PROPOSING AN INTELLIGENT INFORMATION RETRIEVAL (IIR) FRAMEWORK FOR SHARIAH SOURCES RETRIEVAL IN ISLAMIC FINANCIAL INDUSTRY

MARHANUM CHE MOHD SALLEH[1] & RIZAL MOHD NOR[2]

[1*] Department of Finance, International Islamic University Malaysia, 53100 Gombak, Selangor, MALAYSIA. E-mail: marhanum@iium.edu.my

[2] Department of Computer Science, International Islamic University Malaysia, 53100 Gombak, Selangor, MALAYSIA. E-mail: rizalmohdnor@iium.edu.my

Abstract: This research proposes a framework of Intelligent Information Retrieval (IIR) for Shariah sources using Support Vector Machine (SVM) for Shariah decision making in Islamic Financial Industry (IFI). In addition, needs towards an automatic indexing platform for Shariah sources is also discussed in this research. Qualitative research methodology is adopted to review past literatures on IIR, data indexing, and SVM, the popular method of algorithms classification for text categorization. This research would be significant to Islamic banking industry in terms of strengthening the compliancy of the industry towards Shariah (Islamic rules) by proposing an IIR to the industry players. It also would add to the literature on Islamic finance especially in the context of financial technology. This research serves as a cross-field research that integrate the field of technology, Islamic finance, legal, and Shariah for an innovation.

Keywords: Intelligent Information Retrieval (IIR), Support Vector Machine (SVM), Shariah decision making, Islamic Financial Industry.

INTRODUCTION

Technology invention have started since few decades ago and it was the work of groups of scientists, programmers, and engineers. As huge of data was gathered online nowadays, difficulty of selecting a correct and reliable data have become a challenge. Furthermore, tendency to manipulate data have also increased among those who keen to take advantage over the technology advancement. Its now depends on human intention whether to use the data for the benefits of future or to bring into distraction of the world environment. If the data is used to produce benefits to the planet, people would also need to select which data is to be used and how it to be gathered. Computer technologies have proven that online information retrieval have become more efficient and able to reach users with more in-depth information than the traditional approach (full texts and hardcopy documents).

Hence, in the current information-age society, advanced retrieval systems and the automatic abstraction of information from streams of text, coupled with automated indexing, summarization and abstracting become the societal needs which is offered by Intelligent Information Retrieval (IIR). The marriage between IR and Artificial Intelligent (AI) systems are important in deriving huge quantities of raw text in an intelligent manner (Intelligent Information Retrieval). In addition, because of most of the current database are non-bibliographic databases and given that free style queries requested directly from innocent online searchers, the IIR which is controlled by automatic, machine-performed procedures, is needed.

This research therefore proposing an IIR framework and discussing the needs to adopt an Intelligent platform for Shariah decision making process for the betterment of IFI industry. This framework would give an efficient platform for the Shariah scholars as well as industry players in gathering sufficient information for decision making process in order to run the Islamic business and also to resolve Shariah issues that they encountered.

PAST STUDIES

INTELLIGENT INFORMATION RETRIEVAL (IIR)

Information Retrieval (IR) or text information retrieval is basically denoted the 'information'. It is a branch of computer science that involves with activity of processing as well as searching of unstructured documents (Nadkarni, 2002). It caters information need by users pertaining to their query (Sharma & Kumar, 2020). It overlaps with other computer science fields like database technology and natural language processing (NLP). The objective of IR basically to assist text searching activity in order to obtain fast and accurate information based on key words. Nowadays people rely on IR system through index-based search engines like a Google or others to find the information that they need even though it does not give specific answers to the question. This limitation still exist until current decade where a recent study conducted by Sharma and Kumar (2020) have mentioned that there are two major issues for IR which first, elusiveness in specifying user's information need through query and second, limited number of methods to perform partial match between documents and query. In this context, the authors have suggested intelligent information retrieval model which is called Bayesian Rough Set and the model is found to perform well.

