The Landscape of Islamic Computing: A Systematic Mapping Study Focused on the Holy Quran, the Hadith, and the Pillars of Islam

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Abstract
The objective of this mapping study is to provide an overview of the landscape of Islamic computing. It aims to review and summarize published literature in the area with a focus on Islamic pillars and sources of legislation. A total of 228 research papers published during the period from 2015 till 2020 have been reviewed. The results of this study provide findings regarding how technology is used to support sources of legislation, the Quran and the Hadith and the Islamic pillars. It also sheds light on popular research methods in Islamic computing and the technologies used. The results also show how Islamic computing research is distributed among different subject areas, and what classification for the studies exist. In addition, this study has also been useful in identifying research gaps in the field of Islamic computing in general and key areas where further investigation should be performed. Finally, the study concludes with recommendations for the community of researchers in the field of Islamic Computing.
*Keywords***: Quran, Hadith, Zakat, Prayer, Hajj, Systematic mapping study.**

1. Introduction

In recent years, technology has become an important part of people's everyday lives. The need to find answers for complex questions, and gain insights into common issues has lead people to use technology in many different fields, one of which is the field of *Islamic computing*. Islamic computing refers to the use of computing technologies for solving problems related to Islam in different domains such as education and learning, healthcare, finance, law, and others. Islamic knowledge is dependent on Islam's primary sources are the Quran and the Hadith. The Quran contains Allah's (God) verbatim words, which is revealed to prophet Muhammad (peace be upon him), while the Hadith has his words, actions, and approvals. Islam has five pillars, which are the core beliefs and practices of it: (1) the profession of faith (Shahada), (2) Prayer (Salat), (3) Alms (Zakat), (4) Fasting (Sawm), and (5) Pilgrimage (Hajj). These five pillars are considered a physical act except the Shahada since it is a phrase when someone becomes a Muslim by reciting this phrase with conviction in his/her heart.

Researchers need to be aware of what research exists in this important field. They also need to identify what gaps exist so that they can participate in filling these gaps and advancing the field

of Islamic computing research. Looking into past contributions in the field of Islamic computing, we observe that the survey studies focus mostly on the Quran or the Hadith. However, there are no systematic mapping studies that reviewed the most fundamental topics of Islam. This study aims to analyze and synthesize the contributions in Islamic computing, specifically on the topics of the Quran, the Hadith, and the Islam pillars within the period (2015-2020) in the following technology and science databases: IEEE, ACM, Springer, and Scopus, as well as other sources.

This paper is organized as follows: Section 2 reviews the literature of related surveys. Section 3 presents the research method that was used to map Islamic computing research. Section 4 describes data extraction and data analysis. Section 5 presents the results obtained from the systematic mapping study. Finally, the main conclusions are presented in Section 6, with recommendations and future work in section 7.

2. Literature Review

The interest and drive to contribute to Islamic computing research comes from the community itself. It comes from their desire and aspiration to serve Islam, and provide technological solutions supporting humans in aspects relevant to Islamic culture and teachings in their everyday lives. There are a number of survey studies in this area, however the majority focus only a single topic of Islamic computing, such as the Quran (Hakak et al., 2017), (Alginahi, 2018), (Lataifeh et al., 2020), (Fatima & Parveen, 2017) or the Hadith (Azmi et al., 2019).

For the Quran, Hakak et al. (Hakak et al., 2017) analyzed surveys about the Quran content protection and authentication from distortion when it is stored in digital forms for use in applications, systems, and web pages. They reviewed forms of the holy Quran and verification approaches for image, audio/video, and text formats. Therefore, they provided a summary of some of the techniques used for Quran protection to avoid possible threats.

For the specific sub-topic of the Quran search engines, another study by Alginahi in (Alginahi, 2018) surveyed information on search engines and tools available for the Quran text, for the goal to prepare guidelines for the minimum requirements necessary for designing the Quran search engines. The pros and cons of available engines are discussed, and challenges were identified to help design effective Quran-related search tools. In the area of the Quran reciter verification, Lataifeh et al.(Lataifeh et al., 2020) discussed different classifiers such as fine-tuned and deep learning classifiers by performing a survey engaging human expert listeners to detect imitators from authentic reciters. The survey showed high accuracy of classifiers compared to human experts. Thus, this study helps in identifying and verifying any Quranic audio clips. Another study on the Quran verification is the study presented by Fatima and Parveen (Fatima & Parveen, 2017). It provides a review of authentication systems for verifying the digital holy Quran.

