The Development of Ontology in Hadith Studies: A Bibliometric Analysis

Pembangunan Ontologi dalam Pengajian Hadis: Kajian Analisis Bibliometrik

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ABSTRACT

Ontology adaptation has garnered considerable interest in various fields, including Islamic studies. Information system developers have made several attempts to apply ontology to Islamic knowledge, particularly to two sacred sources in Islam, the Qur'an and the hadith. Despite the extensive body of research, a lack of bibliometric studies remains, which hinders the establishment of a foundation for future research on the application of ontology in hadith studies. This bibliometric analysis study is conducted to assist academics who are new to ontology in utilizing hadith data-related studies by identifying key journals and authors for a comprehensive analysis of this area of research. For this purpose, this study used the Scopus and Web of Science (WoS) databases to quantitatively identify ontology-related studies that use hadith data, employing several units of analysis, including the distribution of publications by year and country, citation counts, and the functionality of hadith and ontology. The finding shows that there is a growing interest in exploring the potential of ontologies in this field. It also highlights the concentration of research efforts in Southeast Asia and the Middle East, as well as the importance of international collaborations in this field of study. It implies the potential for further development of this topic in the future.

Keywords: Hadith; ontology; knowledge modeling; bibliometric analysis; trend analysis

ABSTRAK

Adaptasi ontologi dalam bidang kajian yang pelbagai telah menjadi minat yang besar dalam kalangan pengkaji, termasuk dalam bidang kajian Islam. Beberapa percubaan telah dilakukan oleh pembangun sistem maklumat untuk mengaplikasikan ontologi kepada bidang kajian ilmu Islam, khususnya terhadap dua sumber suci dalam Islam, iaitu Al-Quran dan hadis. Walau bagaimanapun, hasil penelitian pengkaji, masih tiada kajian sedia ada yang menggunakan teknik analisis bibliometrik untuk menganalisis trend kajian-kajian sedia ada yang mengadaptasi ontologi di dalam bidang kajian hadis. Oleh itu, kajian analisis bibliometrik ini dijalankan untuk membantu pengkaji yang baru memulakan kajian terhadap adaptasi ontologi menggunakan data hadis untuk menentukan jurnal dan pengarang yang sesuai untuk dirujuk bagi mendapatkan gambaran menyeluruh mengenai fenomena ini. Untuk tujuan tersebut, kajian ini menggunakan pangkalan data Scopus dan Web of Science (WoS) untuk mengenal pasti secara kuantitatif kajian-kajian berkaitan ontologi yang telah menggunakan data hadis untuk dianalisis berdasarkan beberapa unit analisis, iaitu, taburan penerbitan mengikut tahun dan negara, bilangan sitasi yang diterima, dan fungsi yang dimainkan oleh hadis dan ontologi dalam setiap kajian tersebut. Hasil kajian mendapati terdapat peningkatan minat dikalangan pengkaji dalam meneroka potensi ontologi dalam bidang ini. Selain itu, hasil kajian juga mendapati terdapat usaha yang wajar ditonjolkan daripada penyelidikan di Asia Tenggara dan Timur Tengah serta beberapa bentuk kerjasama antarabangsa dalam bidang kajian ini. Ini menggambarkan potensi untuk mengembangkan lagi kajian seumpamanya pada masa akan datang.

Kata kunci: Hadis; ontologi; permodelan pengetahuan; analisis bibliometrik; analisis trend

INTRODUCTION

In Islamic scholarship, a hadith refers to a saying, action, or sanction attributed to the Prophet Muhammad, peace be upon him. Due to the hadith's immense significance in human civilization and society as a whole, extensive research has been conducted on the topic. This has attracted researchers from various disciplines, including the scientific community of information management (Abdelkader et al. 2019; Farooqui et al. 2018). This trend shows how far-reaching technological progress has affected people's daily lives. It has sparked the interest of many academic groups to include hadith studies in the fast growth of global trends like ontology adaptation. Despite the availability of numerous research works, a bibliometric study laying the groundwork for future research on the adoption of ontology in hadith studies is still lacking.

Scopus and Web of Science are two prominent and widely used academic databases that provide exhaustive coverage of scholarly literature across disciplines. Scopus, which was managed by Elsevier, provides access to a vast database of indexed journals, conference proceedings, and patents from around the globe (Abidin & Latif, 2022; Chi, 2013). It includes the natural sciences, the social sciences, engineering, and the humanities. Scopus uses advanced search capabilities and citation analysis tools to facilitate research and discovery, allowing scholars to monitor citations, identify key authors, and evaluate the impact of scholarly work. Web of Science, which is managed by Clarivate Analytics, concentrates on high-quality scientific research and is renowned for its stringent selection criteria. The collection comprises scholarly journals, conference proceedings, and books (Gasparyan, 2013). Web of Science provides researchers with potent citation indexing capabilities, enabling them to trace citation patterns, identify influential articles, and assess research impact.

Both databases are valuable resources for academicians because they provide access to peer-reviewed literature, facilitate interdisciplinary research, and aid in the bibliometric evaluation of scholarly output. Scopus and Web of Science are frequently used by researchers to remain abreast of the most recent developments in their respective fields, conduct literature reviews, and contribute to the advancement of knowledge (Hosseini et al. 2023; Zhu & Liu, 2020). Therefore, this study was conducted to bibliometrically analyze the publications on ontology adaptation in hadith studies to explore the publication trend that may assist scholars in this research in planning their future research in the area.

THE HADITH ONTOLOGY

Initially, ontology refers to the philosophical study of existence, reality, and the essence of being. It seeks to comprehend the fundamental categories and relationships underlying the organization of the world and human knowledge. In the context of information and computer science, an ontology is a formal representation of knowledge that encapsulates concepts, entities, and their relationships within a particular domain. Ontologies function as semantic frameworks, providing a shared comprehension of concepts and facilitating information retrieval, data integration, and knowledge sharing in domains such as medicine, biology, and the web. Ontologies typically include a hierarchical structure of classes, properties, and instances, as well as axioms and rules that regulate their behavior and relationships (Wheeler et al. 2018). They enable machines and humans to consistently and meaningfully reason, query, and interpret information (Wen et al. 2002). The development and application of ontologies require rigorous methodologies, such as conceptual modeling, formal logic, and domain knowledge. Ontology plays a crucial role in enhancing information organization, retrieval, and knowledge representation, thereby contributing to the development of a wide range of academic and practical domains.

The application of information systems to Islamic knowledge is a burgeoning area of study and application. These systems provide tools for searching, categorizing, and analyzing Islamic literature, enabling researchers, academics, and students to delve deeply into Islamic thought and

tradition (Karim & Hazmi, 2005). In addition, information systems contribute to the preservation and digitization of valuable Islamic manuscripts and historical documents, ensuring their accessibility in the future (Ayuba, 2013). By leveraging information systems, Islamic knowledge can be accessed and shared more readily, transcending both space and time. Ultimately, the application of information systems (i.e., ontology adaptation) to the field of Islamic knowledge improves accessibility, dissemination, and engagement with Islamic teachings and scholarship, nurturing a deeper appreciation and understanding of the Islamic intellectual heritage (Alromima et al. 2015).