Accordingly, Intelligent Information Retrieval (IIR) is introduced to compliment the limitation of IR and also known as 'agent' information. The idea of 'intelligent' information retrieval was first introduced in the late 1970s and have become popular in the early 1990s (Belkin, 1996). Under one single umbrella, IIR works as information gathering agent, extracts both unstructured and structured documents, and provides index for information searching activities (Gupta et al., 2012). IIR has been defined variously by different scholars, and a consistent interpretation is it reflects the machine program doing something for the user, or taking over some functions that previously had to be performed by humans (either user or intermediary), retrieves and forwards information to the user without any other interaction. (Belkin, 1996). In this context, the usage of artificial intelligence (AI) in IIR would enhance the efficiency of information retrieval activities (Xie et al., 2003).

In Islamic finance industry, Haider et al. (2020) have suggested the usage of AI in NLP based Islamic FinTech Model that combines Zakat and Qardh-Al-Hasan (benevolent loan) to minimize the negative impact of COVID 19 on individuals and SMEs. The authors were in

opinion that the Islamic finance has big potential to face any kind of situation/pandemic especially the combination of Zakat and Qardh-Al-Hasan. In addition, researches done by Ali et al. (2019) and others (Laldin & Furqani, 2019; Zubaidi & Abdullah, 2017; Evans, 2015) have explored the potential of Fintech which including AI, smart contract, blockchain, and others on the Islamic banking and finance industry in various Asian countries and their findings indicate that Fintech would benefit the industry greatly to be at par with the conventional counterparts. Hence, a lot of effort need to be structured and defined to adopt and implement Fintech successfully so that it would bring significant impact to the society as well as the world at large.

DATA INDEXING

In the effort adopting IIR in the Islamic finance industry, the most important part is indexing information of text documents. It basically involves the process of analyzing the content of the text in order to retrieve its theme (Haraty & Nasrallah, 2019). Indexing texts is necessary in various domains of different types of documents such as articles in newspapers and magazines, academic articles, report, legal document or standards, web page, and others. Most importantly, information or data indexing is used for information retrieval (Haraty & Nasrallah, 2019). There are two types of indexing methods which are thesaurus-based and full text-based indexing (Khoja, 2001). The thesaurus-based indexing method is applied when the index words does not exist in the document as it rely on its synonyms that exist in the text document. The problem of thesaurus-based indexing method is it require human intervention to screen the words' synonym. Meanwhile, the full-text based indexing method relies on selecting words or terms that already exist in the text document. It is easier than the thesaurus-based indexing method (Khoja, 2001). The current research would adopt the second method of indexing which is full-text indexing method in order to retrieve information regarding Shariah and legal sources that is govern the practice of Islamic financial system.

Hence, observing academic research on data indexing, it is found that there are specific studies that have concerned on data indexing which including computer science, language, medical, telecommunications, and others. Unfortunately, very limited studies on data indexing conducted in the context of Islamic finance or banking as this area is considered as internal or technical part of computer sciences. Most of the studies on Islamic finance were conducted on the external matters of technology adoption like blockchain, smart contract, crypto currency, and also customer acceptance on technology adoption in the banking transaction.

Accordingly, studies from others field like computer sciences done by Benrazek et al. (2020) have introduced a new indexing structure to index massive Internet of Things (IoT) data called BCCF-tree (Binary tree based on containers at the cloud-fog computing level). The model is based on recursive partitioning of space using the k-means clustering algorithm to separate space into nonoverlapping subspace to improve the quality of search and algorithm results. In addition, Al-Molijy et al. (2012) have proposed an automatic method to create and index books written in the Arabic language. Their method basically relied on text summarization and abstraction processes to collect main themes and statements in a book. Meanwhile, from the medical context, there are a quiet number of researches on data indexing which including Chen et al. (2016) that have designed a method called MyPHI that forecasts personal health index (PHI) to explore patterns of a large collection of geriatric medical examination (GME) records using data mining techniques. The results of the experiments have indicated the effectiveness of their method based on a real-world GME data set collected from 102,258 participants. Avillach et al. (2007) have developed an information processing method based on terminologies, in order to index medical documents in any given documentary context. Their model is designed based on both symbolic general knowledge extracted from the Unified Medical Language System (UMLS) and statistical knowledge extracted from a

domain of application. A set of 17,079 French standardized discharge summaries (SDSs) were used to test the model and the results indicated that the most important ICD-10 term of each SDS was ranked 1st or 2nd by the method in nearly 90% of the cases.

