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A JOURNEY IMPLEMENTING A KNOWLEDGE PORTAL: THE DAR AL-HIKMAH LIBRARY EXPERIENCE

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Abstract

This article describes how the Dar al-Hikmah Library's knowledge portal was developed through the combined efforts of a select IIUM team and a contracted developer, drawing on insights gained from examining knowledge management portals used in various local academic libraries. The project team significantly improved their proficiency in system development and programming through cooperative work, proactive participation, and technology transfer initiatives. Topics covered in training sessions included user requirements, server configuration, Python, Scrapy, Apache Solr indexing, and more. The architecture of the PHP Laravel-based portal, Solr data storage, and crawling engine achieved efficient data retrieval and storage. Additionally, the team developed 10 knowledge clusters within the portal to enhance information organization and accessibility.

The challenge for institutions to make their users aware of their knowledge portals was emphasized, highlighting the need for additional outreach. The iKnow portal project has produced a useful and navigable platform for knowledge management and sharing.

Keywords: Knowledge Portal, Knowledge Management, Knowledge Sharing, Open Source, IIUM

Introduction

Higher learning institutions are becoming more aware of the importance of managing organizational knowledge in the fast-paced, constantly evolving digital environment. The significance of knowledge capture and utilization to stay updated on developments and maintain competitiveness is highlighted by the evolution of technology.

Knowledge management (KM) is a discipline that promotes an integrated approach to create, capture, organize, access, and use an enterprise's information assets including structured databases, textual information, and most importantly, the tacit knowledge and expertise of individual employees (Harris et al., 1999).

Recognizing the importance of KM, the International Islamic University Malaysia (IIUM) developed the iKnow portal. This initiative was spearheaded by the former Chief Librarian and outlined in the IIUM Roadmap 2021-2022 under the Knowledge Connectivity Initiative. The portal acts as a central hub for the university's information supporting KM (Dar al-Hikmah Library, 2021).

KM enables people to create, share, connect, and utilize knowledge. The practice in IIUM is inspired by the NASAAPPEL Knowledge Inventory. Ten knowledge clusters were selected to represent the knowledge content from various sites in IIUM. In terms of operational support, the portal is managed by the Knowledge Management & Repositories Section (KMRS) of Dar al-Hikmah Library (DaHL), while technical support is handled by the Library Technology Section (LTS) with assistance from the Information Technology Division (ITD) of the University.

The portal can be accessed by the IIUM community and the public at the knowledge owner's accessibility level. A single search platform that connects IIUM knowledge via a federated search is what IIUM wishes to achieve at the end of the project. The portal should be able to filter the knowledge clusters using queries or keyword searches. The project, jointly developed in-house with an appointed vendor, provides many opportunities for DaHL staff to explore the many possibilities of managing the knowledge.

Choosing The Technology

Feasibility Study

Before embarking on this project, a feasibility study was done to identify the suitable technology to use in developing the portal. Among the open-source software explored were Vu Find, Backlight, eXtensible Catalog/XC, Elasticsearch, Algolia, Apache Solr, Laravel, and Apache Lucene Core. Each of these open-source software has its advantages and disadvantages. However, after considering the options, Apache Solr was chosen as the crawling technology with Laravel as the landing page.

Open-source Options And Considerations

A comparison of technical specifications for various software was conducted and are illustrated in Table 1.

Table 1: Comparison of Open-Source Software

Software	Developer	Cost	Open source	Written	Index/search Engine	Database	License	Notes
VuFind	Villanova University	Free	Yes	PHP	Lucene, Solr	MySQL	GPL	Web-based
Blacklight	University of Virginia	Free	Yes	Ruby	Ruby on Rails, Apache, Solr	Java	Apache	Web-based
Extensible Catalog (XC)	University of Rochester	Free	Yes	XC Drupal Toolkit		XC Drupal Toolkit	GPL	Web-based

The technical team from the Information Technology Division (ITD) suggested opting for Laravel and either Apache Solr or Apache Lucene due to the suitability of the software. This suggestion stems from the suitability of Apache Solr's features which cater to the unique needs of IIUM. The primary focus of the portal is advancements in full-text search capabilities which are powered by Lucene. This enables powerful matching, including phrases, joins, grouping, and many more, across any date type.