As for the Hadith, the review study by Azmi et al. (Azmi et al., 2019) presented a survey that addresses all research in the area of Hadith that are computational or NLP based. Their main goal was to classify the related studies into three categories: Hadith content-based studies, narration-based studies, and overall studies. However, our review is broader in nature and is of a higher level. The study by Ibrahim et al. (Ibrahim et al., 2017) reviews studies relevant to the Hadith authentication. They present a hierarchy with different levels of related studies in computational hadith to link with the computational authentication of isnad al-hadith science. They show how the existing studies conducting hadith authentication are placed based on principles of hadith authentication in hadith science. As can be seen, the review studies are either specific to one specific topic (the Quran or the Hadith), and also focuses on one specific

task (content protection, verification, search engines). There is a need for a mapping study that shows the landscape of the Islamic pillars and sources of legislation (the Quran and the Hadith).

3. Research Method

While there are already many literature reviews, focusing on the Quran and the Hadith studies, there is no study reviewing the Islam four pillars (Prayer (Salat), Alms (Zakat), Fasting (Sawm), and Pilgrimage (Hajj)), as well as sources of legislation (the Quran and the Hadith). Therefore, this study focuses on covering all the contributions in these six fundamental topics of Islam that are needed and required by Muslims around the world.

The research method adopted for this study is a systematic mapping study which considers the guidelines specified in (Alkhabbas et al., 2019) to gain an overview of Islamic computing contributions. It involves three stages: (1) planning, (2) conducting, and (3) reporting. In the planning stage, research questions, search strategy, and mapping protocol are defined. In the conducting stage, relevant studies are picked, and the obtained data is analyzed and synthesized. The final stage is reporting the results obtained from the mapping study.

3.1 Research Questions

The research focuses on mapping published studies in Islamic computing in the following topics: the Quran, the Hadith, Prayer, Zakat, Hajj, and Fasting. The following research questions are set:

 (1) What areas are covered by Islamic computing research?
 (2) What is the thematic/conceptual classification for most researches?
 (3) What are the technologies and frameworks used by Islamic computing research?
 (4) Which research method is mostly used in Islamic computing research?
 (5) What are the research challenges in Islamic computing?

The research questions are formulated to support our primary goal, each question addresses a different aspect and aims to achieve a specific objective to understand the landscape of Islamic computing research. Table 1 shows the research questions along with their objectives.

Table 1: Research Questions

Research Question	Objectives
RQ1. What areas are covered by Islamic computing research?	Provide an overview of main areas in Islamic computing; where is the most contribution in each area and research classifications of each topic.
RQ2. What is the thematic map/conceptual classification for most researches?	It aims to discover the most popular classification in Islamic computing. This research question gives us insights into which area has the most studies.
RQ3. What are the technologies and/or frameworks used by Islamic computing research?	Results of this question will help researchers and practitioners to understand available technologies in Islamic computing, and what gaps exist.
RQ4. Which research method is mostly used in Islamic computing research?	It is important to discover popular methods adopted by scholars in Islamic computing. There are three popular research methods: quantitative, qualitative, and mixed methods.
RQ5. What are the research challenges in Islamic computing?	This research question gives us insight on challenges facing the Islamic computing research community, and guides researchers to collaborate to overcome these difficulties.

3.2 Search Strategy

The search strategy is to review relevant studies related to the six topics of Islamic computing published in the area of computer science and covering the period 2015-2020 in the following databases: IEEE, ACM, Springer, and Scopus. We also reviewed journals specializing in Islamic computing. The review covers the Islamic pillars and sources of legislation. The search started by searching in general; the plan is aimed to filter the results to get the most related. Therefore, the first result of filtering is the year of publication and computer sciences subject area. Secondly, filtering using range results to the articles related to our search keywords in the title, abstract, and keywords.

