Application of Artificial Intelligence (AI) in Islamic Investments

Haneffa Muchlis Gazali[*], Junisa Jumadi,
Noor Rasyidah Ramlan, Nurmaisarah Abd Rahmat,
Siti Nor Hazilawati Mohd Uzair, Amirah Norliyana Mohid

Universiti Malaysia Sabah Labuan International Campus

[*]*Corresponding author: haneffa@ums.edu.my*

Abstract

This study examines the application of Artificial Intelligence (AI) in Islamic Investments. AI technology is very popular in both the conventional and Islamic banking systems as reflected in the contributions of AI in Islamic investment. The technology helps investors to analyse their stocks in terms of price levels, the current stability of each stock and the future price forecasts based on current price and stock data. The study is a conceptual discussion on the application of AI in Islamic investment, which focuses on the discussion of Text Mining, Algorithmic Trading, Stock Pick and Robo in Investment, which include Robo Advisor, Robo Islamic Advisor (RIA) and Robo Financial Advisor (RFA) operating in Islamic investment system. Thus, the discussion dwells on the cognitive application along with investment and compliance sectors of the financial services industry. The conclusion of the study highlights the implications, limitations and future research of the subject matter.

Keywords: *Artificial intelligence, Malaysia, Islamic investment system, robots in investment*

1. Introduction

The Islamic financial industry acceptance towards the use of Artificial Intelligence (AI) technologies in investment is particularly important especially as to how the use of AI will affect the Islamic financial growth in Malaysia (Tuomi, 2018). Islamic finance industry is financial activities in accordance with Shariah (Islamic law) in which all operations carried out by this industry should not be involved with *riba, gharar and maysir* (Hussain, 2015). Islamic Finance involves Islamic Financial Institutions (IFIs) where the objectives and operations of the institutions are based on the principles of the Holy Quran (Tabash and Dhankar, 2018). This means that an IFI is not just a bank, but it also covers other types of financial intermediaries that follow Shariah principles in its business conducts. The other point of departure is that the Shariah ostensibly requires the adjustment of all aspects of Muslims' lives and the formation of a complete moral system (Tabash and Dhankar, 2018). In relation to the AI technology, Mat Rahim et al. (2018) explained that digital banking 4.0, FinTech banking and AI have recorded potential applications since 2017 (refer Figure 1).The presented fact testifies to the relevance of the current study in providing adequate information on how the Shariah-based Islamic financial industry aligned with the technological developments such as AI, particularly in terms of Islamic investment.

Since the establishment of the Islamic financial system in Malaysia in 1963, it has seen tremendous growth in the development, demand and acceptance of the system among the Malaysian society. Subsequent to the establishment of the Malaysian Pilgrims Fund Board (Tabung Haji), Bank Islam Malaysia Berhad (BIMB) was the first Islamic Bank to operate on 1 July 1983 and has become the core component of the Islamic financial system in the country. The objective of Islamic banking then was limited to the development

of modern and viable alternatives to meet the financial needs of the Muslims. Malaysian banking is now modelled as one of the most advanced Islamic banking system in the world (Hussain, 2015).

According to Mijwel (2015), the concept of AI has been around since the ancient times, but the advent of digital computers in the 20th century has brought the AI concept to a higher level. AI was understood as a field of computer science in the mid of 1950s. The term AI has been applied to computer programs and system which are capable of more complex tasks than ordinary computers. Although the AI system is not yet in at the level of human intellect and thinking, it has been widely used in specific areas such as information processing, computer games, national security and financial services. The development of AI has led to the use of smart contracts, Robo Advisor Islamic Banking, Robo Islamic Advisors (RIA), Robo Financial Advisor (RFA), Robo Mentor and Smart *Muftis,* especially in the Islamic financial services (Fazmi, 2019). AI contains all information about the sender, receiver and analysis of the financial performance. As a result of its rapid development, the systems can contribute to both conventional and Islamic financial systems. The use of AI technology among firms in the world is reported by Ramaswamy (2017) (Refer Figure 2).

Figure 1: Digital Banking Evolution
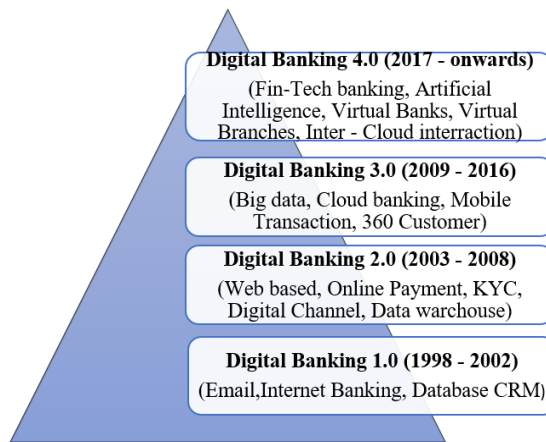
Source: AI, Smart Contracts and Islamic Finance (Mat Rahim et al., 2018)