Other Apache Solr features include a comprehensive administration interface. The built-in responsive user interface facilitates the control of Solr instances. In addition, it is compatible with standards-based open interfaces such as XML, JSON, and HTTP which simplifies application development. Solr has a flexible and adaptable design with easy configuration to accommodate DaHL needs.

Content Creation/Management

Content Structure

iKnow is aimed at becoming a single search platform that connects relevant IIUM knowledge by crawling related content from repositories and websites. This vision aligns with the common features of knowledge portals, which typically include content management databases, repositories, search functions, embedded applications and services, collaboration and communication tools, user accounts, and a user-friendly interface that supports knowledge-sharing and knowledge-brokering processes (Weber et al., 2023a).

The content for iKnow was crawled from different sources, organized, and categorized into 10 clusters. The content management of a knowledge management system should have the ability to integrate, organize, and categorize knowledge from various sources (Benbya et al., 2004). The 10 clusters for iKnow are illustrated in Table 2.

Table 2: Knowledge Clusters in iKnow

No	Knowledge Cluster	Description
i	Rules and Policies	IIUM Policies, standards, guidelines, etc.
ii	Experts Corner	IIUM experts' profiles.
iii	Awards and Achievements	Awards and achievements received by IIUM.
iv	Knowledge Resources	Knowledge resources available at IIUM such as thesis, manuscript, book, etc.
v	Research Outputs	Research and scholarly publications by the IIUM community.
vi	SDG and Flagship	Information related to Sustainable Development Goals (SDG) and Flagship projects of IIUM.
vii	Knowledge Sharing	IIUM knowledge-sharing activities held at the university.
viii	Community Engagement	IIUM community engagement programs.
ix	History	IIUM corporate memories and archive collections.
x	Lessons Learnt	Lessons learned and success stories of the IIUM community.

Strategies For Ensuring The Quality And Relevance Of The Content: Data Sources

To ensure the quality, relevance, and consistency of the content, a template of data sources and metadata schemes was created and shared with the Knowledge Champions and Webmasters. This template consisted of URLs to be crawled. A scheduler was set to periodically crawl for any additions or changes to the websites. Any changes or additions to content are communicated to the project team.

Despite regular updates of the data sources template, there were still some risks and issues that arise at the knowledge owners' websites such as:

- a. Unavailability of content
- b. Broken URLs
- c. Outdated content

It is the responsibility of the knowledge owners to consistently update their websites so that the content of the portal is current.

User Interface (UI)

User-Friendly And Accessible

A good portal must have a user-friendly interface that is easily accessible for retrieving content. Currently, most portals adopt graphical user interfaces (UI) with minimal text. A poorly designed UI will lead to an underutilized portal due to difficulties in retrieving information. This is supported by Rosala (2020) who found that users tend to judge a portal based on the interface appearance rather than its functionality or content. However, in some cases depending on the nature of the portal, text-based interfaces are still relevant and used.

The concept of iKnow was inspired by NASA's Knowledge Inventory. DaHL decided to include elements such as a search box and icons representing the main clusters in the iKnow interface. Following the creation of various designs and feedback from the team, adjustments were made to ensure that the interface was user-friendly and adhered to accessibility principles in design as illustrated in Figure 1.