It is noticeable that some of the words are initially Arabic, and there is no standard English translation for them. That is why we search for different spelling for the same word. Moreover, fasting keyword was not included in our search keywords because when searching for fasting and computer science related articles, we get results that relate to fast algorithms. Therefore, this survey focuses on specific keywords written in the following strings:

- ("Quran" OR "AlQuran" OR "Holy Quran" OR "AlMushaf").
- ("Hadith" OR "AlHadith" OR "Hadeeth" OR "AlHadeeth")
- ("Hajj" OR "AlHajj" OR "Pilgrims" OR "Pilgrimage")
- ("Zakat" OR "Zakah" OR "AlZakah" OR "AlZakat")
- ("Prayer " OR "Prayers" OR "Salah" OR "Salat")
- ("Holy month" OR "Holy Ramadan" OR "Ramadan")

We excluded the author name because sometimes some author names have the same terms, such as Ramadan and Hajj keywords. Hence, we exclude it not to affect the search results. Some papers are not available as a full text, only the abstract, title, author, and keywords, so this information was used to review the study. The year range, keywords, included, and excluded elements have been unified in all of the other selected databases. Finally, we remove the duplicated papers and the studies related to Islam but not related to the selected criteria.

3.3 Selection Criteria

As mentioned in the previous section, the searching process focused only on six Islamic computing topics: Quran, Hadith, Prayer, Fasting, Zakat, and Hajj. We excluded any paper with the following criteria: journal papers that did not focus on Islamic computing, not in English, and duplicate papers in different sources. The search was conducted on article title, abstract, and keywords. We included only the papers with the type "journal" and are related to Islamic computing and published within the years (2015 – 2020). Tables 2,3,4,5,6, and 7 show the results of applying the search selection criteria.

For collecting and organizing the articles, we used Mendeley[1], it is a free, web-based tool for organizing research work and citations and annotating their accompanying PDF articles. The complete list of articles included in this systematic mapping study are presented in the Appendix.

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[1] https://www.mendeley.com/?interaction_required=true

Table 2. Search Results of Quran, Hadith and Hajj Based on the Selection Criteria

Quran Search Keywords	Quran, AlQuran, AlMushaf, Holy Quran				
Database	IEEE	ACM	Scopus	Springer	Other
Total Results	859	180	4501	5414	45
Journal Articles	39	34	2789	1442	45
2015-2020	32	22	1521	926	43
Computer Science	2	22	202	50	43
Islamic Computing	1	2	112	1	43
Duplicates	15				
Non-Related	29				
Final	115				

Table 3. Search Results of Hadith Based on the Selection Criteria

Hadith Search Keywords	Hadith, Hadeeth, AlHadith, AlHadeeth				
Database	IEEE	ACM	Scopus	Springer	Other
Total Results	289	37	1227	4,210	20
Journal Articles	10	27	789	675	20
2015-2020	9	24	455	357	20
Computer Science	9	1	82	14	20
Islamic Computing	2	1	30	2	20
Duplicates	1				
Non-Related	1				
Final	53				

Table 4. Search Results of Prayer Based on the Selection Criteria

Prayer Search Keywords	Prayer, Prayers, Salah, Salat				
Database	IEEE	ACM	Scopus	Springer	Other
Total Results	2149	1071	12353	78139	3
Journal Articles	518	670	7568	24259	3
2015-2020	287	380	2723	7940	2
Computer Science	0	8	89	225	2
Islamic Computing	0	8	10	3	2
Duplicates	--				
Non-Related	3				
Final	19				

Table 5. Search Results of Zakat Based on the Selection Criteria

Zakat Search Keywords	Zakat, Zakah, AlZakah, AlZakat				
Database	IEEE	ACM	Scopus	Springer	Other
Total Results	100	11	596	2155	1
Journal Articles	6	1	443	333	1
2015-2020	3	1	298	169	1
Computer Science	3	1	36	2	1
Islamic Computing	3	0	5	0	1
Duplicates	4				
Non-Related	2				
Final	2				

Table 6. Search Results of Fasting Based on the Selection Criteria

Fasting Search Keywords	Holy month, Holy Ramadan, Ramadan				
Database	IEEE	ACM	Scopus	Springer	Other
Total Results	261	147047	2585	11280	0
Journal Articles	59	6284	1914	5135	0
2015-2020	22	2974	854	2313	0
Computer Science	22	84	13	41	0
Islamic Computing	1	0	0	0	0
Duplicates	-				
Non-Related	-				
Final	1				