Scoping specifically to the context of hadith studies, the application of information systems to the field of hadith studies also illustrates a significant development. Factually, there are so many discussions that can be extracted within the hadith realm, including linguistics, Islamic history, Islamic jurisprudence, Islamic legal maxims, and several others (Asni et al. 2021; Jamal et al. 2018). Therefore, ontology has been adopted to serve as a systematic framework that facilitates the organization and analysis of the knowledge encompassed within hadith texts (Al-Sanasleh & Hammo 2017). One potential application of ontologies is the categorization of hadiths according to their respective topics, such as prayer, fasting, or zakat (Al-Rumkhani et al. 2016; Saad et al. 2011; Tawil et al. 2017). Additionally, ontologies can facilitate the identification and analysis of linkages between various concepts and entities stated within the hadiths, such as the interconnections between the Prophet Muhammad and his associates (Dalloul, 2013). Therefore, the incorporation of ontologies signifies a notable progression, facilitating researchers in their pursuit of enhanced comprehension and analysis of this pivotal corpus of Islamic literature.

Despite the evolution of researchers' focus on the adaptation of ontology with hadith data, an observation has found that a study bibliometrically analyzes the publication trend in this area has been relatively limited. Consequently, this study aims to address this gap by first gathering and extracting relevant literature on ontology-related research that utilizes hadith data. Subsequently, a bibliographic analysis will be performed to examine various aspects such as both hadith and ontology function, publication distribution based on years and countries, and highly cited documents, providing valuable insights for future research on ontology and hadith.

METHODS

Bibliometric analysis is a statistical technique used to investigate and monitor the production and patterns of research in a particular field. Its primary purpose is to assess the rate of progress, evaluate the current status of scientific output, and identify significant contributions in a specific field of study (Ellegaard & Wallin, 2015). Bibliometric analyses generate exhaustive profiles of publications, reveal trends within a given discipline, and highlight qualitative and quantitative changes in a particular research field through the application of statistical techniques (Oliveira et al. 2019). Therefore, conducting a bibliometric study can serve as a valuable resource for researchers interested in ontological hadith research as well as professionals wishing to assess scholarly activity in this field. Compared to traditional literature reviews, this form of study represents a significant methodological innovation. The following Figure 1 elucidates the document identification procedure that was conducted in this study. The researcher adopted the PRISMA technique in this study as it is known for its functions in assisting the researcher to collect relevant articles on the focused topic (Harizan & Mustafa, 2020).
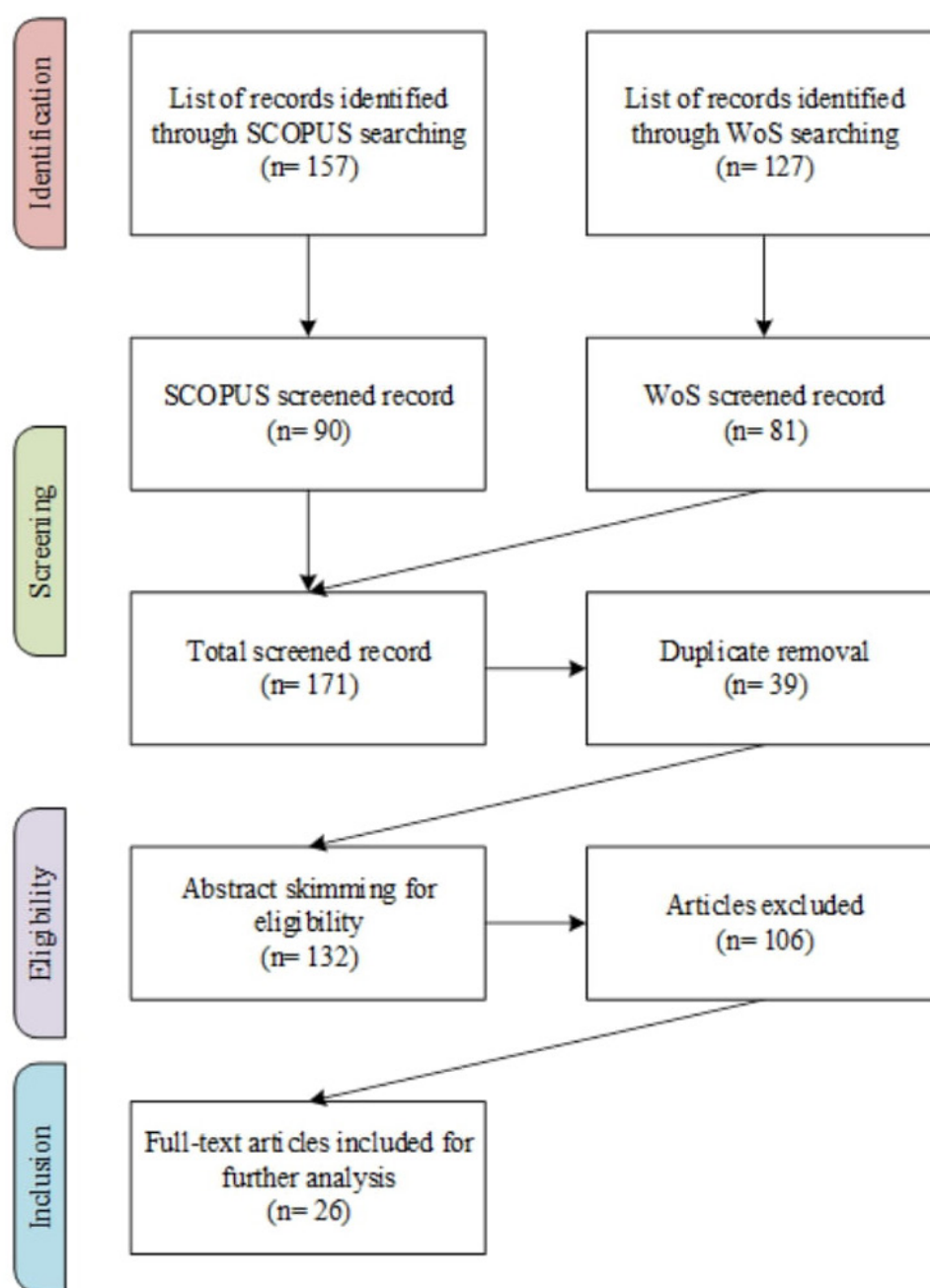
FIGURE 1. Document identification procedure adopting the PRISMA technique.

The purpose of this review is to conduct a comprehensive bibliometric analysis of hadith ontology studies. The analysis will incorporate numerous variables, such as publication trends, citation patterns, and ontology-hadith functionality aspects. Using bibliometric mapping, a common statistical technique for examining large volumes of scientific data in specific disciplines, this review aims to shed light on the current state and emerging trends on the topic. This study utilizes two widely recognized online databases, Scopus and WoS, which encompass research across various disciplines. These databases are chosen due to their comprehensive coverage of scientific journals and their ability to provide data on research output, dissemination, collaboration, and impact (Zhu & Liu 2020). By leveraging the advanced search functionalities offered by Scopus and WoS, relevant articles are identified using predetermined inclusion and exclusion criteria specifically designed for this research, as shown in Table 1. The availability of data and the extensive capabilities of these databases make it feasible to conduct a thorough bibliometric analysis. This research focuses on a specific inclusion and exclusion criterion as follows:

TABLE 1. Inclusion and exclusion criteria for article extraction procedure.