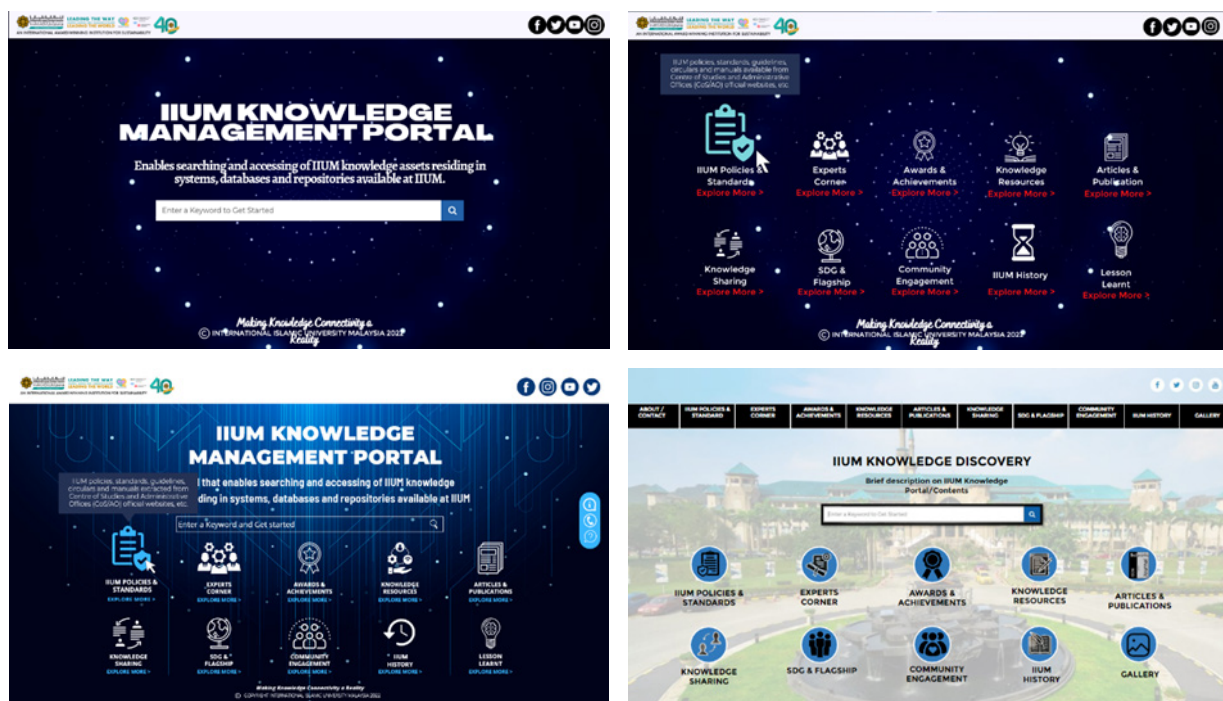


Figure 1: Several Proposed Designs for the iKnow User Interface

Efforts were made to design a user-friendly interface for iKnow. According to Norman's 2002 theory, when users perceive a highly intuitive user interface design within a web portal, they find it easy to navigate through the website. This leads to a self-explanatory experience with fewer errors, ease of use, ease of recall, and ease of learning (Norman, 2002). DaHL tried to produce an interface following this theory, by imagining ourselves as the users of the iKnow portal. The interface for iKnow (Figure 2) was designed by a student intern hired to assist in developing the portal.

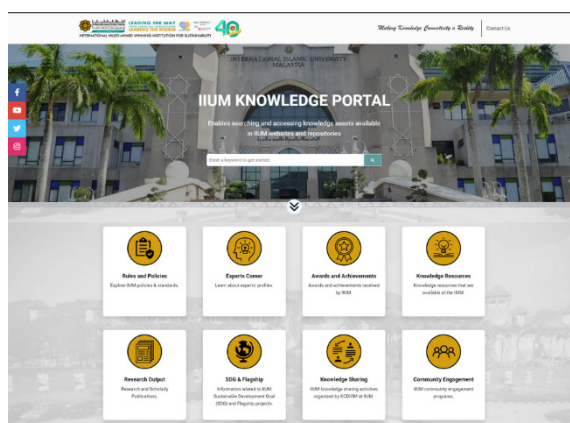


Figure 2: Final User Interface for iKnow

NAVIGATION AND INFORMATION ARCHITECTURE

The architecture of the crawling engine for this portal comprises three main components: the crawling engine (spider), Solr data storage, and the PHP Laravel-based knowledge portal. iKnow system architecture is illustrated in Figure 3. The crawling engine fetches and extracts data from the specified sources. The crawling engine will run on a dedicated server to ensure optimal performance and resource allocation. The Solr server is used to store the information gathered. Solr is a highly scalable and reliable search platform used for storing and indexing information retrieved by the crawling engine. The information is hosted on separate servers for efficient storage and retrieval. The architecture is designed to be modular, ensuring that each component can be developed, maintained, and scaled independently. This modularity allows for easier troubleshooting, better resource allocation, and future improvements.