Table 7. Search Results of Hajj Based on the Selection Criteria

Hajj Search Keywords	Hajj, AlHajj, Pilgrims, Pilgrimage				
Database	IEEE	ACM	Scopus	Springer	Other
Total Results	188	561	9545	42,987	5
Journal Articles	16	180	5645	12,571	5
2015-2020	5	159	2171	3,503	5
Computer Science	5	19	90	111	5
Islamic Computing	1	19	30	2	5
Duplicates	3				
Non-Related	16				
Final	38				

4 Data Extraction and Data Analysis

Based on our search on Islamic computing research field, we identified initially six high-level categories of Islamic computing : Prayer, Quran, Hadith, Hajj, Zakat and Fasting. During reading, we extracted further classifications based on the root categories. To be explained further in the results section.

Each paper is classified based on the previous categories to answer RQ1. While classifying each paper, we identify the research method used if it is mentioned to answer RQ4. Additionally, a paper can be classified based on its domain and identifying the technology and/or framework used in each category to answer RQ2 and RQ3 respectively. Finally, to answer RQ5 we need to address the challenges that face Islamic computing research to overcome them in future research. Worth mentioning, since this is a high-level analysis, this survey is based on initially reviewing the paper abstract only. If the abstract was not enough to extract the data needed, the whole paper is read to get the information to answer the research questions. For some papers, where the complete article was not available, the abstract was used.

5   Results

To answer our research questions, we conducted a quantitative analysis and synthesized the extracted data form the selected studies. Below we show the results for each of the research questions.

5.1 RQ1: What areas are covered by Islamic computing research?

To answer this question, we synthesized the articles to identify classifications. We found the following classifications:

- The Quran: ontology, linguistics, recitation, search engine, tafsir, segmentation, translation, teaching, memorization, tajweed, and authentication.
- The Hadith: classification, translation, ontology, authentication, learning, search engine, question answering, and Takhrij.
- The Prayer and Zakat: zakat assistance, zakat ontology, and prayer assistance.
- The Hajj: crowd management, Hajj learning, and Hajj healthcare.

We also analyzed the number of publications in each subject area. As shown in Figure. 1, the highest number of publications was in the area of the Quran, representing 51%. This result is expected, since the Quran is the holy book for Muslims and is relevant to every aspect of their daily lives. Next, is the Hadith with 23%, while Hajj has a 17% share. Next is Prayer with 8%, and finally Zakat with 1%.

Figure. 2 shows the different topics and classifications in the Quran related papers. The highest percentage is 17% which represents the Quran segmentation studies, and the Quran recitation studies. Segmentation is important for all applications using the Holy Quran, as the text/image is segmented to identify different parts of the holy Quran. The reason for the Quran recitation having a reasonable percentage due to the need of reciting and reading Quran is essential habits in a Muslim's life.
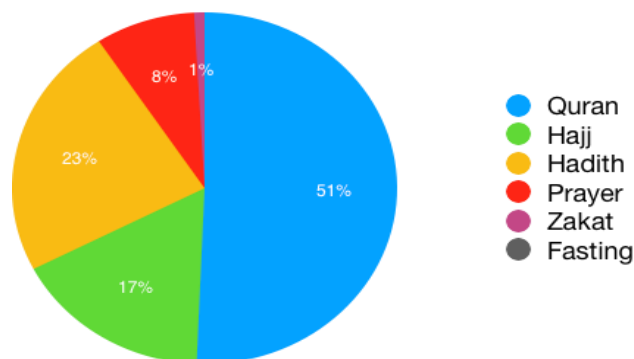

Figure. 1 Distribution of Literature According to Subject Area

Next comes Quran ontology, authentication, and search engines which represent 12%, since the Quran is a rich and important knowledge source for Muslims, many research studies focus on how to represent various aspects of the Quran using an ontological structure. Authentication is also an important aspect to consider when using the Quran in digital forms. Also, the Quran is the source of legislation for Muslims and it is important that systems using the Quran should be using a protected and authenticated version of the Quran, and ensure that no distortion happens to the Holy text of the Quran. Search engines are also a core element in applications using the Quran to help people find relevant content.

Quran translation and Quran linguistics represent have similar percentages at 9% of the studies reviewed in the Quran topic. This is due to the fact that non-Arabic speaking Muslims need to understand the Quran verses correctly. Studies on the Quran memorization, Tajweed, Teaching, and Tafsir come at a low percentage, this indicates the need for more study in this important area.