Criterion	Inclusion	Exclusion
Literature type	Research article & Conference proceeding Paper	Research Article Review, Book Chapter, & Conference Review.
Language	English, Malay, Indonesia	Turkish, French, German, Lithuanian, Russian, & Spanish

Table 2 shows the searching strings that have been used as the command query in searching the documents from the Scopus and Web of Science databases, respectively. A search string is a combination of keywords and operators used to retrieve relevant articles from databases like Scopus and Web of Science. Crafting an efficient search query is essential for retrieving accurate and exhaustive results. When constructing a search string for Scopus and Web of Science, it is crucial to consider the specific research objectives and intended study scope. The search string should include essential concepts, synonyms, and related terms pertinent to the research topic (Malik et al. 2020). Boolean operators including "AND," "OR," and "NOT" can be used to effectively refine and combine keywords. The use of truncation symbols, such as asterisks (*) or question marks (?), can also account for variations in word endings or orthography. Researchers can maximize the retrieval of relevant scholarly articles for their research by meticulously constructing the search string and considering the unique features and capabilities of Scopus and Web of Science.

TABLE 2. Search string for article extraction procedure.

Database	Searching String
Scopus	TITLE-ABS-KEY ((ontolog* OR "ontolog* develop*" OR "pembangun* ontolog*" OR "ontolog* construct*" OR "ontolg* proced*" OR "prosidur* ontolog*" OR "ontolog* method*" OR "ontolog* model*" OR "ontolog* concept*" OR ("knowledge represent*" AND concept*) OR (represent* AND konsep*) OR (ontolog* AND konsep)) AND (had?th OR had?s OR sunnah OR sunah OR prophet* OR "prophet* narrat*" OR ((prophet* OR nabi) AND *riwayat*) OR ((prophet* OR nabi) AND muhammad*))) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "cp")) AND (LIMIT-TO (LANGUAGE , "English") OR LIMIT-TO (LANGUAGE , "Indonesian") OR LIMIT-TO (LANGUAGE , "Malay"))
WoS	TS= ((ontolog* OR "ontolog* develop*" OR "pembangun* ontolog*" OR "ontolog* construct*" OR "ontolg* proced*" OR "prosidur* ontolog*" OR "ontolog* method*" OR "ontolog* model*" OR "ontolog* concept*" OR ("knowledge represent*" AND concept*) OR (represent* AND konsep*) OR (ontolog* AND konsep)) AND (had?th OR had?s OR sunnah OR sunah OR prophet* OR "prophet* narrat*" OR ((prophet* OR nabi) AND *riwayat*) OR ((prophet* OR nabi) AND muhammad*))) and Article or Proceeding Paper (Document Types) and English or Indonesian (Languages)

UNITS OF ANALYSIS

The objective of this bibliometric study utilizing Scopus and WoS is to investigate research on ontology and its application to the analysis of hadith data. The investigation was conducted in December 2022 by analyzing all relevant Scopus and WoS articles. Using the specified search query, 284 documents were identified and extracted initially. However, only 26 papers were included for further analysis, as the remaining publications (n = 258) did not precisely correlate with the topic of interest. This process was majorly guided by the inclusion and exclusion criteria that were initially determined, as mentioned earlier (see Table 1). The list of articles that were included in this study is presented in the following Table 3.

TABLE 3. List of extracted articles.

No.	Author	Publication Title	Journal/ Proceeding title	Publication Year
1.	Daud, A; Ullah, MH; Banjar, AR; Alshdadi, AA	Ontological Modeling and Semantic Search in Quran	International Journal of Computer Science and Network Security	2022
2.	Othman R., Tawil S.F.M.	Ontological Methodologies for Counselling Intervention: *Do'a* and *Zikr Al-Ma'thur* Corpus	Baghdad Science Journal	2021
3.	Alamri, S	Growing Hadiths Ontology	International Journal of Computer Science and Network Security	2021
4.	Fairouz, B; Nora, T; Nouha, AA	An Ontological Model of Hadith Texts Semantic Representation of Hadith	International Journal of Advanced Computer Science and Applications	2020
5.	Rodzman S.B.B., Ismail N.K., Rahman N.A., Aljunid S.A., Nor Z.M., Noor A.Y.M.	Domain Specific Concept Ontologies and Text Summarization as Hierarchical Fuzzy Logic Ranking Indicator on Malay Text Corpus	Indonesian Journal of Electrical Engineering and Computer Science	2019
6.	bin Rodzman, SB; Ismail, NK; Rahman, NA; Aljunid, SA; Rahman, HA; Nor, ZM; Khalif, KMNK; Noor, AYM	Experiment with Text Summarization as A Positive Hierarchical Fuzzy Logic Ranking Indicator for Domain Specific Retrieval of Malay Translated Hadith	2019 IEEE 9TH Symposium on Computer Applications & Industrial Electronics (ISCAIE)	2019
7.	Rodzman S.B.B., Ismail N.K., Rahman N.A., Aljunid S.A., Nor Z.M., Khalif K.M.N.K.	Expert Judgment Z-Numbers as A Ranking Indicator for Hierarchical Fuzzy Logic System	IAES International Journal of Artificial Intelligence	2019
8.	Abdelkader A., Najeeb M., Alnamari M., Malik H.	Creation of Arabic Ontology for Hadith Science	International Journal of Advanced Trends in Computer Science and Engineering	2019
9.	Elkhammash, E; Ben Abdessalem, W	A Holy Quran Ontology Construction with Semi-Automatic Population	Bioscience Biotechnology Research Communications	2019
10.	Farooqui, NK; Noordin, MF; Othman, R	Ontology Matching: A Case of English Translation of Al-Quran Tafsir	Proceedings 2018 International Conference on Information and Communication Technology for The Muslim World (ICT4M)	2018
11.	Khan J.R., Siddiqui F.A., Siddiqui A.A., Saeed M., Touheed N.	Enhanced Ontological Model for The Islamic Jurisprudence System	2017 International Conference on Information and Communication Technologies, ICICT 2017	2018
12.	Basir N., Nabila N.F., Zaizi N.J.M., Saudi M.M., Ridzuan F., Pitchay S.A.	Retrieval Performance for USIM's Quranic Search Engine	International Journal of Engineering and Technology	2018
13.	Alkhatib, M; Monem, AA; Shaalan, K	A Rich Arabic Wordnet Resource for Al-Hadith Al-Shareef	Arabic Computational Linguistics (ACLING 2017)	2017
14.	Sevkli A.Z., Motiwalla L., Abdulkarem H.F.	The Design and Implementation of a Context-Aware Mobile Hadith Learning System	International Journal of Mobile Learning and Organisation	2017
15.	Al-Sanasleh, HA; Hammo, BH	Building Domain Ontology Experiences in Developing the Prophetic Ontology Form Quran and Hadith	2017 International Conference on New Trends in Computing Sciences (ICTCS)	2017

