradox to the test: Online privacy and security behaviors among users with technical knowledge, privacy awareness, and financial resources.	**S31**
Buchanan et al	2007	Development of measures of online privacy concern and protection for use on the internet	**S32**
D'costa-Alphonso & Lane	2010	The adoption of single sign-on and multifactor authentication in organisations: a critical evaluation using TOE framework	**S33**
Zwilling et al.	2022	Cyber security awareness, knowledge and behavior: a comparative study.	**S34**
Sun et al	2011	What makes users refuse web single sign-on? an empirical investigation of OpenID.	**S35**
James et al	2020	Impact of single sign-on adoption in an assessment triage unit: a hospital's journey to higher efficiency	**S36**
Qader et al	2022	Capabilities and Opportunities: Linking Knowledge Management Practices of Textile-Based SMEs on Sustainable Entrepreneurship and Organizational Performance in China	**S37**
Zhang et al	2021	EL PASSO: Efficient and Lightweight Privacy-preserving Single Sign On	**S38**

In this research, the evaluation has been done regarding extracted codes. The coding status of the first and second researchers is shown in Table 5 and the results of the analyzes obtained from SPSS statistical software are shown in Table 6. As can be seen, the significant number obtained for the Kappa index is less than 0.05, so the assumption of independence of the extracted codes is rejected and the dependency of the extracted codes is confirmed, so it can be claimed that the tools used to extract the codes had sufficient reliability.

Table5. *Codification table of 1st and 2nd encoders*

Total score of 1st encoder	**2nd encoder's opinion**			
	No	Yes		
33	3	30	Yes	1st encoder's opinion
5	0	5	No	
38	3	35	Total score of 2nd encoder	

Table6. *Agreement measurement values*

	Value	Significant
Agreed Kappa	0.902	0.001
Number	38	

Step 4: Information extraction from articles

In this research, the information of the selected studies was compiled in a table. This table includes the following information:

ID information of the research: title, name, and surname of the inventors and year of publication. Key methodological information: research method and goal. Main findings information: research results and findings.

Figure 3 shows the example of coding in the ATLAS TI software:

Figure 3. *An example of extracted codes in ATLASTI software*

The selected codes are shown in table 7:

Table 7. *An example of extracted codes*

Source	Open Code
C3-C8-C11-C19-C20	**Communication infrastructure**
C1-C4-C8-C9-C16	**Support for all data formats**
C3-C6-C15	**Software architecture platform**
C10-C14-C17	**Determining the ownership of a digital resource**
C1-C2-C21	**Ability to receive personal files**
C25-C28-C33	**The ability to convert text resources into desired display and text formats**
C18-C21-C26-C33	**Set access levels**
C2-C4-C7-C13	**Metadata output**
C5-C7-C8	**The possibility of storing archival versions**
C3-C8-C11-C19-C20	**The possibility of introducing academic colleagues around the world**
C6-C22-C25-C37-C38	**Ability to determine interest**
C10-C12-C19	**The possibility of designing a personal library**
C18-C22-C26	**The possibility of tagging**
C6-C22-C25-C37-C38	**The possibility of connecting to many digital knowledge systems**
C3-C8-C11-C19-C20	**Ease of resource management**
C4-C8-C18-C20-C21-C25-C29	**Using the RSS system**
C4-C8-C18-C20-C21-C25-C29	**Integrated access to user e-mails**
C3-C5-C7-C10-C14-C15-C22-C25-C31-C38	**Integrated authentication**
C30-C31-C33-C34-C35-C38	**Data encryption**
C5-C7-C10-C14-C15-C22-C25-C31-C38	**Use of security standards**
C6-C22-C25-C37-C38	**Preparation of various reports of trust systems**