For Hadith classifications, Figure. 3 shows that the highest percentage (31%) goes to the Hadith classification, next comes the Hadith ontology representing 30% of the Hadith studies. Next are the Hadith Question Answering studies with a percentage of 10%. The Hadith authentication studies represent 9% and the Hadith learning represent 7%. The topics with low percentages are the Hadith translation, search engines, Takhrij and corpus. This highlights that these subareas in the Hadith topic with low percentage are suitable areas for advancing research in the field.
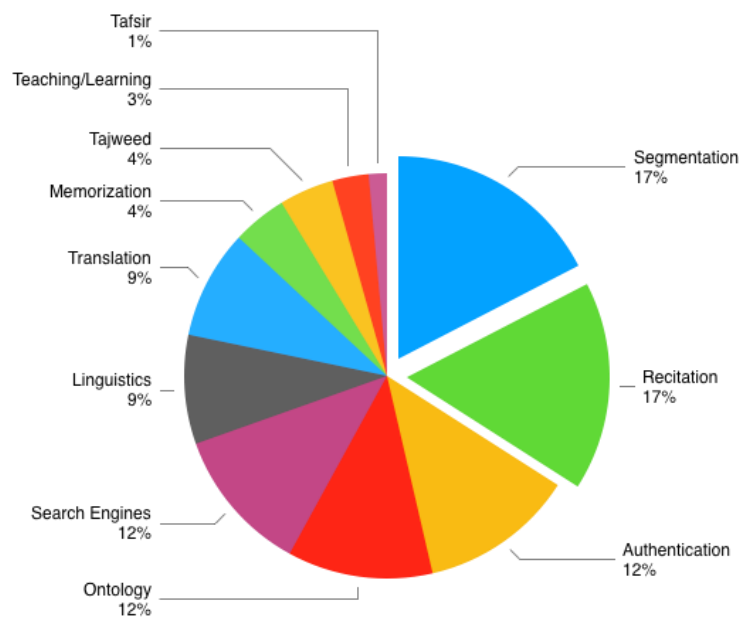

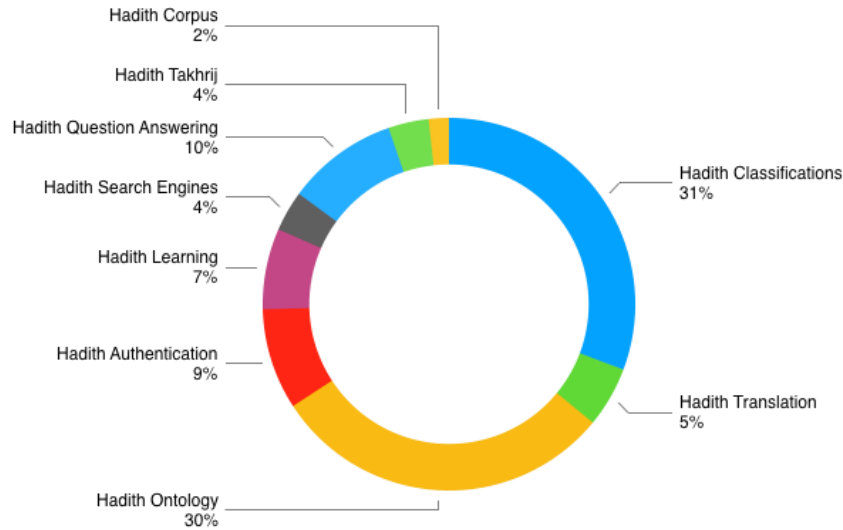Figure. 2 Classification of Quran computing research