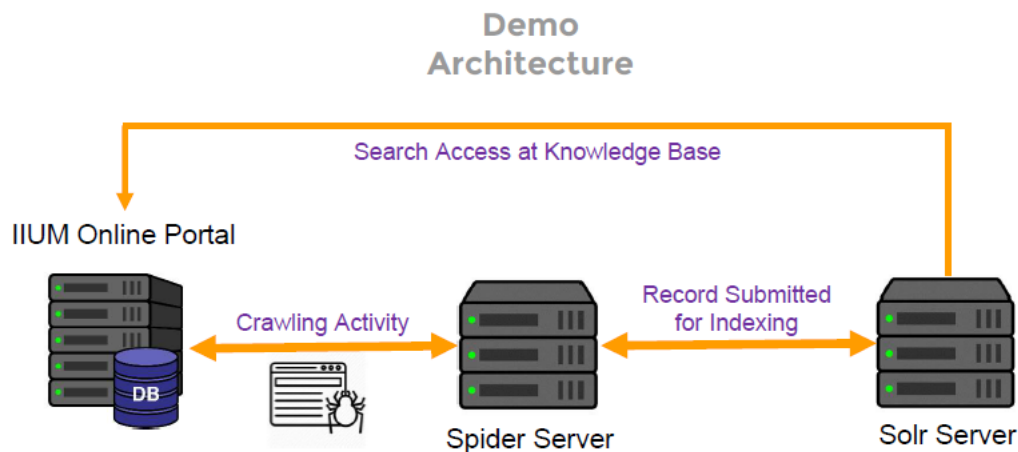


Figure 3: iKnow System Architecture

Search Functionality

iKnow allows federated searches using keywords. The portal uses search engine technology that can crawl results within the 10 clusters. The results appear and are sorted based on the relevancy of the searched keywords, the date of content being crawled, and the category of the resources. iKnow also provides a filtering feature for users to filter their search results by the category of the resource; name of the Kulliyah, centre, department, institute, office, or Mahallah (KCDIOM); and type of resource. A faceted search is also provided. This can assist the users in specifying their search and promptly bring them to the required resource. The portal offers an accessibility menu for users with special needs.

However, the Solr system only allows Boolean searches with the operator AND. Truncations and wildcards are not applicable due to limitations of the system. Regardless of these limitations, iKnow aims to reduce information retrieval time by connecting users with relevant IIUM knowledge through a single search platform. It is emphasized that "the vision, the main goal of the project "Knowledge Portal" is to develop a central access system in terms of a 'single point of access' for all electronic information services" (Neubauer & Piguet, n.d., p. 2). iKnow allows users to efficiently explore and retrieve the information they seek, contributing to a more informed and connected community.

Monitoring And Analytics

Google Analytics (GA) is a cloud-based analytics tool that is widely used to measure and report website traffic. In iKnow, GA is used to generate relevant reports for monitoring and analytics purposes as demonstrated in Figure 4. GA provides valuable insight into how visitors discover and utilize the portal, aiding in strategies to retain their engagement. Beyond traffic metrics like sessions and users, it offers data on user interactions, engagement levels, page views, average session duration, bounce rates, link clicks, and geographical information such as user locations and operating systems.