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16.	Basir N., Nabila N.F., Zaizi N.J.M., Saudi M.M., Ridzuan F.H.M., Pitchay S.A.	Intelligent Quranic Ontology Retrieval	Advanced Science Letters	2017
17.	Junaidi J., Jamal I.H., Ghazali N.M., Ahmad H., Salam R.A.	Expanding Hadith Understanding Using Ontology	Advanced Science Letters	2017
18.	Jaafar, AH; Pa, NC	Hadith Commentary Repository: An Ontological Approach	Proceedings of The 6th International Conference on Computing And Informatics: Embracing Eco-Friendly Computing	2017
19.	Al-Rumkhani, A; Al-Razgan, M; Al-Faris, A	Tibbonto: Knowledge Representation of Prophet Medicine (Tibb Al-Nabawi)	4TH Symposium on Data Mining Applications (SDMA2016)	2016
20.	Arpinar I.B., Kursuncu U., Achilov D.	Social Media Analytics to Identify and Counter Islamist Extremism: Systematic Detection, Evaluation, And Challenging of Extremist Narratives Online	Proceedings - 2016 International Conference on Collaboration Technologies and Systems, CTS 2016	2016
21.	Jaafar, SN; Masrom, S; Mahtar, SNM; Khairudin, N; Rahim, SKNA; Azizan, A	Enhancing Semantic Metadata of Reliable Hadith with Automated Annotation	Advanced Science Letters	2016
22.	Soudani, N; Bounhas, I; ElAyeb, B; Slimani, Y	Toward An Arabic Ontology for Arabic Word Sense Disambiguation Based on Normalized Dictionaries	On The Move to Meaningful Internet Systems: OTM 2014 Workshops	2014
23.	Al-Arfaj, A; Al-Salman, A	Towards Ontology Construction from Arabic Texts-A Proposed Framework	2014 IEEE International Conference on Computer and Information Technology (CIT)	2014
24.	Saad, S; Noah, SAM; Salim, N; Zainal, H	Rules And Natural Language Pattern in Extracting Quranic Knowledge	2013 Taibah University International Conference on Advances in Information Technology for The Holy Quran and Its Sciences	2013
25.	Saad S., Salim N., Zainal H., Muda Z.	A Process for Building Domain Ontology: An Experience in Developing *Solat* Ontology	Proceedings of the 2011 International Conference on Electrical Engineering and Informatics, ICEEI 2011	2011
26.	Azmi, AM; bin Badia, N	E-Narrator - An Application for Creating an Ontology of Hadiths Narration Tree Semantically and Graphically	Arabian Journal for Science and Engineering	2010

This study considered a variety of bibliometric indicators, such as the distribution of publications by year and country, citation counts, and publication focus on the aspect of hadith and ontology function.

PUBLICATION BY YEAR

The analysis of publishing patterns within a specific academic subject might offer useful information regarding its development and present condition. The examination of publication frequency over time can facilitate the identification of nascent study domains, monitor shifts in scholarly pursuits, and assess the influence of significant occurrences such as scientific breakthroughs, technological progressions, or policy modifications. In addition, the analysis of publishing trends can also provide insights into citation patterns. It can offer valuable contextual information regarding citation metrics, such as the average number of citations per paper or the h-index, which are often employed to assess research productivity. Additionally, it

has the potential to encourage interdisciplinary discourse and cultivate partnerships among research communities that possess complementary interests (Vasudevan et al. 2016). To gain a comprehensive picture of research activity and make well-informed decisions within the academic community, it is imperative to analyze the publishing trend.
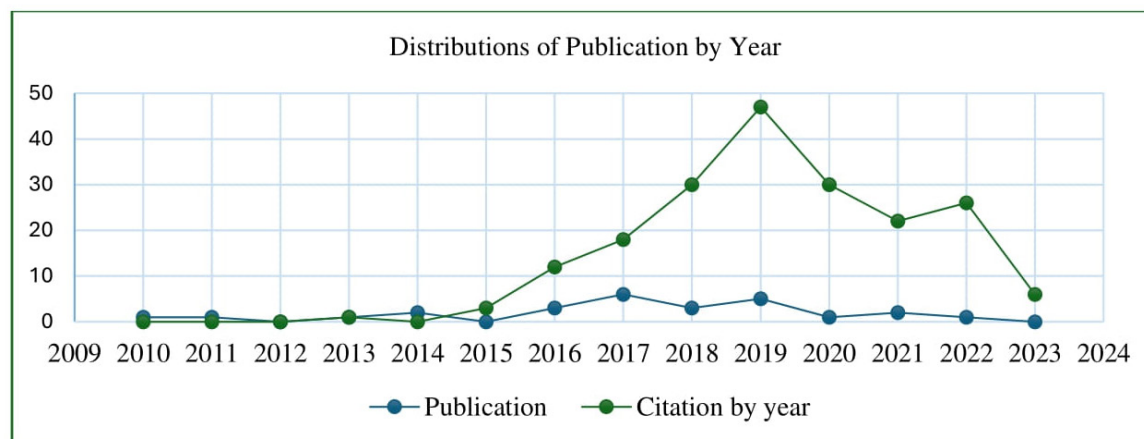

FIGURE 1. Publication and citation distributions by year.

The extracted documents were analyzed starting from the first publication of the topic to the recent years without any time limit. Based on Figure 2, a few publications were found, starting with a total of 2 publications in 2010, 1 publication in 2011, and none in 2012. This indicates that the field of ontology in hadith studies got off to a relatively sluggish start. There was a modest increase in the number of publications in 2013, with three publications and two in 2014. This indicates that the discipline was gaining momentum, albeit slowly. 2015 and 2016 saw a significant increase in the number of publications, with a total of 6 publications in 2015 and 3 publications in 2016. This indicates a developing interest in ontology within the field of hadith studies. The number of publications continued to rise, with a total of six in 2017, three in 2018, and five in 2019. This indicates that the field continued to acquire traction. The publication, however, shows a declining trend, with only one publication in 2020, two in 2021, and one publication in 2022.

On the citation aspect, the analysis of the publication trend on annual citations for ontology (computer science) adaptation in hadith studies reveals a consistently growing interest in the field over the past decade. Specifically, the annual publication rate has increased steadily, with a significant increase in 2019 ($n = 47$), closely followed by 2020

($n = 30$). The trend remains consistent, as there were 22 citations recorded in 2021 and 26 citations in 2022. This indicates that the field has garnered significant attention and recognition in recent years, with an increasing number of scholars contributing to its growth.

HIGHLY CITED DOCUMENTS

One of the analyses in this bibliometric research is on the highly cited documents. The examination of extensively referenced papers might provide insights into emerging patterns and subjects, enabling researchers to forecast forthcoming trajectories and make well-informed choices on research allocations (Ponomarev et al. 2014). The utilization of citation analysis enables the depiction of the intellectual framework within a particular discipline, thereby illuminating the interconnections across various research domains and facilitating the identification of cohesive groups of closely associated scholarly articles and authors (Ferreira, 2018). In summary, the examination of highly referenced articles in bibliometric analysis provides a multitude of advantages, facilitating a more comprehensive comprehension of the scholarly environment and bolstering well-informed decision-making within the academic sphere.

TABLE 4. The most cited document.