Figure. 3 Classification of Hadith computing research

For the Prayer and Zakat topics, it is noticeable from Figure. 4 that the majority (75%) of the studies are in the area of Prayer assistance, since praying is a main Pillar in the Islamic code of practice. Meanwhile, the prayer corpus category has the lowest number of studies with 1% due to limited number of studies. For Zakat topic, the highest percentage is for Zakat assistance.
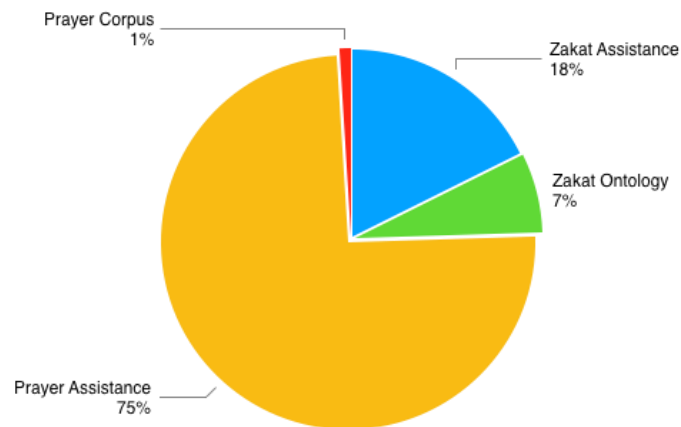

Figure. 4 Classification of Zakat and Prayer computing research

Regarding the Hajj topic, Figure. 5 shows the number of published studies related to Hajj classifications. The crowd management classification has the highest number of studies which is 74%. This high percentage is due to the importance of crowd-management in Hajj. The lowest number of papers is Hajj learning which has 5% of studies, highlighting the need to investigate this area with more studies.
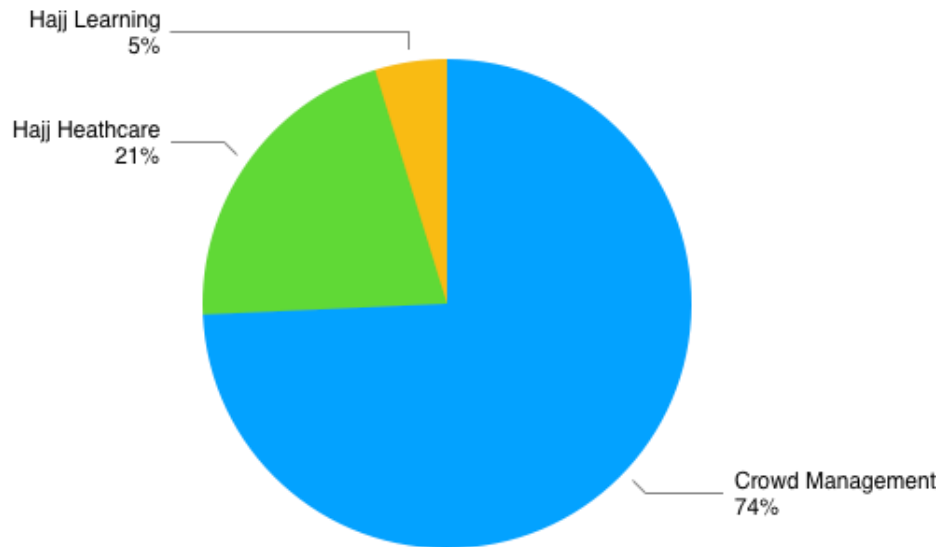
Figure. 5 Classification of Hajj computing research

5.2 RQ2: What is the thematic classification (sector) for Islamic Computing research?

Figure. 6 shows that majority of studies (77%) were conducted in the technology sector, 18% in the education sector, and 5% were in the healthcare sector.
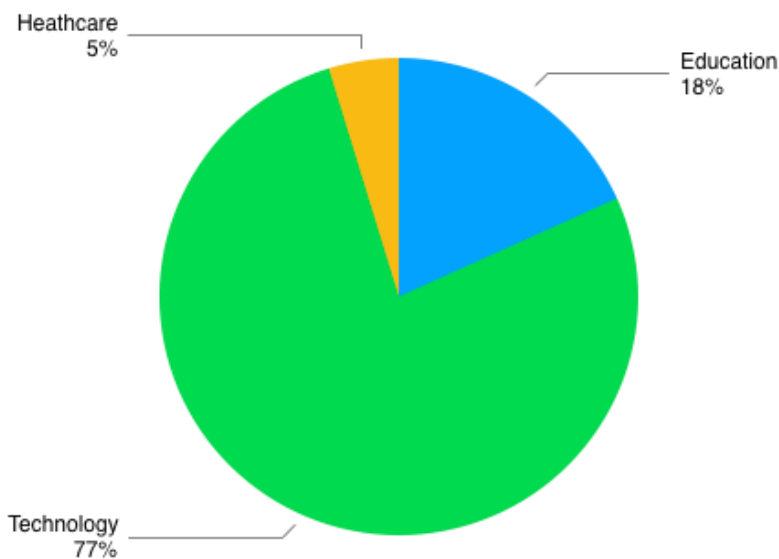

Figure. 6 Thematic classifications of Islamic computing research

5.3 RQ3: What are the technologies and/or frameworks used by Islamic Computing research?

Regarding the technologies/frameworks used in Islamic computing literature, Table 8 shows that Information Retrieval methods, Natural Language Processing (NLP) and Clustering are most popular among the reviewed studies.