C4-C8-C18-C20-C21-C25-C29	**Secure digital data exchanges**
C30-C31-C32-C33-C34-C35-C36-C38	**Credit of digital resources**
C24-C26-C28-C29-C30-C31-C32-C33-C34-C38	**Automated messaging**
C22-C26-C28-C29-C30-C31-C32-C33-C34-C38	**Geographical unlimitedness**
C28-C31-C32-C33-C34-C35-C36-C38	**Saving time and money in accessing resources**
C4-C9-C7-C26-C28-C29-C30-C31-C32-C33-C34-C38	**Access using unit code**
C9-C22-C26-C28-C29-C30-C31-C32-C33-C34-C38	**Unlimited databases available**
C6-C9-C20-C22-C25-C29	**Smart search**
C3-C8-C11-C19-C20	**Save search history**
C6-C17-C20	**Integrated and unified search**
C4-C8-C11-C19-C20	**Reporting of failed searches**
C3-C8-C11-C19-C20-C27-C29	**Expanding the search**
C4-C9	**The possibility of modification and changes**
C11-C33	**Ability to access old data**
C18-C25	**Relationship management and referrals**
C7-C8-C14-C15	**Introduction of updated information**
C5-C19-C28	**Optimizing search results**
C3-C8-C17-C19-C20	**Ranking results**
C6-C9-C20	**Share knowledge with other users**

It can be seen in Table 7 that some primary codes are in common in different articles.

Figure 4. *Codes cloud*

Step 5: Analyze qualitative findings

In this research, first, all the factors extracted from the studies were considered as identifiers, and then by considering the meaning of each of them, identifiers were defined in a similar concept; Next, similar concepts were categorized in explanatory categories to identify the fields explaining the factors affecting the context of the knowledge extraction system based on SSO in libraries in the form of the main components of research. The following table presents the main and sub-categories of qualitative analysis:

Table 8. *Main categories and corresponding codes*

Open source	SSO components	Dimensions of knowledge extraction
Communication infrastructure	User input	**Infrastructural measures of knowledge extraction**
Support for all data formats		
Software architecture platform		
Determining the ownership of a digital resource		
Ability to receive personal files		
The ability to convert text resources into desired display and text formats	Standard output	
Set access levels		
Metadata output		
The possibility of storing archival versions	User and personalization services	**Knowledge organization**
The possibility of introducing academic colleagues around the world		
Ability to determine interest		
The possibility of designing a personal library		
The possibility of tagging		
The possibility of connecting to many digital knowledge systems	Smart tools	
Ease of resource management		
Using the RSS system		
Integrated access to user e-mails		
Integrated authentication	Security	**Integration of knowledge**
Data encryption		
Use of security standards		
Preparation of various reports of trust systems	Trust	
Secure digital data exchanges		
Credit of digital resources		
Automated messaging		
Geographical unlimitedness	Easy accessibility	
Saving time and money in accessing resources		
Access using unit code		
Unlimited databases available		
Smart search	Information search	**Monitoring and updating knowledge**
Save search history		
Integrated and unified search		
Reporting of failed searches		
Expanding the search		
The possibility of modification and changes	Information recovery	
Ability to access old data		
Relationship management and referrals		
Introduction of updated information		
Optimizing search results	Information development SSO components User input	
Ranking results		
Share knowledge with other users		

We observe from Table 8 that there are 4 main categories in the field of knowledge extraction based on SSO. They include Infrastructural measures of knowledge extraction (2 SSO components and 8 codes), Knowledge organization (2 SSO components and 9 codes), Integration of knowledge (3 SSO components and 11 codes), and Monitoring and updating knowledge (3 SSO components and 12 codes).

Step 6: Control of analysis quality

Four quantitative criteria have been used to assess validity, transferability, verifiability, and reliability: The Holstein coefficient, Scott's Pi coefficient, the Cohen's kappa coefficient (κ), and Krippendorff's alpha (α).

The correlation of the experts' viewpoints with the calculation of the Holstein coefficient or "Percentage of Observed Agreement" (PAO) is obtained 0.850 which is a significant value. According to the drawbacks of the Holstein method, Scott's Pi coefficient has also been calculated, which is 0.807. The fourth indicator for assessing the validity of qualitative research is Cohen's kappa coefficient. The Cohen's kappa coefficient in this study is 0.795. Finally, Krippendorff's alpha has been used which in this study it is estimated 0.843.

Step 7: Presenting the report and studying the findings

In this step of the meta-synthesis method, the findings of the previous steps are presented. At this stage, using the Shannon entropy method, the support level of previous studies from the findings of this study is shown statistically.

Shannon entropy

According to the Shannon entropy method, data processing in the discussion of content analysis is presented with a new perspective, quantitatively and qualitatively (Lin, 1991).