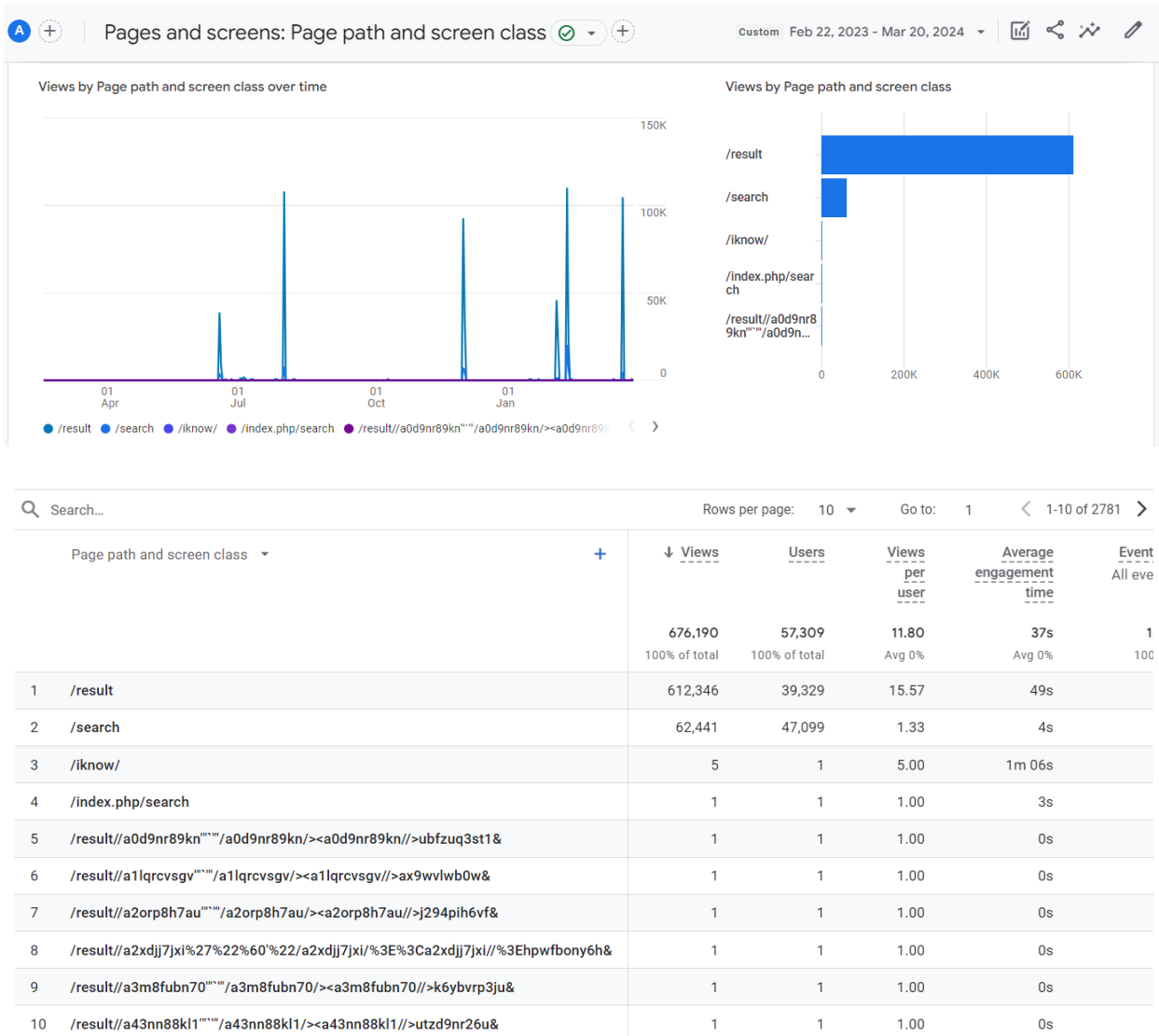


Figure 4: iKnow Website Traffic

System Maintenance And Security Measures

Given that iKnow will be used by both internal and external communities, security from cyber threats is a top priority. Several measures have been put in place to guarantee its safety.

i. HTTPS Implementation for Secure User-Server Communication

iKnow incorporates HyperText Transfer Protocol Secure (HTTPS) to guarantee the protection of data security and integrity during the transmission process. The Secure Sockets Layer (SSL) certificate secures communication between the user and the portal server through encryption and decryption procedures. This will cultivate trust and inspire confidence in users who visit iKnow.

ii. Prevention of Common Threats

Common security risks such as Structured Query Language (SQL) injection, denial-of-service (DoS) attacks, and cross-site scripting (XSS) are mitigated by implemented security controls. SQL injection was a possible when the portal first opened. The issue was solved by implementing rigorous input validation techniques. Although the technical staff has not received formal training on secure coding practices, they are constantly upskilled through self-exploration and remain vigilant against emerging security threats

iii. Penetration Testing

Comprehensive cycles of penetration testing were carried out to evaluate vulnerabilities before iKnow went live and during the post-launch phase. Every system in the library, including iKnow, is subject to a penetration test that is arranged to be carried out annually. Table 3 shows the number of issues by severity based on the vulnerability testing of iKnow.