SUPPORT VECTOR MACHINE (SVM)

There are a lot of classification methods introduced by scholars to classify algorithms for data retrieval. For example, Naïve Bayes proposed by McCallum and Niagam (1998), decision trees by Sahami et al. (1998), neural networks by Joachims (1998) and Harrag and El Qawasmeh (2009), and Support Vector Machine or SVM by Dumais (1998) and Turney and Pantel (2010). Based on comparison study by Yang and Liu (1999), SVM is the best classification method of algorithm for text indexing. SVM is basically machine learning for regression, classification, and outliers detection. It is mostly adopted in solving classification problems where it constructs hyperplanes in the n-feature dimensions. In the SVM algorithm, hyperplane is found in an N-dimensional space where N is the number of features (groups) that distinctly classifies the data (Gandhi, 2018). Details explanation of how SVM works as explained by Gandhi (2018) are as below;
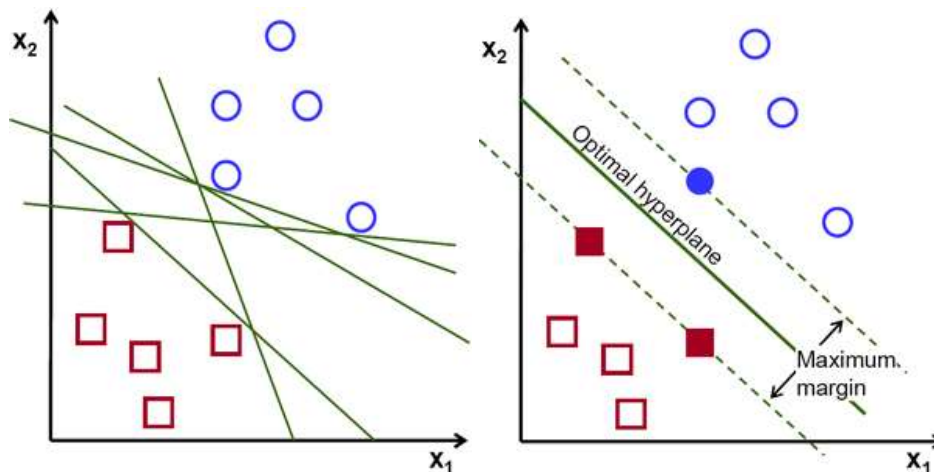

Figure 1: Examples of various hyperplanes in a huge data text (Gandhi, 2018)

Figure 1 above shows there are many possible hyperplanes that could be chosen to classify data. The objective of SVM is to find a plane that has the maximum margin, which represents the maximum distance between data points of both classes. Maximizing the margin distance provides some accuracy so that future data points can be classified with more confidence. Hyperplanes are decision boundaries that assist researcher to classify the data points. The dimension of the hyperplane depends upon the data feature whereby it will be divided based on how many groups that the data presents. The figure would become more complicated if the features is more or exceed three. Among the advantages of SVM are it able to separate a clear margin of data, effective in high dimensional spaces, works well in cases where the number of dimensions is greater than the number of samples, uses a subset of training points in the decision function which called support vectors.

Among past studies that have utilised SVM in the field of banking and finance is by Okasha (2014) who investigated SVM in financial forecasting. By comparing SVM with an autoregressive integrated moving average (ARIMA) and ANN, to test Al-Quds Index of the Palestinian Stock Exchange Market time series data, where accuracy of forecasting is tested, the results indicated that SVM provides more accurate and efficient forecast than the other two

methods. In addition, earlier study by Li et al. (2004) on credit assessment in financial and banking industry. This article applies support vector machines (SVM), a relatively new machine learning technique, to the credit assessment problem for better explanatory power. The structure of SVM has many computation advantages, such as special direction at a finite sample and irrelevance between the complexity of algorithm and the sample dimension. A real credit card data experiment shows that SVM method has outstanding assessment ability. Compared with the methods that are currently used by a major Chinese bank, the SVM method has a great potential in predicting accuracy.