Table 8. Technologies popular in Islamic computing research

Hadith	No. of Studies
Support Vector Machine (SVM)	6
Naïve Bayes (NB)	4
Information Retrieval	3
Annotation	3
Named Entity Recognition (NER)	2
Knowledge Extraction (KE)	2
Vector Space Model	2
Ontology	2
Quran	
Information Retrieval	12
Natural Language Processing (NLP)	10
Clustering	10
Text Mining	5
Speech Recognition	5
Naïve Bayes (NB)	4
K-Nearest Neighbor (KNN)	4
Support Vector Machine (SVM)	3
Deep Learning	3
Decision Tree	3
Ontology	3
Neural Networks	2
Hajj	
Bluetooth Low Energy (BLE)	3
Internet of Things	2
User Experience	2
Zakat	
Management	2
Prayer	
Mobile Applications	6
Chatbots	2
Augmented Reality	2

5.4 RQ4: Which research method is mostly used in Islamic computing research?

The results of RQ4 shown in Figure. 7. The study revealed that 61% of the reviewed papers applied quantitative methodology. Besides, a reasonable number of papers, about 33%, applied qualitative methodologies. Whereas 6% of the reviewed studies applied both qualitative and quantitative analysis methods. Therefore, from the analysis of the extracted data, the quantitative analysis research method was the most popular research methodology applied in the Islamic computing research field.
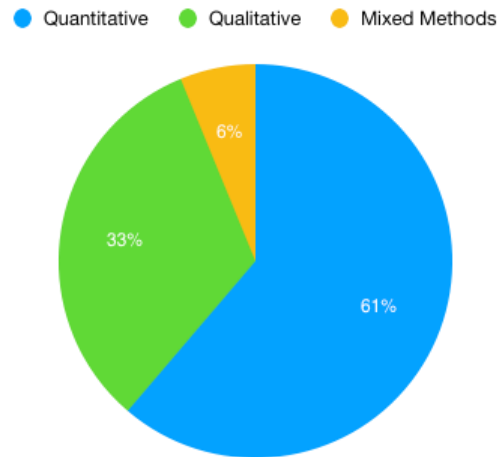
Figure 7. Islamic computing research methods

5.5 RQ5: What are the research challenges in Islamic computing?
In this review, numerous studies have been taken into consideration, and some discuss the challenges faced. For example, the lack of published research studies, compared to literature in other areas of computing shows that Islamic computing does not have similar attention. Moreover, Islamic computing research is distributed among indexing databases, libraries, personal web pages, and other digital forms that might not be accessible. In addition, there is a large amount of research that is not published in indexed databases, therefore they are not accessible. Additionally, some research results in a product or application, although extensive research has gone into their design and production are not published. Another challenge regarding Islamic computing research is the lack of resources either language related or topic specific, as well as the need to include human experts form fields outside of computing, since the topics are sensitive and it is important to be authentic and accurate whenever computer-based research and products are developed in the Islamic domain.

6   Discussion
This study provided a review and analysis on the published literature in the area of computing and the Islamic pillars and sources of legislation. We reviewed 228 published journal papers during the period (2015-2020) in the areas of the Quran, the Hadith, the Prayer, the Zakat, the Fasting, and the Hajj. We collected the articles and extracted data to be able to answer the following five research questions:

RQ1: What areas are covered by Islamic computing research?
Answer: For the Quran: ontology, linguistics, recitation, search engine, tafsir, segmentation, translation, teaching, memorization, Tajweed, and authentication. For the Hadith: classification, translation, ontology, authentication, learning, search engine, question answering, and Takhrij. For the Prayer and Zakat: zakat assistance, zakat ontology, and prayer assistance. Finally, for the Hajj: crowd management, Hajj learning, and Hajj healthcare.