Table 3: Number of Issues by Severity Based on Vulnerability Testing of iKnow

Vulnerable Test No.	Issues by severity				Total
	High	Medium	Low	Information	
Cycle 1	17	4	4	55	80
Cycle 2	5	6	4	50	65
Cycle 3	6	5	6	63	80
Cycle 4	5	0	4	39	48
Cycle 5	2	0	0	45	47

These comprehensive security measures, annual testing, and the dedication of the iKnow teams are critical to ensuring that iKnow remains safe and reliable for the community it serves

iv. System Backup and Maintenance

The Backup Management Plan was prepared and documented as a guide for executing the portal and server backup. A complete backup of the system is done on the 10th day of every month. It involves a comprehensive backup of the critical data systems. One of the advantages of implementing a full backup method is that all data is captured. This makes data restoration faster because all data is available in one place. It is important for comprehensive protection from data loss due to system corruption and for fast system recovery. Additionally, a daily backup with a six-

day cycle record retention period is done using Nutanix Snapshot. The daily backup is done at the IIUM Data Centre by the Data Centre Team (Information Technology Division, 2019) and stored in the Nutanix cluster. Nutanix Snapshot is a space-efficient system to save point-in-time copies of the virtual machine server.

Training And Technology Transfer

In implementing the project, DaHL took the initiative to develop iKnow via the joint development approach. Joint development is a collaborative approach to develop a portal that involves multiple participants working together on different aspects of the project. This approach was taken for several reasons.

The first reason was to reduce costs by not fully outsourcing to an appointed vendor. This approach reduced the human resource cost and consequently contributed to reducing the total project cost.

Second, it involved active participation by the IIUM team with guidance from the appointed developer. The transfer of technology ensures that the project team will be able to maintain iKnow and will be able to add value to it continuously.

In addition, it allowed sharing of responsibilities and the integration of team contributions to develop a cohesive portal. DaHL appointed a student intern to develop and design the UI whereas, the technical and appointed developer focused on developing the crawling and indexing modules. The team worked together with the student intern to develop the iKnow in different areas. From this project, the student gained industrial programming experience and developed competencies in programming and building modular systems.

The appointed developer provided training as well as the transfer of technology to the technical team. The training was divided into technology transfer, indexing, and crawling modules. The first part of the training and technology transfer focused on user requirements and specifications, server setup, and installation of Scrapy, Python, and Solr (Table 4).

Table 4: Technology Transfer Module

Training & Technology Transfer	
Module 1	User requirements and specifications Development server setup & configuration Installation of Scrapy & Python Library Installation of Solr
Module 2	Python for beginners part 1
Module 3	Python for beginners part 2
Module 4	Apache Solr for development
Module 5	Scrapy for beginners
Module 6	Scrapy for intermediate users

The second part of the training was the indexing module (Table 5).

Table 5: Training on Indexing Module

Indexing Module	
Module 1	Apache Solr production installation & configuration
Module 2	Apache Solr backup & replication
Module 3	Managing & fine-tuning Apache Solr
Module 4	Securing Apache Solr
Module 5	Apache Solr query part 1
Module 6	Apache Solr query part 2

To complete the training and technology transfer, the appointed developer trained the project members on the crawling module which involved developing, testing, and user acceptance tests for the spider crawling, as shown in Table 6.

Table 6: Training on Crawling Module

Training & Technology Transfer	
Module 1	Develop, test, and User Acceptance Test (UAT) for Spider Crawling Site 1
Module 2	Develop, test, and UAT for Spider Crawling Site 2
Module 3	Develop, test, and UAT for Spider Crawling Site 3
Module 4	Develop, test, and UAT for Spider Crawling Site 4
Module 5	Final Acceptance Test (FAT) & provisioning spiders for all sites

User Adoption Strategies

Knowledge portals developed by universities are vital in providing information and knowledge to clients. Knowledge portals provide the opportunity for clients to access and retrieve knowledge. They also become the access point to resources and information and become a place for knowledge dissemination, creation, and technology transfer (Abdul Latif, 2022). Among the promotion programs or strategies that can be implemented to encourage user adoption are:

i. Promotional Posters Through Social Media and Email Campaigns

This strategy is used for all types of promotions at IIUM. However, based on research evaluating the use of a knowledge portal for health policymakers, it was found that promotion through social media was ineffective because social media is cluttered with various advertisements (Weber et al., 2023b). Hence, the promotion to support iKnow should use other methods, strategies, and channels of communication.

ii. Engagement with Relevant Offices and Faculties

Another strategy is through engagement with the relevant KCDIOM especially those who still have not shared their knowledge. During the engagement, the KCDIOM will be presented with the search techniques and iKnow features to allow them to get a clear picture of what the portal can do.

iii. High-Quality Content

The project team members need to ensure that the portal is updated with relevant, accurate, and valuable content to encourage user adoption. Regularly updating the portal with high-quality content enables the users to access current, accurate, and relevant knowledge available at IIUM.