In addition, Li et al. (2013) have examined systemic risk in a banking landscape as well as on the financial stability during a financial crisis. They authors have adopted SVM in order to predict Chinese banking systemic risk and their findings indicate that SVM is an efficient method to explain their prediction. Interesting, Benhayoun et al. (2014) have investigated towards Islamic Finance practice and its impact on companies' financial condition. Adopting Linear Regression Model and SVM with 3 years data of 20 firms (40 financial variables), the authors have found that SVM prediction model have successfully proved that interest-based loan have significant impact towards companies' financial behaviour.

Wu et al. (2015) in their proposal on enhancing classification function via modified kernel function have adopted information-geometric method that is based on the structure of the Riemannian geometry. SVM algorithms basically utilise a set of mathematical functions which is known as kernel. The objective of kernel is to receive data as input and transform it into the required form. Different kernel function would require different SVM algorithms. There are types of kernel which including Polynomial, Gaussian, Gaussian Radial Basis Function, Laplace RBF, and other Kernels. The authors in this paper adopted the Gaussian Radial Basis Function which is a general-purpose kernel and is adopt when there is no prior knowledge about the data. Using financial data of Chinese listed companies, they concluded that the modified kernel function model has the ability to reduce the number of support vectors, and finally enhanced the classification accuracy.

In other study by SirElkhatim and Salim (2017), SVM is utilised to predict the case of Sudanise bank failure. Based on 11 financial and non-financial ratios, capital adequacy, asset quality, Earning, and liquidity (CAMELS) have been selected as predictor variables. All results were evaluated using SVM accuracy of prediction method. Further analysis is done on classifying financial ratios using Discriminant analysis and there were 3 ratios with highest predictive power have been identified in their study which are: EAS (Ratio of equity capital to total asset), LADF (Ratio of liquid assets to deposits and short term funds) and RFR (Rain Fall Ratio).

Recent study that have utilise SVM in the context of financial system including by Gupta et al. (2019), Endri et al. (2020), and Shrivastaz and Ramudu (2020). Gupta et al. (2019) have adopted SVM for regression purposes where the authors have proposed twin support vector regression to predict financial time series for noisy data and nonstationary information. Financial time series datasets which were nonstationary included in this research were information technology, stock market, banking sector, and the oil and petroleum sector. Based on 44 datasets and the root mean squared error and the standard deviation values, the twin support vector regression is found faster than other standard support vector regression. Endri et al. (2020) on other context of research have structured an early warning system model that can anticipate the occurrence of delisting of Islamic stocks (ISSI) using SVM. Among financial variables adopted in their research were debt to equity, return on invested capital, asset turn over, quick ratio, current ratio, return on assets, return on equity, leverage, long term debt, and others. Relied on 335 Islamic shares registered at ISSI in the period 2012-2017 (102

companies), they authors have come out with 4 different models of SVM and found that the financial indicators had a significant predictive power to the occurrence of delisting of Islamic shares. Among the four models, SVM Model 4 have shown the highest accuracy rate of predictive effect which was 100% accuracy rate.

Finally, in Indian context, Shrivastaz and Ramudu (2020) have conducted a comparative analysis of financial stress among Indian public banks by adopting Linear and Radial Basis Function Kernel of SVM. Results of the study revealed that the SVM with Linear Kernel have achieved 92.86% forecasting accuracy whereby the Radial Basis Function Kernel have only shown 71.43% accuracy rate. Differences of accuracy rate basically would depend on the data of the study as well as the study's context. As a conclusion, based on literatures review, it is observed that most of the researches done in the area of financial industry in adopting SVM in the methodology have focused on financial forecasting using time series data, risk prediction, financial stress and behaviour, and other financial impact. In addition, the usage of SVM are mostly on prediction and classification. Unfortunately, there are limited literatures that have been conducted to examine an information classification in the financial industry especially the Islamic financial industry using SVM. Therefore, it is believed that there is a dire need to classify various information that are available and useful to the industry players in order to enhance its practice towards Shariah compliant. Moreover, given this era of technology, the task of information classification or indexation should be done using computational approach for fast and accuracy.