After identifying the research indicators based on content analysis and determining the units of analysis (words and themes), the Shannon entropy method will be used to analyze the data as following:

- First, the frequency of each of the identified categories must be determined based on content analysis.
- The intended matrix must be normalized. For this purpose, the linear normalization method is used:

$n_{ij}= \frac{\text{xij}}{\Sigma \text{xij}}$

The information load of each category must be calculated. The following equation is used for this purpose:

$k = \frac{1}{Ln(a)}$ a = Number of options

$Ej=-k\Sigma[n_{ij}LN(n_{ij})]$

The coefficient of importance of each category must be calculated. The higher information load, the more important each category is. The following equation is used for this purpose:

$w_{\text{j}} = \frac{\text{Ej}}{\Sigma \text{Ej}}$

Therefore, in the first step, the decision matrix is formed. The scores obtained from the decision matrix on the issue are presented in the following table:

Table9. *Determining the importance and emphasis of previous research on identified factors*

Code	Frequency	Importance factor Wj	Uncertainty Ej	$\sum P_{ij} \times knP_{ij}$	Rank
Communication infrastructure	5	0.0241	0.0234	-0.0863	**15**
Supporting all data formats	5	0.0241	0.0234	-0.0863	**15**
Software architecture platform	3	0.0164	0.0159	-0.0588	**29**
Determining the ownership of a digital resource	3	0.0164	0.0159	-0.0588	**29**
Ability to receive personal files	3	0.0164	0.0159	-0.0588	**29**
The ability to convert text resources into desired display and text formats	3	0.0164	0.0159	-0.0588	**29**
Setting access levels	4	0.0204	0.0198	-0.0731	**26**
Metadata output	5	0.0241	0.0234	-0.0863	**15**
The possibility of storing archival versions	3	0.0164	0.0159	-0.0588	**29**
The possibility of introducing academic colleagues around the world	5	0.0241	0.0234	-0.0863	**15**
Ability to determine interest	5	0.0241	0.0234	-0.0863	**15**
The possibility of designing a personal library	3	0.0164	0.0159	-0.0588	**29**
The possibility of tagging	4	0.0204	0.0198	-0.0731	**26**
The possibility of connecting to many digital knowledge systems	5	0.0241	0.0234	-0.0863	**15**
Ease of resource management	5	0.0241	0.0234	-0.0863	**15**
Using the RSS system	7	0.0307	0.0298	-0.1101	**9**
Integrated access to user e-mails	7	0.0307	0.0298	-0.1101	**9**
Integrated authentication	10	0.0393	0.0382	-0.1409	**3**
Data encryption	6	0.0275	0.0267	-0.0986	**13**
Use of security standards	9	0.0366	0.0356	-0.1312	**6**
Preparation of various reports of trust systems	5	0.0241	0.0234	-0.0863	**15**
Secure digital data exchanges	7	0.0307	0.0298	-0.1101	**9**
Credit of digital resources	8	0.0337	0.0328	-0.1209	**7**
Automated messaging	10	0.0393	0.0382	-0.1409	**3**
Geographical unlimitedness	10	0.0393	0.0382	-0.1409	**3**
Saving time and money in accessing resources	8	0.0337	0.0328	-0.1209	**7**
Access using unit code	12	0.0444	0.0431	-0.1591	**1**
Unlimited databases available	11	0.0419	0.0407	-0.1502	**2**
Smart search	6	0.0275	0.0267	-0.0986	**13**
Save search history	5	0.0241	0.0234	-0.0863	**15**

Integrated and unified search	3	0.0164	0.0159	-0.0588	**29**
Reporting of failed searches	5	0.0241	0.0234	-0.0863	**15**
Expanding the search	7	0.0307	0.0298	-0.1101	**9**
The possibility of modification and changes	2	0.0120	0.0116	-0.0429	**39**
Ability to access old data	3	0.0164	0.0159	-0.0588	**29**
Relationship management and referrals	2	0.0120	0.0116	-0.0429	**39**
Introduction of updated information	4	0.0204	0.0198	-0.0731	**26**
Optimizing search results	3	0.0164	0.0159	-0.0588	**29**
Ranking results	5	0.0241	0.0234	-0.0863	**15**
Sharing knowledge with other users	3	0.0164	0.0159	-0.0588	**29**

As can be seen in Table 9, Access using unit code with the rank of 1 and frequency of 12 is one of the most important components in a knowledge extraction system based on SSO in libraries, which has been mentioned in previous studies. On the other hand, Relationship management and referrals and The possibility of modification and changes are ranked at the lowest with frequency of 2.