No.	Publication Title	Citation Counts
1	A Rich Arabic WordNet Resource for Al-Hadith Al-Shareef	31
2	Toward an Arabic Ontology for Arabic Word Sense Disambiguation Based on Normalized Dictionaries	25
3	E-Narrator - An Application for Creating An Ontology of Hadiths Narration Tree Semantically and Graphically	24
4	A Process for Building Domain Ontology: An Experience in Developing Solat Ontology	23
5	Towards Ontology Construction from Arabic Texts-A Proposed Framework	15
6	Social media analytics to identify and counter Islamist extremism: Systematic detection, evaluation, and challenging of extremist narratives online	15

Based on Table 4, the publication titled "A Rich Arabic WordNet Resource for Al-Hadith Al-Shareef" has been identified as the most often cited work in the domain of ontology adaptation within the field of hadith studies, accumulating a total of 31 citations. The paper likely garnered a positive response within the community as it prioritized the development of a comprehensive resource for Arabic word sense disambiguation, a crucial undertaking in the fields of natural language processing and computational linguistics (Alkhatib et al. 2017). The work titled "Towards an Arabic Ontology for Arabic Word Sense Disambiguation Based on Normalised Dictionaries" (Soudani et al. 2014) has received the second-highest number of citations, totaling 25.

The work titled "E-Narrator - An Application for Creating an Ontology of Hadiths Narration Tree Semantically and Graphically" ranks third in terms of citation count, with a total of 24 citations. The popularity of this publication might be attributed to its emphasis on the development of graphical depictions of hadith narration trees. This approach aids in the comprehension and examination of intricate connections among hadiths, hence enhancing knowledge and analysis of the subject. The work titled "A Process for Building Domain Ontology: An Experience in Developing Solat Ontology" is ranked fourth in terms of citation counts, with a total of 23 citations. This paper presents a comprehensive methodology for constructing domain ontologies, a critical aspect of knowledge representation in diverse fields, such as hadith studies (Saad et al. 2011).

The remaining papers exhibit citation counts below 15, suggesting a diminished level of impact or influence within the area. Nevertheless, these contributions continue to play a significant role in the broader academic conversation and have the potential to serve as a basis for subsequent scholarly investigations. One notable contribution that stands out is the research titled "Social Media Analytics to Identify and Counter Islamist Extremism: Systematic Detection, Evaluation, and Challenging of Extremist Narratives Online." This study offers a distinct approach by utilizing ontology adaptation from the field of computer science in the context of hadith studies. The aim is to tackle contemporary social concerns associated with radicalization and the spread of misinformation (Arpinar et al. 2016).

PUBLICATION BY COUNTRY

The utilization of country affiliation-based analysis in bibliometric analysis can contribute to the mapping of international connections and the identification of networks of co-authorship among researchers from various nations. This approach facilitates scientific diplomacy, fosters global alliances, and addresses global concerns. At the national level, doing an analysis of publishing patterns at the country level allows for the evaluation of research output and performance (Hofman et al. 2009). This evaluation may then be used to assess the effectiveness of research programs, allocate research funding, and develop strategies to enhance research competitiveness.

TABLE 5. Publication distributions based on affiliated countries.

No.	Affiliated Country	Counts
1	Malaysia	11
2	Saudi Arabia	5
3	Malaysia/ Saudi Arabia	2
4	Jordan	1
5	Algeria	1
6	Pakistan	1
7	United States	1
8	Egypt & UAE	1
9	Pakistan & Saudi Arabia	1
10	Tunisia & UAE	1
11	Turkey & United States	1

Based on the analysis as listed in Table 5, Malaysia records the highest number of publications ($n = 11$) in the discipline of ontology (computer science) adaptation in hadith studies. This trend is possibly a result of the country's emphasis on Islamic studies and computer science research. Saudi Arabia follows with five publications, which is not surprising given the country's prominence in the Islamic world and its investment in scientific research. The two countries show their dominance in this research, as two publications were recorded as collaborations between researchers from these two nations. The majority of the remaining countries have only one publication, such as Jordan, Algeria, and Pakistan, including some of the collaborated nations such as "Egypt & UAE," "Pakistan & Saudi Arabia," and "Tunisia & UAE."

Intriguingly, the multiple instances of international collaboration, for example, the publication "Malaysia and Saudi Arabia," implies collaboration between researchers from these two nations. Similarly, "Pakistan & Saudi Arabia" and "Tunisia & UAE" represent the collaborative endeavors of international researchers, thus demonstrating a global interest in this research field. Overall, the analysis indicates that Malaysia leads Saudi Arabia in the adaptation of ontology (computer science) to hadith studies. Nonetheless, there is evidence of international cooperation and shared interests among numerous nations, which could contribute to the formation of future partnerships and advancements in this field.

HADITH FUNCTION

In the domain of ontology studies, the inclusion of hadiths serves a crucial function in enhancing the depth and breadth of the knowledge representation process. The integration of hadiths in ontology studies facilitates the development of computational models that can assist in answering queries, resolving ambiguities, and promoting consistency in the representation of Islamic knowledge. Overall, hadiths play a significant role in enriching ontology studies by incorporating the wisdom and guidance of the Prophet Muhammad, offering valuable insights for understanding and applying Islamic teachings within a computational framework.
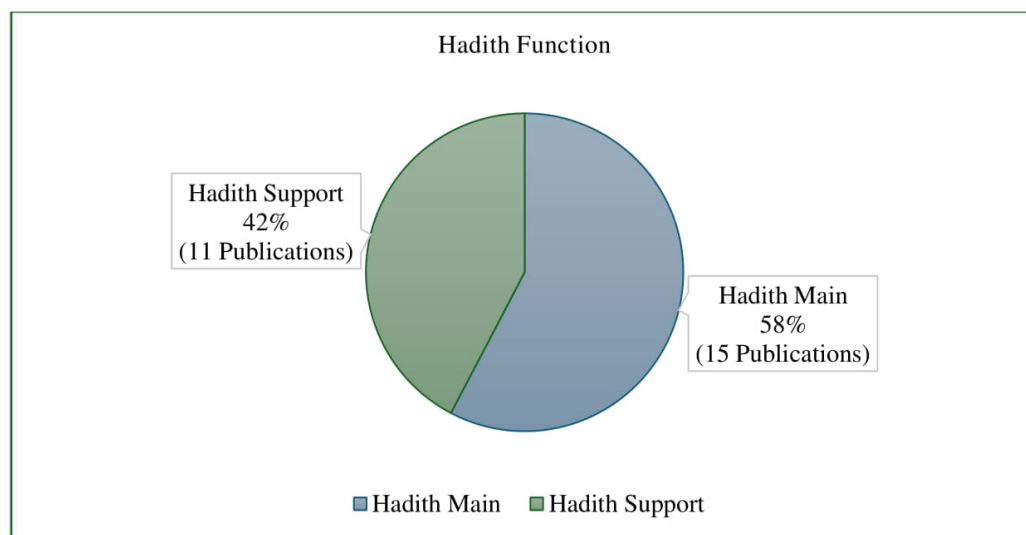
FIGURE 2. Publication trend based on hadith function

In general, the hadith function in the analyzed publications can be divided into two different roles: having hadith become the main subject (labelled "hadith main") or supporting another major subject (labelled "hadith support") of the studies (see Figure 3). The number of publications in which hadith plays a central role is 15. This observation suggests that the study of hadith holds significant importance in many research endeavors about the implementation of ontology within the field of computer science. The substantial quantity of papers within this particular field indicates that scholars are actively investigating the potential of ontologies in the realm of hadith studies. They are utilizing the extensive and profound knowledge of hadith to create novel computational models, algorithms, and systems.

In addition, the cumulative number of publications in which hadith serves as a supplementary component counts to 11. The primary focus of these works does not revolve around hadith but rather utilizes it as a means of inspiration, validation, or evaluation for the proposed techniques. This observation indicates that scholars are increasingly acknowledging the significance of hadith in diverse computer science applications and integrating its insights and ideas into their research endeavors.