Different SVM Kernel Function

SVM is a machine learning where its usage mostly on information classification, regression, and outliers' discovery. SVM algorithms basically adopt a set of mathematical functions that are known as Kernel. Different SVM algorithms would rely on different types of Kernel functions. Standard Kernel Function Equation (https://www.geeksforgeeks.org/major-kernel-functions-in-support-vector-machine-svm/)

$$K\left(\overline{x}\right) = 1, \text{ if } \|\overline{x}\| <= 1$$

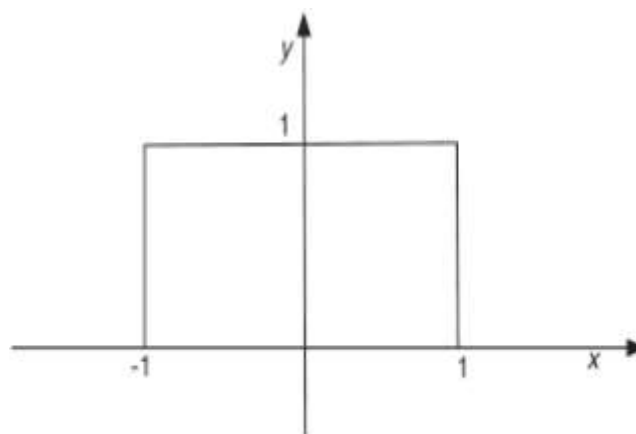$$K\left(\overline{x}\right) = 0, \text{ Otherwise}$$

Figure 3: Kernel Function

Among commonly adopted Kernel functions are following;

    i.   Gaussian Radial Basis kernel Function (RBF).
        It is used to enhance transformation when there is no prior knowledge about data.
        It has localized and fixed response along the entire x-axis.

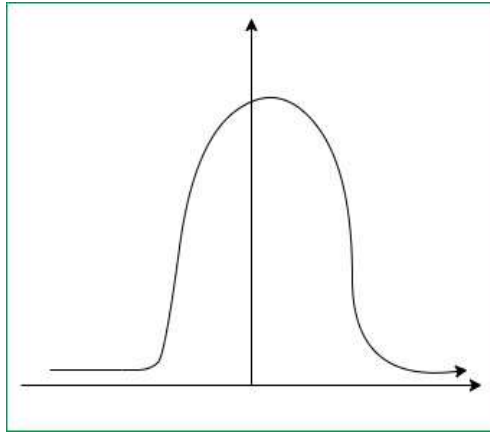$$k(\mathbf{x_i}, \mathbf{x_j}) = \exp(-\gamma \|\mathbf{x_i} - \mathbf{x_j}\|^2)$$

$$\text{For } \gamma > 0$$

Figure 4: Gaussian Radial Basis kernel function (RBF).

    ii.   Gaussian Kernel
        It is a general-purpose kernel and used when there is no prior knowledge about the
        data.

$$k(x, y) = \exp\left(-\frac{\|x - y\|^2}{2\sigma^2}\right)$$

    iii.   Sigmoid Kernel
        It is used as a proxy for neural networks and as activation function for artificial
        neurons.

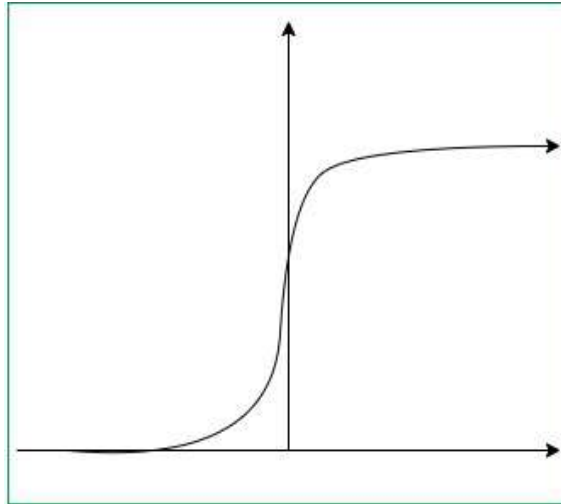$$k(x, y) = \frac{J_{v+1}(\sigma \|x - y\|)}{\|x - y\|^{-n(v+1)}}$$