Finally, based on the extracted codes, the dimensions of the system are shown in the figure below in the ATLAS TI software.

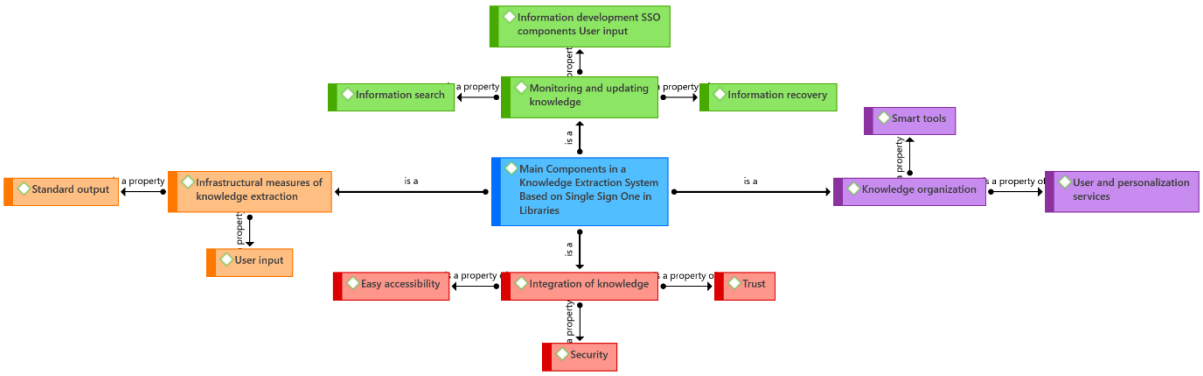

Figure 4. *Dimensions of knowledge extraction system based on SSO in libraries in ATLASti software*

In the following, the Interpretive Structural Modeling (ISM) method was used in MICMAC software for data analysis. Designing an Interpretive Structural Model (ISM) is a method to investigate the effect of each variable on other variables; This design is a comprehensive approach to measuring communication and this design is used to develop the framework of the model so that the general objectives of the research are possible.

The first step in ISM is to calculate the internal relationships of the indicators. Experts' viewpoints are used to reflect the internal relationships between indicators. The research components were coded in Table 10.

Table 10. *Coding of identified components*

Variable	Symbol
User input	**C1**
Standard output	**C2**
User and personalization services	**C3**
Smart tools	**C4**
security	**C5**
trust	**C6**
easy accessibility	**C7**
Information search	**C8**
information recovery	**C9**
Information development	**C10**

The matrix obtained in this step shows which variable affects another variable and from which variables it is affected. Conventionally, symbols like Table 11 are used to identify the relationship pattern of elements.

Table 11*. Modes and signs used in expressing the relationship of the identified indicators*

O	X	A	V
Absence of relationship	Two-way relationship	Variable j affects i	**Variable i affects j**

The Structural Self-Interaction Matrix consists of the dimensions and indicators of study and their comparison using four modes of conceptual relations. The resulting information is formed based on the ISM method of summation and the final Structural Self-Interaction Matrix. According to the signs listed in Table 11, the structural self-interaction matrix will be as Table 12.

Table 12. *The Structural Self-Interaction Matrix (SSIM)*

C10	C9	C8	C7	C6	C5	C4	C3	C2	C1	Variable
V	V	V	V	V	V	V	V	X		**C1**
V	V	V	V	V	V	V	V			**C2**
V	V	V	V	V	V	X				**C3**
V	V	V	V	V	V					**C4**
V	V	V	X	X						**C5**
V	V	V	X							**C6**
V	V	V								**C7**
X	X									**C8**
X										**C9**
										C10

The received matrix is obtained by transforming the SSIM into a two-valued matrix of zero and one. In the received matrix, the dimensions of the main diameter are equal to one. Therefore, the received matrix of the ISM technique is presented in Table 14.

Table 14*. Received matrix of identified indicators*

C10	C9	C8	C7	C6	C5	C4	C3	C2	C1	Variable
1	1	1	1	1	1	1	1	1		**C1**
1	1	1	1	1	1	1	1		1	**C2**
1	1	1	1	1	1	1		0	0	**C3**
1	1	1	1	1	1		1	0	0	**C4**
1	1	1	1	1		0	0	0	0	**C5**
1	1	1	1		1	0	0	0	0	**C6**
1	1	1		1	1	0	0	0	0	**C7**
1	1		0	0	0	0	0	0	0	**C8**
1		1	0	0	0	0	0	0	0	**C9**
	1	1	0	0	0	0	0	0	0	**C10**

The method of obtaining the access matrix is by using Euler's theory, where we add the adjacency matrix to the unit matrix.