ONTOLOGY FUNCTION

The concept of ontology provides a robust framework for organizing, classifying, and categorizing information, thereby facilitating efficient information retrieval, data integration, and reasoning. Ontology enhances the accuracy, consistency, and interoperability of information systems by representing knowledge in a structured and machine-understandable format (Imran & Young, 2016). Overall, ontology studies are essential for ontology development, the establishment of an ontology foundation, and the effective representation and organization of knowledge across multiple domains. Thus, this analysis focuses on analyzing the ontology function in ontology hadith studies to observe its trend.
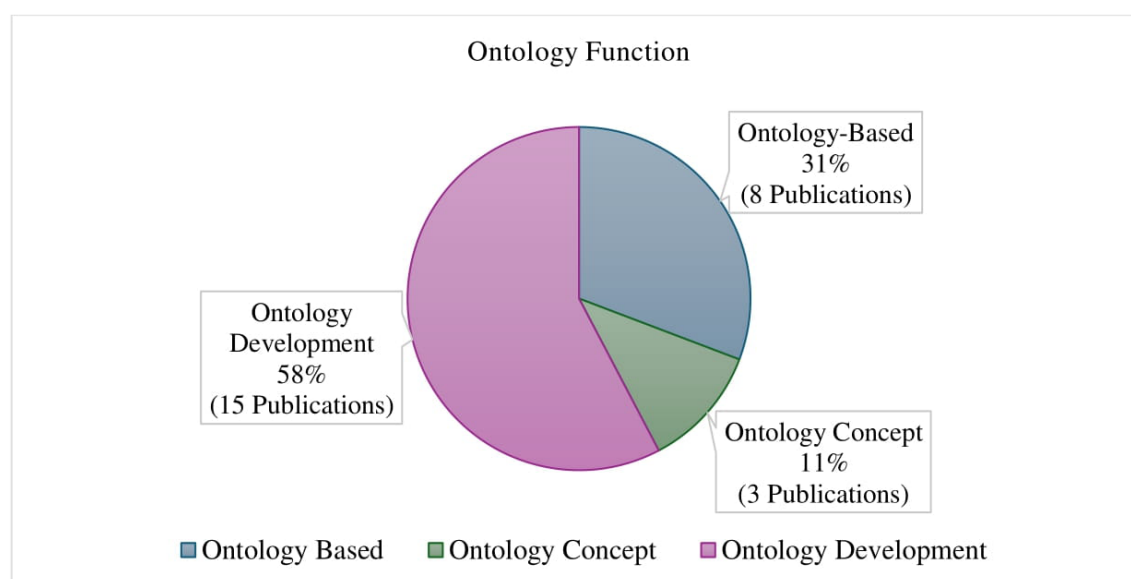
FIGURE 3. Publication distribution based on ontology function

As in the previous discussion, the extracted publication can be classified into several categories based on the ontology function aspect (see Figure 4). The ontology functions were divided into three major classifications: ontology development, ontology-based, and ontology concept. "Ontology development" refers to the study that completed the ontology development procedure to the end of the process, whereas "Ontology concept" refers to the study that explains the ontology adaptation from the conceptual dimension. On the other hand, "ontology-based" refers to the study that adapts ontology as part of the other main objective, such as semantic web development or others.

Based on the analysis, the majority of the hadith ontology articles primarily focus on ontology development ($n = 15$). The focus of this research is centered around the development, execution, and assessment of ontologies within the field of hadith studies. On the other hand, the number of articles in which the ontology was adopted but did not become the main focus of the study (ontology-based) is 8. The substantial quantity of papers within this particular category serves to emphasize the importance of ontology development within the discipline. This observation indicates that scholars acknowledge the necessity of well-crafted ontologies in facilitating the examination and comprehension of hadith information.

Lastly, the number of publications in which the ontology was employed only for its operational concept in the field of hadith studies is three. The aforementioned research utilizes ontology principles, specifically classes, properties, and relationships, as a means to describe knowledge pertaining to hadith but does not develop into the complete ontology structure. The limited quantity of articles within this particular category may suggest that scholars are currently in the first phases of investigating the potential applications of ontology principles in the field of hadith studies. However, the existence of these studies indicates that ontology concepts have the potential to enhance the study and comprehension of hadith information.

DISCUSSION

In general, this study has presented a comprehensive list of authors and publishers who have written articles relevant to ontology using hadith data (see Figure 3). According to the data, there are a total of 78 authors in which a few authors have produced several papers meanwhile most of the authors have only published a few articles. This indicates that there are individuals who are prolific authors with many of them having produced only one piece. The authors who have the greatest number of publications are Zulhilmi Mohamed Nor, Syed Ahmad Aljunid, Shaiful Bakhtiar Rodzman, Nurazzah Abd Rahman, and Normaly Kamal, each with three articles. Besides, the table also presents the publisher of articles linked to ontology using hadith data. There are a total of 24 sources mentioned, and each source has published between 1 and 3 publications. The publications with the highest frequency of occurrences are Advanced Science Letters, which

has published 3 papers, and the International Journal of Computer Science and Network Security, which has published 2 articles.

PUBLICATION TREND

The present analysis reveals a discernible surge in scholarly attention toward the utilization of ontology in the field of hadith study during the preceding decade. It illuminates that there has been a growing interest among researchers in investigating the potential of ontologies in the field of hadith study (Khan et al. 2013), particularly in recent times. However, it is worth noting that there have been intermittent variations in the quantity of published works about this subject matter. This discussion can also be supported by the data illustrated in the citation trend among the publications, as it surged scholarly attention towards the utilization of ontology in the field of hadith study during the preceding decade. Even though it is worth noting that there have been occasional variations in the frequency of citations each year, there has been a noticeable trend among academics to reference the literature of ontologies in the field of hadith studies, particularly in recent times.

The researcher's interest in this topic can also be imperatively explained by analyzing the data from the publication trend in the associated countries' dimension. One noteworthy finding derived from the data is the presence of a notable clustering of research endeavors within specific geographical regions, namely Southeast Asia (Malaysia and Indonesia), as also mentioned by Leung et al. (2011), and the Middle East (Pakistan, Saudi Arabia, and the UAE). Besides, there are multiple occurrences of co-authorship among academics hailing from distinct nations, including the collaborative efforts of researchers from Malaysia and Saudi Arabia (with two publications), Pakistan and Saudi Arabia (with one publication), as well as Turkey and the United States (with one publication) (see Table 4). The presence of several circumstances, including the accessibility of financial support (Heffner, 1981) and prospects for collaboration (Barnes et al. 2002), may account for this phenomenon in these particular places. Moreover, the prevalence of esteemed research centers and universities in these areas may also be a contributing factor to the substantial number of publications.

The examination of publication trends about the "affiliated country" feature provides valuable insights into the geographic distribution of research activities within the subject of ontology and hadith study. The results indicate that scholars in specific geographical areas, including Southeast Asia and the Middle East, are significantly contributing to the advancement of research in this particular field. This is consistent with research conducted by Kim (2013) which reports that international research collaboration has increased considerably over the last 30 years. Furthermore, the observed collaboration patterns among academics hailing from diverse nations highlight the significance of international partnerships in the advancement of knowledge within this particular field.