Figure 5: Sigmoid Kernel

iv.   Polynomial Kernel
      It represents the similarity of vectors in training set of data in a feature space over polynomials of the original variables used in kernel. It is popular in image processing.

$$k(\mathbf{x_i}, \mathbf{x_j}) = (\mathbf{x_i} \cdot \mathbf{x_j} + 1)^d$$
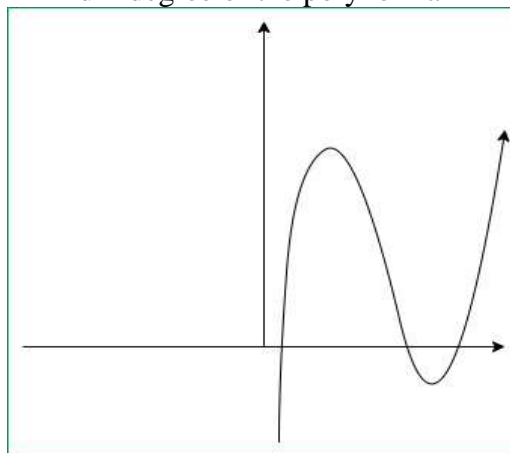
d = degree of the polynomial

Figure 6: Polynomial Kernel

METHODOLOGY

To achieve the research objective, qualitative methodology is adopted in this research where the discussion is based on literatures review to propose the IIR framework. In general, SVM with Gaussian Radial Basis kernel Function (RBF) is proposed in the framework as method of classification.   Below is the proposed framework for information classification and indexation.
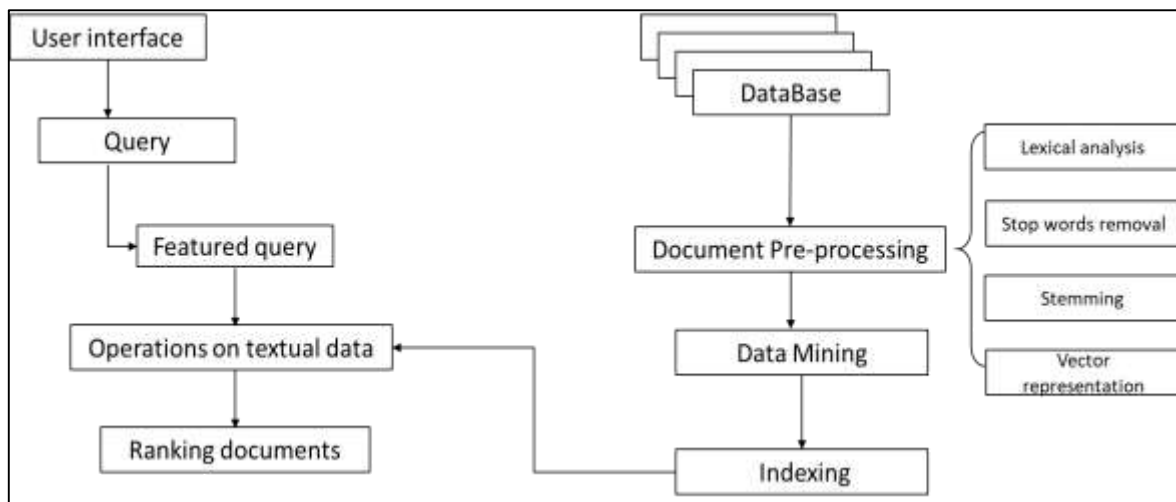
Figure 2: The Proposed IIR Framework

As based on the literatures review, the proposed framework of IIR would be based on SVM method of information classification. Figure 2 above depicts two aspects of information retrieval which are internal and external retrieval. The internal information retrieval process would include collection of various information to become an information database. The process would continue with information or document pre-processing where it will go through various stages of information screening including lexical analysis (also known as tokenization where the whitespaces or comments is removed), stop words removal (example of stop words are 'the', 'a', 'an'), stemming (the process of reducing a word to its root word stem that affixes to suffixes and prefixes), and vector representation (graft presentation represented by arrows with their length representing the magnitude and their direction where this part would present SVM results of accuracy for information classification). Once the information is proven to be accurate, the process is continued with data mining and indexing. This is the end of internal part of information retrieval process where everything is done using computational system.