RQ2: What is the thematic/conceptual classification for Islamic computing studies?
Answer: reviewing the extracted papers enables us to establish a high -level classification (Figure. 6) of the literature in Islamic computing with a focus on the six subjects selected in this study; the Quran, the Hadith, Prayer, Zakat, Fasting, and Hajj. This conceptual map can help and support researchers in categorizing their study according to this classification, and also identifying where gaps exist.

RQ3: What are the technologies and frameworks used by Islamic computing research?
Answer: Information Retrieval methods, Machine Learning, clustering, and NLP are among the top used technologies in Islamic Computing studies. This highlights the need to review how state of the art technologies such as deep-learning and transformer-based technologies can be adopted to solve problems relevant to Islamic topics.
RQ4: Which research method is mostly used in Islamic computing research?
Answer: The majority of the reviewed papers applied quantitative research methodology, next comes qualitative research methods, and lastly mixed methods. This result shows that the Islamic computing research community focuses more on experimental type of research, in which quantitative methods are most popular. However, it is important that qualitative be incorporated as well so that the utility and user experience for these solutions can be measured and evaluated.

RQ5: What are the research challenges in Islamic computing?
Answer: Islamic computing is an important area for research, however there are a number of challenges that face researchers, among them are the lack of resources (computational and human resources), as well as language and translation challenges.

Apart from answering the research questions, this research has also resulted in some recommendations for the community. Since the studies are distributed among different databases, and many duplicates were identified, a suggestion would be to establish a database that specializes in Islamic Computing research for published work in English and other languages, to help researchers in this filed find relevant research studies. Moreover, while conducting this study we encountered so many translations for Islamic terminology, this has made it difficult for us to extract all studies in a specific topic. A suggestion is to provide a unified standard reference for all Islamic computing literature to use.

Finally, being able to see the landscape can help in building a classification system for Islamic computing studies, similar to the standard computing classification systems. Such system would be very helpful in organizing the literature in this area.

7   Conclusion and Future Work

Although this study has provided a view of the landscape of the Islamic computing field, there are some limitations in this study that can be a starting point for future work. For example, we limited the scope of the time period, the databases selected, and the type of publication (journals only) for timing constraints on this work. In addition, we only selected six subject areas in Islamic computing that we see are important (the Quran, the Hadith, Prayer, Zakat, Fasting and Hajj) due also to the same reason, timing constraints. In future work, we would like to extend publication years, databases searched, and subject areas to have a much clear picture of the landscape of Islamic computing literature to support the community in identifying gaps and directing future research.

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Biodata

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APPENDIX
PUBLICATIONS LIST USED IN THE STUDY

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مشهد الحوسبة الإسلامية: دراسة منهجية للخرائط تركز على القرآن الكريم والحديث الشريف وأركان الإسلام

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الخلاصة. تهدف هذه الدراسة المسحية الاستطلاعية إلى تقديم تصور شامل عن طبيعة الأبحاث العلمية في مجال الحوسبة الإسلامية. وقد قام الباحثون فيها بمراجعة واستخلاص العناصر الأساسية للدراسة من المؤلفات المنشورة في المجال بالتركيز على أركان الإسلام الخمسة ومصادر التشريع (القرآن الكريم والسنة النبوية). وقد شملت الدراسة مراجعة ما مجموعه 228 ورقة بحثية تم نشرها خلال الفترة من 2015 حتى 2020. وتقدم هذه الدراسة نتائج تتعلق بكيفية استخدام التكنولوجيا لدعم مصادر التشريع (القرآن والسنة) وأركان الإسلام، كما تلقي الضوء على منهجيات البحث الشائعة في مجال الحوسبة الإسلامية وكذلك التقنيات المستخدمة. وتظهر نتائج البحث توزيع أبحاث الحوسبة الإسلامية على المواضيع والتخصصات المختلفة في المجال. بالإضافة إلى ذلك، تفيد هذه الدراسة أيضًا في تحديد الثغرات البحثية في مجال الحوسبة الإسلامية بشكل عام والمجالات الرئيسية التي يجب إجراء مزيد من البحث فيها. وتختتم الدراسة بتوصيات عامة للمهتمين في البحث العلمي في مجال الحوسبة الإسلامية.

الكلمات الجوهرية. القرآن الكريم، الحديث، الصلاة، الزكاة، الحج، دراسة مسحية.