FUNCTIONALITY OF HADITH ONTOLOGY

Observation on hadith functionality as described in the previous section indicates that scholars in this particular domain are predominantly dedicated to the advancement and implementation of ontologies concerning the hadith as their main focus. The potential reasons for this phenomenon encompass a range of criteria, including the perceived significance attributed to the major hadith texts (Dalloul, 2013; Fairouz et al. 2020), the accessibility of relevant resources and data (Basharat et al. 2016; Rostam & Malim, 2019), and the research agenda prioritized by the academic community. Besides that, one plausible interpretation of this phenomenon is that scholars are primarily directing their efforts toward the creation and enhancement of ontologies focusing on the hadith, which hold significant importance in the realm of Islamic scholarship. After the establishment and validation of these ontologies, researchers can then broaden their focus to encompass the study in which hadith plays an accompanying function.

Nevertheless, it is important to acknowledge that the disparity in publication counts across the aforementioned categories is not substantial, and there remains a considerable body of scholarly work focusing on hadith in their study as supported data (Noh et al. 2013; Saad et al. 2011, 2009). This discussion suggests that scholars acknowledge the significance of taking into account the wider framework of hadith literature while employing ontologies in the field of hadith research. It can be concluded that the scholarly community is actively involved in the advancement and implementation of ontologies in the field of hadith studies, particularly with an emphasis on the core texts of Hadith. Nevertheless, there exists potential for expansion

and advancement in the domain of hadith as supporting data, which could benefit from additional investigation and ingenuity.

In the realm of ontology function, the existing publication trend concentration lies in the construction and refinement of these ontologies, with a notable emphasis on direct applications, as opposed to the establishment of ontology from the theoretical underpinnings. This phenomenon suggests that scholars are increasingly embracing the potential advantages of utilizing ontologies in the field of hadith studies through the adaptation of ontology. Experts believe that ontology can serve as a valuable tool for formalizing and organizing this knowledge (Konys, 2018; Wheeler et al. 2018), so enhancing the process of analysis and inference of hadith data. Yet, the complexity and intricacy of hadith studies necessitate the meticulous examination of historical, cultural, and linguistic contexts using ontology modelling technology.

However, the inherent difficulties and constraints associated with the application of ontologies within the hadith domain are also considered the main concern. For instance, the study of hadith frequently entails grappling with ambiguity, variability, and contradicting sources that require expert guides (Jamal et al. 2018), hence posing challenges in the development of ontologies. Consequently, a collaboration of expertise between ontology and hadith studies is required to accelerate the adaptation of these two elements. This may be the reason why some academic works on hadith ontology, such as the studies done by Jamal et al. (2018) and Junaidi et al. (2017), only focus on the conceptual discussion. Nevertheless, the result obtained in this bibliometric analysis shows that there exists a potential for further expansion and advancement of this study to completely develop the hadith ontology to the finest.

CONCLUSION

This bibliometric analysis discusses the increasing scholarly attention towards the use of ontology in the field of hadith study. Researchers have shown a growing interest in exploring the potential of ontologies in this field, particularly in recent times. The analysis also highlights the concentration of research efforts in Southeast Asia and the Middle East, as well as the importance of international collaborations. Scholars primarily focus on advancing and implementing ontologies related to the core hadith texts, but there is room for further expansion and progress in the field. The current publication trend emphasizes the construction and refinement of ontologies, with a focus on practical applications and tool creation. Scholars recognize the potential benefits of using ontologies in hadith studies but also acknowledge the challenges and limitations associated with their application. Collaboration between ontology and hadith studies expertise is crucial to accelerating the integration of these two elements. Additionally, there is potential for further development in the theoretical foundations of hadith ontology.

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AUTHORS' CONTRIBUTIONS

Conceptualization, Ikmal Hafiz Jamal; methodology, Ikmal Hafiz Jamal; software, Ikmal Hafiz Jamal; validation, Siti Fatimah Mohd Tawil; formal analysis, Ikmal Hafiz Jamal; investigation, Ikmal Hafiz Jamal; resources, Ikmal Hafiz Jamal; data curation, Ikmal Hafiz Jamal; writing—original draft preparation, Ikmal Hafiz Jamal; writing—review and editing, Siti Fatimah Mohd Tawil, Norzulaili Mohd Ghazali, Amna Javed; visualization, Ikmal Hafiz Jamal; supervision, Siti Fatimah Mohd Tawil and Norzulaili Mohd Ghazali; project administration, Siti Fatimah Mohd Tawil; funding acquisition, Norzulaili Mohd Ghazali. All authors have read and agreed to the published version of the manuscript.

REFERENCE

Abdelkader, A., Najeeb, M., Alnamari, M., & Malik, H. 2019. Creation of arabic ontology for hadith science. *International Journal of Advanced Trends in Computer Science and Engineering* 8(6): 3269–3276.

Abidin, M. S. Z., & Latif, F. A. 2022. kajian bibliometrik penerbitan mengenai al-Ghazali dalam pangkalan data scopus. *ISLAMIYYAT: The International Journal of Islamic Studies* 44(Isu Khas): 41–52.

Alkhatib, M., Monem, A. A., & Shaalan, K. 2017. A Rich Arabic WordNet Resource for Al-Hadith Al-Shareef. 3rd International Conference on Arabic Computational Linguistics, ACLing 2017, 117: 101–110. https://doi.org/10.1016/j.procs.2017.10.098

Alromima, W., Moawad, I. F., Elgohary, R., & Aref, M. 2015. Ontology-based Model for Arabic Lexicons: An Application of the Place Nouns in Holy Quran. 2015 11th International Computer Engineering Conference (ICENCO).

Arpinar, I. B., Kursuncu, U., & Achilov, D. 2016. Social Media Analytics to Identify and Counter Islamist Extremism: Systematic Detection, Evaluation, and Challenging of Extremist Narratives Online. International Conference on Collaboration Technologies and Systems, CTS 2016, 611–612. https://doi.org/10.1109/CTS.2016.113

Asni, F., Sulong, J., & Ismail, A. 2021. Analysis of the use of daif hadith in the fatwa on Islamic inheritance law (Faraid) in Malaysia. *ISLAMIYYAT* 43(2): 17–26.

Ayuba, M. A. 2013. Information and communication technologies in preserving arabic and Islamic manuscripts. *Mahmud Adesina Ayuba* 3(2).

Barnes, T., Pashby, I., & Gibbons, A. 2002. Effective university - Industry interaction: A multi-case evaluation of collaborative R&D projects. *European Management Journal* 20(3): 272–285.

Basharat, A., Abro, B., Arpinar, I. B., & Rasheed, K. 2016. Semantic hadith : Leveraging linked data opportunities for Islamic knowledge.

Chi, Y. 2013. Global trends in medical journal publishing. *Journal of Korean Medical Science* 28(8).

Dalloul, Y. M. 2013. An ontology-based approach to support the process of judging hadith isnad. 2012 International Conference on Advanced Computer Science Applications and Technologies, March, 1–108.