Meanwhile, for external part, it usually started with query by user. Once it is detected, the system will analysis the featured query and make it as textual data and after that connect with document rank. This process then relates to the internal part of data retrieval whereby the system with tally the data with the index that already built based on existing database. This framework is believed to be significant to the Islamic financial industry especially Islamic banks to enhance its decision regarding the Shariah issues where a lot of information still scattered in the market in which if it is pulled in one indexed database, it would be resourceful to the industry players especially Shariah advisors and Shariah officers. It is because they are the backbone of the industry to remain comply with the Shariah.

CONCLUSIONS

The needs to have a standardized and automatic platform for information retrieval which is called as Intelligent Information Retrieval (IIR) in the Islamic financial industry is obvious. It is because of there is limited automatic indexing platform of Shariah and legal sources especially for Malaysian financial industry for decision making process. This is due to the existence of various nonbibliographic databases in the industry supplied by local authority like the Central Bank of Malaysia, Malaysian Shariah Advisory Council (SAC), or international Shariah Body like Accounting and Auditing Organization of Islamic Financial Industry (AAOIFI) and others which becomes a challenge for the scholars and practitioners to collect all sources of information in order to derive a solid Shariah decision.

Other than that, it is also become a challenge to the scholars and industry practitioners to access the information system where there are different languages of document (in this context; English, Malay, Arabic), command language, various database selection as well as problem regarding the system interface (user friendliness and ease of use). This problem has delayed the Shariah decision making process as the number of Shariah issues always in increasing trend (complicated Islamic banking product arrangement) which demanded to be solved within short period of time.

Finally, it is a standard enforced by the Central Bank of Malaysia through Shariah Governance Policy Paper which was issued on September 2019 for the Shariah committee to "establish a robust methodology to guide its decision-making process" (Standard 10.4) and they "shall be accountable for the quality, accuracy and soundness of its own decision or advice" (Standard 10.3). Therefore, it is believed that the Intelligent platform which is proposed in this research for Shariah decision making process via IIR would contribute to the information accuracy and completeness and at the same time would assist the Shariah committee and industry practitioners to come out with solid decision to solve the Shariah issues.

REFERENCES

Baeza-Yates R, Ribeiro-Neto B. (1999). Modern Information Retrieval. Addison-Wesley Longman; Harlow, UK.

Laldin, M. A., & Furqani, H. (2019). FinTech and Islamic Finance. Fintech in Islamic Finance: Theory and Practice.

Salton G. (1989). Automatic Text Processing: the transformation, analysis, and retrieval of information by computer. Addison-Wesley; Reading, MA.

Van Rijsbergen CJ. (1979). Information Retrieval. Butterworths; London, UK.

Witten IH, Moffat A, Bell TC. (1999). Managing Gigabytes. Morgan Kaufman; San Francisco, CA.

Ali, H., Abdullah, R., and Zaini, M. Z. (2019). Fintech and Its Potential Impact on Islamic Banking and Finance Industry: A Case Study of Brunei Darussalam and Malaysia, International Journal of Islamic Economics and Finance Vol. 2(1), pg 73-108.

Al-Molijy, A., Hmeidi, I. and Alsmadi, I. (2012), "Indexing of Arabic documents automatically based on lexical analysis", International Journal on Natural Language Computing (IJNLC), Vol. 1 No. 1, pp. 1-8.

Benhayoun, N., Ikram Chairi1, Amina El Gonnouni1, Abdelouahid Lyhyaoui, (2014). Islamic Banking Challenges Lie in the Growth of Islamic Economy Despite of the Free Interest Loans Policy: Evidences from Support Vector Machine Approach, ACRN Journal of Finance and Risk Perspectives Vol. 3, Issue 1, Jan. 2014, p. 19 - 31 ISSN 2305-7394 19

Benrazek, A. E., Kouala, Z., Farou, I., Ferrag, M. A., Seridi, H., and Kurulay, M. (2020). An efficient indexing for Internet of Things massive data based on cloud-fog computing, Emerging Telecommunications Technologies, 31(3), https://doi.org/10.1002/ett.3868

Chen, L., Li, X., Yang, Y., Kurniawati, H., Sheng, Q. Z., YunHu, H., and Huang, N. (2016) Personal health indexing based on medical examinations: A data mining approach, Decision Support Systems, Volume 81, January, Pages 54-65

Endri, E., Kasmir, K & Syarif, A. (2020). Delisting sharia stock prediction model based on financial information: Support Vector Machine, Decision Science Letters , 9(2), 207-214.