Table 15. *The final access matrix of the identified indicators*

C10	C9	C8	C7	C6	C5	C4	C3	C2	C1	Variable
1	1	1	1	1	1	1	1	1	**1**	**C1**
1	1	1	1	1	1	1	1	**1**	1	**C2**
1	1	1	1	1	1	1	**1**	0	0	**C3**
1	1	1	1	1	1	**1**	1	0	0	**C4**
1	1	1	1	1	**1**	0	0	0	0	**C5**
1	1	1	1	**1**	1	0	0	0	0	**C6**
1	1	1	**1**	1	1	0	0	0	0	**C7**
1	1	**1**	0	0	0	0	0	0	0	**C8**
1	**1**	1	0	0	0	0	0	0	0	**C9**
1	1	1	0	0	0	0	0	0	0	**C10**

Determining relationships and leveling dimensions and indicators

To determine the relationships and leveling of the criteria, the set of outputs and the set of inputs for each criterion should be extracted from the received matrix.

- Access set (row elements, outputs, or effects): Variables that can be accessed through this variable.
- Prerequisite set (column elements, input, or effects): variables through which this variable can be reached.

The set of outputs includes the criterion itself and the criteria that are affected by it. The set of inputs includes the criterion itself and the criteria that affect it. Then, the set of two-way relations of the criteria is specified.

Table 16. *Set of inputs and outputs (effects) for each variable*

Affected	Affecting	Symbol
2	10	**C1**
2	10	**C2**
4	8	**C3**
4	8	**C4**
7	6	**C5**
7	6	**C6**
7	6	**C7**
10	3	**C8**
10	3	**C9**
10	3	**C10**

For the C_i variable, the access set (inputs or effects) includes the variables that can be reached through the C_i variable. The prerequisite set (output or effects) includes the variables through which the variable C_i can be reached.

After determining the achievement set and the prerequisite set, the subscription of the two sets is calculated. The first variable for which the commonality of the two sets equals the attainable set (outputs) will be the first level. Therefore, the elements of the first level will have the most influence on the model. After determining the level, the criterion whose level is known is removed from the whole set, the set of inputs and outputs is formed again and the next variable level is obtained.

Table 17. *Determining the first level in the ISM hierarchy*

Level	Unity	Input	Output	Symbol
1	C1-C2	C1-C2	C1-C2-C3-C4-C5-C6-C7-C8-C9-C10	**C1**
1	C1-C2	C1-C2	C1-C2-C3-C4-C5-C6-C7-C8-C9-C10	**C2**
2	C3-C4	C1-C2-C3-C4	C3-C4-C5-C6-C7-C8-C9-C10	**C3**
2	C3-C4	C1-C2-C3-C4	C3-C4-C5-C6-C7-C8-C9-C10	**C4**
3	C5-C6-C7	C1-C2-C3-C4-C5-C6-C7	C5-C6-C7-C8-C9-C10	**C5**
3	C5-C6-C7	C1-C2-C3-C4-C5-C6-C7	C5-C6-C7-C8-C9-C10	**C6**
3	C5-C6-C7	C1-C2-C3-C4-C5-C6-C7	C5-C6-C7-C8-C9-C10	**C7**
4	C8-C9-C10	C1-C2-C3-C4-C5-C6-C7-C8-C9-C10	C8-C9-C10	**C8**
4	C8-C9-C10	C1-C2-C3-C4-C5-C6-C7-C8-C9-C10	C8-C9-C10	**C9**
4	C8-C9-C10	C1-C2-C3-C4-C5-C6-C7-C8-C9-C10	C8-C9-C10	**C10**

Therefore, the variable C1-C2 is the first level variable. After identifying the variables of the first level, these variables are removed and the set of inputs and outputs is calculated without considering the variables of the first level. The common set of identification and the variables whose commonality is equal to the set of inputs is selected as the second-level variables.

C3-C4 variables are second-level variables.

C5-C6-C7 variables are third-level variables.

C8-C9-C10 variable is the fourth level variable.