iv. User Guides and Tutorials

Another promotion strategy to encourage user adoption of iKnow is providing comprehensive documentation and training materials for users. DaHL can provide users with user guides and tutorials. These tutorials can be posted via YouTube channels and featured on the iKnow front page. Users should be able to easily find tutorials and guides on how to maximise the use of iKnow whenever they access it.

v. Promote Success Stories to Create Awareness

Success stories can be used to encourage user adoption of iKnow. When others know that some of the KCDIOM have successfully shared their knowledge through iKnow becoming more visible, it will encourage others to share their knowledge.

vi. Sharing Sessions (Hands-On)

Sharing sessions on how to use the portal are planned by DaHL to encourage user adoption and to popularize iKnow. A roadshow promotional tour is planned to each campus to conduct the sharing via hands-on sessions.

vii. Feedback

Another important yet valuable strategy is to get user feedback through surveys, polls, and suggestion boxes to continuously improve iKnow. From the user feedback, DaHL can identify the needs, improve the content or knowledge available, and modify the crawler to make suitable and relevant knowledge available.

Knowledge Portals At Other Higher Learning Institutions

A knowledge portal (KP) is “a type of portal that purposely supports and stimulates knowledge transfer, knowledge storage and retrieval, knowledge creation, knowledge integration, and knowledge application (i.e., the processes of knowledge management) by providing access to relevant knowledge artifacts” (Loebbecke & Crowston, 2012, p. 3). Knowledge portals enable users to efficiently search and retrieve information using keywords, filters, or advanced search functions. Portals offer various features to ease information retrieval. In Malaysia, only some of the higher learning institutions have successfully developed knowledge portals, as illustrated in Table 7.

Table 7: List of Knowledge Portals in Malaysian Higher Learning Institutions

List of Public Universities in Malaysia	List of Knowledge Portals
Universiti Malaya (UM)	-
Universiti Sains Malaysia (USM)	-
Universiti Kebangsaan Malaysia (UKM)	-
Universiti Putra Malaysia (UPM)	Portal Agri@UPM
Universiti Teknologi Malaysia (UTM)	-
Universiti Teknologi MARA (UiTM)	My Knowledge Management (MyKM)
Universiti Islam Antarabangsa Malaysia (UIAM)	IIUM Knowledge Portal (iKnow)
Universiti Malaysia Sabah (UMS)	-
Universiti Malaysia Sarawak (UNIMAS)	-
Universiti Utara Malaysia (UUM)	-
Universiti Pendidikan Sultan Idris (UPSI)	-
Universiti Tun Hussein Onn Malaysia (UTHM)	-
Universiti Teknikal Malaysia Melaka (UTeM)	-
Universiti Malaysia Perlis (UniMAP)	-
Universiti Malaysia Terengganu (UMT)	-
Universiti Malaysia Pahang (UMP)	-
Universiti Sains Islam Malaysia (USIM)	-
Universiti Sultan Zainal Abidin (UniSZA)	-
Universiti Malaysia Kelantan (UMK)	Open Knowledge Management (OKM)
Universiti Pertahanan Nasional Malaysia (UPNM)	Knowledge Web Portal for Military Tacit Knowledge

The UiTM Library has developed the MyKM system which focuses on collecting, managing, and disseminating knowledge information based on their reference materials. It acts as a centralized hub for the UiTM community, offering online access to various academic resources and information. MyKM provides complete information search, categorization, and personalization services which differ from iKnow. This portal is only accessible to the UiTM community as it requires login authentication.

Another example can be seen at UMK, which has developed the OKM portal. This portal provides an overview of knowledge management such as types of knowledge, benefits of knowledge management, etc. To access other resources or additional information, this portal requires login authentication.

UPNM has developed the KMS portal, an online discussion forum for their cadet officers where they can share and access military tacit knowledge, experiences, and training skills. This portal is for their internal community and is not available for public access (Zainol et al., 2018).

Finally, UPM has developed the Agri@UPM portal, which accesses various agricultural resources such as publications, experts, references, tutorial videos, etc.

To summarise, while other institutions differ in how they manage knowledge and allocate resources, their solutions are determined by the needs of their respective institutions' objectives.