Evans, C. (2015). Bitcoin in Islamic Banking and Finance. Journal of Islamic Banking and Finance, 3(1), 1–11.

Gupta A., Verma, D. and Gambhir, K. (2012). Intelligent Information Retrieval, Global Journal of Computer Science and Technology Software & Data Engineering Volume 12 Issue 12 Version 1.0 Year 2012 Research Journal Publisher: Global Journals Inc. (USA) Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Gupta D, Pratama M, Ma Z, Li J, Prasad M (2019). Financial time series forecasting using twin support vector regression. PLoS ONE 14(3): e0211402. https://doi.org/10.1371/journal.pone.0211402

Okasha, Mahmoud K. (2014). Using Support Vector Machines in Financial Time Series Forecasting International Journal of Statistics and Applications, 4(1): 28-39 DOI: 10.5923/j.statistics.20140401.03

Sharma, A. and Kumar, S. (2020). Bayesian rough set based information retrieval, Journal of Statistics and Management Systems, DOI: 10.1080/09720510.2020.1799575

Shouwei Li, Mingliang Wang, Jianmin He, "Prediction of Banking Systemic Risk Based on Support Vector Machine", Mathematical Problems in Engineering, vol. 2013, Article ID 136030, 5 pages, 2013. https://doi.org/10.1155/2013/136030

Shrivastav, Santosh Kumar and Ramudu, P. Janaki. (2020). Bankruptcy Prediction and Stress Quantification Using Support Vector Machine: Evidence from Indian Banks, Risks, MDPI, Open Access Journal, vol. 8(2), pages 1-22, May.

SirElkhatim, Mohamad A. and Salim, N. (2017). Predicting Bank Financial Failures Using Discriminant Analysis, And Support Vector Machines Methods: A Comparative Analysis in Commercial Banks In Sudan (2006-2014), International Journal Of Scientific & Technology Research Volume 6, Issue 04, issn 2277-8616 207

Wu, C., Wang, Lu, & Shi, Z. (2016). Financial Distress Prediction Based on Support Vector Machine with a Modified Kernel Function, Journal of Intelligent Systems, 25(3), 417-429. doi: https://doi.org/10.1515/jisys-2014-0132

Zubaidi, I. B., & Abdullah, A. (2017). Developing a Digital Currency from an Islamic Perspective: Case of Blockchain Technology. International Business Research, 10(11), 79.

Avillach, P., Joubert, M., and Fieshi, M. (2007). A Model for Indexing Medical Documents Combining Statistical and Symbolic Knowledge, AMIA Annu Symp Proc, page 31–35.

Li, Jianping., Liu, Jingli., Xu, Weixuan., and Shi, Yong. (2004). Support Vector Machines Approach to Credit Assessment, • Conference: Computational Science - ICCS 2004, 4th International Conference, Kraków, Poland, June 6-9, 2004, Proceedings, Part IV, DOI: 10.1007/978-3-540-25944-2_115

Xie, S. Y., Liu, J. C., Liu and Han Wang. (2003). Research of intelligent information retrieval system based on three layers agent structure," Proceedings of the 2003 International Conference on Machine Learning and Cybernetics (IEEE Cat. No.03EX693), Xi'an, 2003, pp. 2329-2332 Vol.4, doi: 10.1109/ICMLC.2003.1259897.

Gandhi, R. (2018). Support Vector Machine, Introduction to Machine Learning Algorithms SVM model from scratch, Retrieved at https://towardsdatascience.com/support-vector-machine-introduction-to-machine-learning-algorithms-934a444fca47

https://data-flair.training/blogs/svm-kernel-functions/ Retrieved on 13th October 2020

https://www.geeksforgeeks.org/major-kernel-functions-in-support-vector-machine-svm/
Retrieved on 13th October 2020