The final pattern of the levels of the identified variables is shown in the figure. In this diagram, only the meaningful relationships of the elements of each level on the elements of the lower level, as well as the meaningful internal relationships of the elements of each row, are considered.

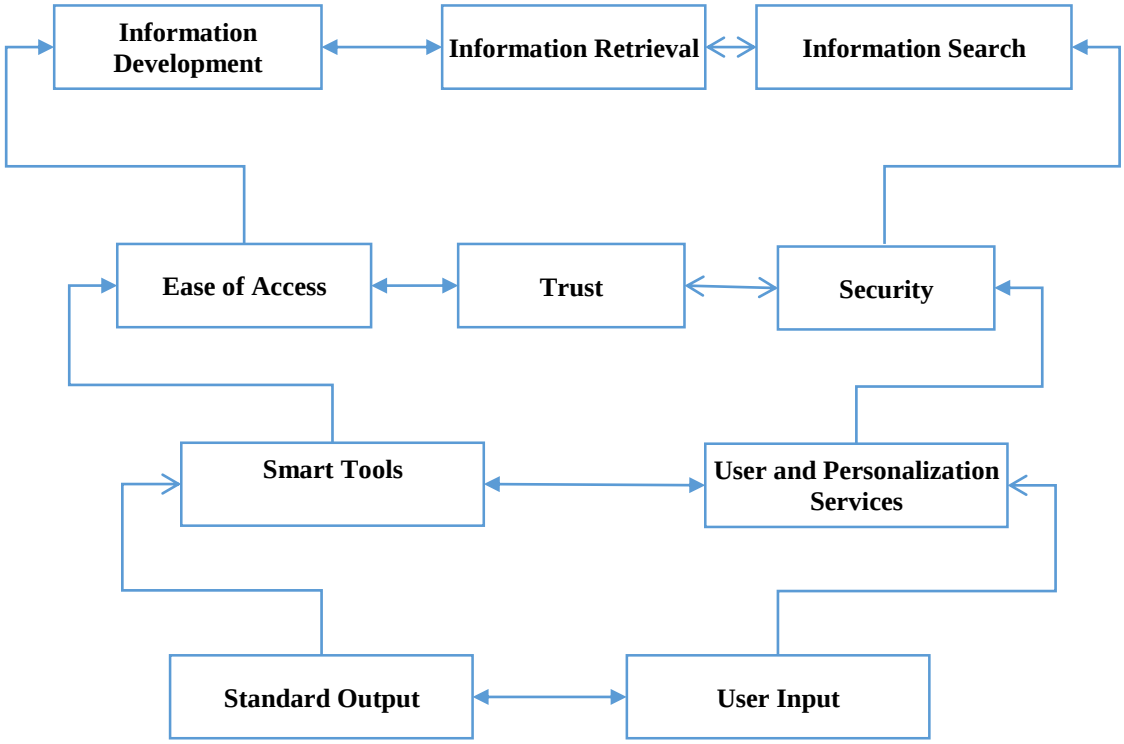

Figure 5. *Basic model developed by ISM method*

Discussion

Public, academic, educational, and even national libraries need to acquire and extract knowledge from their users' activities in order to provide better services to them. With the development of technology and its application in the field of libraries, the method of extracting customer knowledge has changed. SSO is one of the hot trends and high topics in the field of libraries. Therefore, in this research, based on SSO features, we have provided a knowledge extraction framework for library users. By using this model, library managers and officials can find out the search preference and information needs of library users by following their activities in an integrated environment. Therefore, librarians can help users in the search for the resources they need and improve their services by establishing cooperation with other libraries at the regional and international levels. Also, saving time, users can search and study in the library village without going out of their destination. In this article, using ISM, a model for designing a knowledge extraction system based on SSO in libraries was presented, which has 4 levels. The results of this research are in line with the researchers' studies: One of the important components in the field of knowledge extraction systems based on SSO is user input and standard output, which requires technological infrastructure. Chowdhury, Chowdhury & Crossley (2022) state that in a distributed and integrated system, one of the major issues is communication infrastructure for reliable data transmission, the lack of which is a potential problem in implementation. Viros-i-Martin & Selva (2021) mentions IEC 61850 carrier communication and communication infrastructure as suitable telecommunication infrastructure and communication protocol. Also, in the knowledge extraction process section, the user's input for implementing the necessary instructions in the plan is also mentioned. The use of artificial intelligence tools to facilitate the extraction of knowledge in quick decisions has been considered, and standard output is needed for the ability to read and use information, which has been mentioned in different studies (Saha et al., 2021; Omidipoor et al., 2020).