Ellegaard, O., & Wallin, J. A. 2015. The bibliometric analysis of scholarly production: How great is the impact? *Scientometrics* 105(3): 1809–1831. https://doi.org/10.1007/s11192-015-1645-z

Fairouz, B., Nora, T., & Nouha, A. A. 2020. An ontological model of hadith texts: Semantic representation of hadith. *International Journal of Advanced Computer Science and Applications* 11(4): 367–371. https://doi.org/10.14569/IJACSA.2020.0110451

Farooqui, N. K., Noordin, M. F., & Othman, R. 2018. Ontology matching: A case of english translation of al-Quran tafsir. 2018 International Conference on Information and Communication Technology for the Muslim World, ICT4M 2018, 1–6. https://doi.org/10.1109/ICT4M.2018.00010

Ferreira, F. A. F. 2018. Mapping the field of arts-based management: Bibliometric coupling and co-citation analyses. *Journal of Business Research* 85: 348–357.

Gasparyan, A. Y. 2013. Choosing the target journal: Do authors need a comprehensive approach? *Journal of Korean Medical Science*, 28(8).

Harizan, S. H. M., & Mustafa, M. S. 2020. Islamic entrepreneurship : Analysis of research trend. *ISLAMIYYAT* 42(2): 71–85.

Heffner, A. G. 1981. Funded research, multiple authorship, and subauthorship collaboration in four disciplines. *Scientometrics* 3: 5–12.

Hofman, K. J., Kanyengo, C. W., Rapp, B. A., & Kotzin, S. 2009. Mapping the health research landscape in sub-Saharan Africa: A study of trends in biomedical publications. *J Med Libr Assoc.* 97(1).

Hosseini, S. S., Alirezaei, Z., & Basirianjahromi, R. 2023. Supply and demand of Quranic information in the web environment: A decade of infodemiology study in Iran. *ISLAMIYYAT* 45(1): 263–273.

Imran, M., & Young, R. I. M. 2016. Reference ontologies for interoperability across multiple assembly systems. *International Journal of Production Research* 54(18): 5381–5403.

Jamal, I. H., Junaidi, J., Ghazali, N. M., & Ahmad, H. 2018. Revisiting scholars' principles on extracting proper hadith understanding. *Journal of Islamic, Social, Economics and Development* 3(10): 87–98.

Junaidi, J., Jamal, I. H., Ghazali, N. M., Ahmad, H., & Salam, R. A. 2017. Expanding hadith understanding using ontology. *Advanced Science Letters* 23(5): 4611–4614. https://doi.org/10.1166/asl.2017.8939

Karim, N. S. A., & Hazmi, N. R. 2005. Assessing Islamic information quality on the internet: A case of information about hadith. *Malaysian Journal of Library & Information Science* 10(2).

Khan, H. U., Saqlain, S. M., Shoaib, M., & Sher, M. 2013. Ontology based semantic search in Holy Quran. *International Journal of Future Computer and Communication* 2(6): 570–575.

Kim, K.-W. 2013. Measuring international research collaboration of peripheral countries: Taking the context into consideration. *Scientometrics* 66: 231–240.

Konys, A. 2018. An ontology-based knowledge modelling for a sustainability assessment domain. *Sustainability* 10(2).

Leung, D., Leung, R., & Bai, B. 2011. Asian wave in travel and tourism research. *Journal of Travel & Tourism Marketing* 28(2): 196–209.

Malik, N. M. A. N. A., Shahimi, S., Ismail, M. A., & Shafiai, M. H. M. 2020. Faktor penyebab penyisihan sosial dalam kalangan masyarakat berdasarkan sorotan karya bersistematik dan keperluan analisis lanjut daripada perspektif. *ISLAMIYYAT* 42(1): 31–38.

Noh, M. A. C., Hussein, A., Ghani, O., & Suhid, A. 2013. The study of Quranic teaching and learning: A review in Malaysia and United Kingdom. *Middle East Journal of Scientific Research* 15(10): 1338–1344. https://doi.org/10.5829/idosi.mejsr.2013.15.10.11509

Oliveira, O. J. de, Silva, F. F. da, Juliani, F., Barbosa, L. C. F. M., & Nunhes, T. V. 2019. Bibliometric method for mapping the state-of-the-art and identifying research gaps and trends in literature: An essential instrument to support the development of scientific projects. IntechOpen.

Ponomarev, I. V., Williams, D. E., Hackett, C. J., Schnell, J. D., & Haak, L. L. 2014. Predicting highly cited papers: A method for early detection of candidates breakthroughs. *Technological Forecasting and Social Change* 81: 49–55.

Rostam, N. A. P., & Malim, N. H. A. H. 2019. Text categorisation in Quran and Hadith : Overcoming the interrelation challenges using machine learning and term weighting. *Journal of King Saud University - Computer and Information Sciences*. https://doi.org/10.1016/j.jksuci.2019.03.007

Al-Rumkhani, A., Al-Razgan, M., & Al-Faris, A. 2016. Tibbonto: Knowledge Representation of Prophet Medicine (Tibb Al-Nabawi). Symposium on Data Mining Applications, SMDA 2016, 138–142. https://doi.org/10.1016/j.procs.2016.04.021

Saad, S., Salim, N., & Zainal, H. 2009. Pattern Extraction for Islamic Concept. International Conference on Electrical Engineering and Informatics, ICEEI 2009, 333–337. https://doi.org/10.1109/ICEEI.2009.5254719

Saad, S., Salim, N., Zainal, H., & Muda, Z. 2011. A process for building domain ontology: An experience in developing Solat ontology. Proceedings of the 2011 International Conference on Electrical Engineering and Informatics, ICEEI 2011, July. https://doi.org/10.1109/ICEEI.2011.6021572

Al-Sanasleh, H. A., & Hammo, B. H. 2017. Building domain ontology: Experiences in developing the prophetic ontology form Quran and Hadith. Proceedings - 2017 International Conference on New Trends in Computing Sciences, ICTCS 2017, 2018-Janua, 223–228. https://doi.org/10.1109/ICTCS.2017.35

Soudani, N., Bounhas, I., ElAyeb, B., & Slimani, Y. 2014. Toward an Arabic Ontology for Arabic Word Sense Disambiguation Based on Normalized Dictionaries. On the Move to Meaningful Internet Systems: OTM 2014 Workshops, 655–658. https://doi.org/10.1007/978-3-662-45550-0_68

Tawil, S. F. M., Ismail, R., Wahid, F. A., Norwawi, N. M., & Mazlan, A. A. 2017. Application of OASys approaches for dates ontology. 2016 3rd International Conference on Information Retrieval and Knowledge Management, CAMP 2016 - Conference Proceedings, August, 131–135. https://doi.org/10.1109/INFRKM.2016.7806349

Vasudevan, R. K., Ziatdinov, M., Chen, C., & Kalinin, S. V. 2016. Analysis of citation networks as a new tool for scientific research. *MRS Buletin* 41: 1009–1016.

Wen, T., Fang, G., & Cungen, C. 2002. Designing a top-level ontology of human beings: A multi-perspective approach. *Journal of Computer Science and Technology* 17: 636–656.

Wheeler, T. S., Michael Vallis, T., Giacomantonio, N. B., & Abidi, S. R. 2018. Feasibility and usability of an ontology-based mobile intervention for patients with hypertension. *International Journal of Medical Informatics* 119: 8–16. https://doi.org/10.1016/j.ijmedinf.2018.08.002

Zhu, J., & Liu, W. 2020. A Tale of Two Databases: The Use of Web of Science and Scopus in Academic Papers. *Scientometrics* 123: 321–335.