Issues, Challenges And Lessons Learnt

In conducting this project, DaHL encountered some issues and challenges such as:

i. Staff Focus and Shortage of Resources

To address this challenge, a proper plan was designed to ensure the operational tasks were completed within project timelines.

ii. Complexity of the Data Sources

Selenium and manual import were used to address issues of data source complexity. An additional spider was developed and segregated for crawling activities.

iii. Changes in the Data Sources

DaHL needs to be alerted to any error log. All enhancements and changes to the data sources need to be communicated so that the technical project team is notified.

iv. Staff Competency to Complete the Project Deliverables

Hands-on and refresher sessions on technology transfer need to be continuously held and staff members must work together with the developer to ensure all deliverables are successfully delivered.

From the DaHL experience, it has been learned that the implementing team must be committed and have good communication to ensure the project deliverables are delivered as expected. When issues or problems arise, a good monitoring mechanism must be in place to address them.

DaHL created a WhatsApp group for team communication and a shared drive for document sharing and storage. Ongoing team meetings are also held every two weeks to ensure everyone understands the objectives and deliverables of the project.

DaHL also learned some best practices that can be adopted or applied to similar projects in the future:

- i. A standard metadata scheme is crucial in ensuring the search results are accurate, comprehensive, and reliable.
- ii. A standard design for all KCDIOM websites will facilitate crawling activities by spiders, enabling the identification of categories or subcategories of knowledge contents such as title, author, etc.
- iii. Delegation of tasks among team members is crucial and the team must focus on high-priority tasks.
- iv. The Webmaster should regularly update the website content so that it will ease the crawling activities and make the knowledge accessible to the users.

Future Developments And Continuous Improvement

The emergence of Artificial Intelligence (AI) provides a new technology tool to be utilized by knowledge portals. An example of AI in knowledge portals was the creation of a chatbot during the COVID pandemic named Jennifer, which served as a credible and easy-to-access information portal. AI technology can be used to support the intellectual analysis of a knowledge portal. It can also be used as a technique for capturing and categorizing knowledge (Xiao et al., 2023). Xiao et al. (2023) demonstrate applications of AI in knowledge portals for various purposes, such as organizing scientific knowledge, facilitating knowledge sharing, and providing information to the community during a crisis.

In the case of IUM, the plan to use AI technology is to support a greater demand of the university's top management and IUM community as well as to encourage and facilitate knowledge sharing and provide fast and easy access to IUM knowledge.

IUM expects that the portal will be able to respond to any question from the IUM community. Therefore, the portal's content management system needs to be frequently updated and enriched with accurate, up-to-date, and relevant knowledge. For the portal to crawl the websites of the KCDIOM, DaHL has worked hard to encourage them to share their knowledge and improve their content.

The searching features also need to be improved and enhanced to include advanced searches such as faceted navigation, natural language processing, and Boolean operators. With the advancement of technology, DaHL believes that the portal could serve as a search engine that gives users complete access to IUM knowledge. During the current development of the portal, only the AND Boolean operator was functioning. As a result, the portal search functionalities and techniques are limited. It is hoped that improvement and further development will be feasible.

Another important feature that needs to be taken into consideration is the UI. It should be enhanced to attract users to the portal. The UI design must be user-friendly, easy to navigate, and interactive to enhance user engagement.

Making the portal accessible on multiple devices and platforms is another plan for future enhancement. Navigation on multiple devices would help the user access the portal easily, at anytime, anywhere, from any device.

Implementing these enhancements and improvements would make the portal mature into a dynamic and user-centric platform that empowers the IUM community to effectively access, share, and make valuable knowledge visible.

Conclusion

The development of the iKnow portal through open-source solutions will greatly alter the methods of accessing, disseminating, and sharing knowledge at the university. This will provide many benefits to users and increase the efficiency of library's knowledge resources.

The objective of the iKnow portal is to connect all IUM-relevant knowledge and make it easily accessible. It aims to collect, store, share, and retrieve the available knowledge practically and effectively. The article has outlined the steps taken in developing the portal to achieve those objectives.

The portal has been successfully developed with the full commitment of the Chief Digital Officer (CDO) as the project sponsor and the team members. Despite the challenges encountered during the development phase, the portal was successfully launched on schedule. In the future, it is hoped that iKnow will be one of the driving forces that can change the university KM ecosystem.

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