Personalization services and smart tools are at the second level of this system which have been mentioned by other researchers too. Personalization services can reduce information overload and

thus increase user satisfaction while taking into account differences between individuals to increase usability (Ojino, 2018) and provides textual and personalized content based on the user's needs and interests (Shivakumar, S. K., & Sethii, 2019).; and they are essential in an SSO framework to provide authentication and authorization (Shivakumar, 2020). Janita, Kannan & Kumaratharan (2020) state that smart devices require an SSO service to create an automatic configuration. Knowledge extraction as a knowledge acquisition method in the knowledge management process also requires smart tools. As mentioned in this paper, by using SSO, the process of knowledge extraction can be improved in the libraries that use SSO the most.

Establishing a secure communication infrastructure in an SSO-based knowledge extraction system should ensure integrity and confidentiality. This communication can be implemented using current standard protocols such as TLS, SSL, and IPsec (Fragoso-Rodriguez et al., 2006). Challenges related to the needs of users and their attitude toward using library resources and the ownership of digital resources are involved in determining the level of access of users to resources (Vij, 2018). The strict ownership of digital resources by reducing the amount of user access to the required information also limits the libraries in identifying the amount of use of the users' resources.

Levels of open access are now at a tipping point (Bosman & Kramer, 2018; Tay, 2022). To create a library village where access to knowledge is available to users anywhere in the world, open access levels are important. Due to confidentiality, user access is defined according to their expertise and activity. Therefore, by determining the appropriate access for the user, in each specialized and non-specialized organization, one can be aware of the knowledge needs of that area and try to provide services to respond to the existing knowledge gap.

Trzmielewski & Gnoli (2022) deals with the organization of knowledge in the university medical library system to retrieve and extract knowledge from electronic resources. Also, Vega García (2015) in his business context with the definition of SSO points out the importance of organizing knowledge using thesauruses to classify different digital assets to facilitate knowledge extraction. Nithesh & Rakshak (2018) address the importance of integrity and security due to the importance of big data and the significant contribution they have in extracting knowledge and decision-making. Considering its importance, we should be aware of security breaches in the future. Makropodis (2021) states that the authentication process should be used in the application or web service to create a higher level of security because the applications do not have direct access to user information. Liu, Q., Wang, X., & Pan, (2020) mentions SSO as a solution in data recovery. Also, the use of SSO can facilitate the information retrieval process in libraries (Suhartika & Haryanti, 2020). The use of SSO is effective in information retrieval and data sharing in centralized and decentralized systems (Domalis et al., 2020), and information search (Wu, 2018; Bhardwaj, 2021). Yao (2021) mentions the use of SSO in the development of self-focused information. It is also important in creating data security and developing secure authentication information (Taherdoost, 2021).

In order to provide the best services to library users, it is important to organize knowledge to implement knowledge extraction techniques. The dataset resulting from the user's online activities is analyzed using knowledge extraction techniques such as data mining and its hidden knowledge is discovered. Determining the topic of interest and tagging is important in extracting the knowledge of library users.

Conclusion

In this case, libraries need to set a defined platform for SSO with the capability of storing the search and download history of users. Therefore, based on the need of the library an SSO provider should be chosen and personalization of the SSO implementation should be considered. As one of the weaknesses of SSO is losing data after the system-breaking or being hacked, there should be a backup service to not to lose the collected data for the library and users. Using a flexible SSO platform can protect and share the staff's knowledge with newcomers on a safe platform; in this way, no knowledge will be destroyed after the staff's retirement or leaving work. Hiring knowledge managers with the skill of data mining and artificial intelligence should be considered in the library staff hierarchy. By having the qualification in the knowledge field, knowledge managers can build and generate diagnosis models and flows based on the data stored in the library platform and help library managers to run the library in the line with the needs and requirements in a safe way. This data is extracted directly from users' activities which shows one by one knowledge gaps in the society and region. On the other hand, using SSO leads users to use the library services easily and data is collected without

any time wasting. Moreover, the problem with users who are not comfortable with talking to librarians or having some communication problems will be omitted.

Declaration of Competing Interest

The author declares that he has no competing financial interests or known personal relationships that would influence the report presented in this article.

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