Figure 2: The Use of AI among Investment Companies Around the World.
TATA Consultancy Services Survey on 835 Companies in 2017
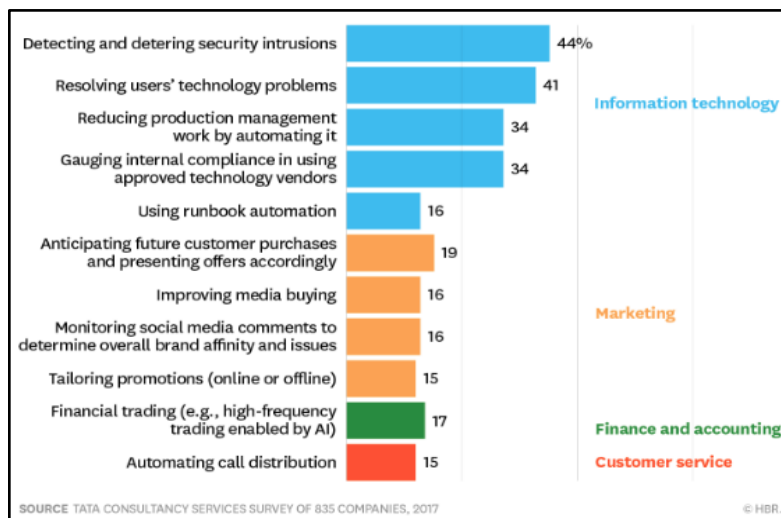
Source: (Ramaswamy, 2017)

Investment is an asset or item that is purchased with the hope that it can generate income in the future. Based on Jiao (2018) investment is an activity of purchasing of valuable goods to generate wealth in the future. In finance, an investment is a monetary asset which is purchased with the idea that the asset will be sold at a higher price to earn profit. In Shariah, the elements of *riba, gharar and maysir* are prohibited because they are regarded as long-term abuse of behaviour between human (Mijwel, 2015). Hence, the prohibited elements must be controlled in order to bring peace in this world and the hereafter (Mijwel, 2015).

Nowadays, as customers become more sophisticated and knowledgeable, they prefer to make financial transactions with less human interaction (Mat Rahim et al., 2018). Hitherto, the scope of technology is expanding and has the potential to improve the efficiency of the overall financial system. One of the popular tools to improve efficiency is the smart contract: a computer program that can record and list all receivers and senders (Mat Rahim et al., 2018). This computer program also has applications in other areas such as in the banking system, insurance (takaful) and management. Formulated as any other technology and innovation-driven, AI might be adopted in some Islamic finance products. Mijwel (2015) found that AI can create machine learning tools and deep neutral networks, which can bring a whole new experience to the financial industry.

Previous research revealed that AI will have a huge impact on the future of the Islamic finance industry (Mat Rahim et al., 2018). Dahlan (2018) in his study discovered that the inclusion of AI into the way of life of Muslims is affecting their daily life despite being not significant. For an example, Wahed Invests is an online Halal investment platform that has facilitated and used more automation in Islamic investment. They have also provided cost-effective access to Shariah-compliant equity investments (DinarStandard, 2018). However, Hussain (2015) stated that the implementation of AI to evaluate products/services with Islamic features will be challenged.

Several studies have focused on the impact of AI in financial services and its influence on economic growth. However, there has been very little effort to explore the impact of Islamic finance principles on economic growth using AI. To fill this literature gap, this study investigates the potential effects of AI in Islamic investment and instruments on economic growth. We believe that the results of this study will help decision-makers and investors from local and global markets to understand the advantages of AI in Islamic investments, and their role in enhancing economic growth of a nation.

This study centrally examines the applications of AI in Islamic investments. It is hoped that this study will provide a better understanding about AI technology in Islamic finance investment. At this age of rapid advancement in technology, AI will certainly be useful to support human intelligence as it could process and store big data. This study intends to provide an understanding of the development of AI into the financial industry, to assess the performance of AI implementation in the investment industry, to highlight the potential of AI in supporting the financial industry and to promote the application of AI technology in the Islamic financial system in Malaysia.

This study begins with the discussion of the history of AI, the research problems, questions and objectives. The second part explains the emergence of literature in the context of AI in Islamic investment. Next is the discussion on how the AI works in helping the investment activities in the Islamic financial system. The final part concludes the study with a discussion on implications, limitations and future research.

2. Literature Review
In this section, we review the related literature of the study. The literature review will enlighten the discussions on Text Mining, Algorithmic Trading, Stock Picks and Robots in Investments.

2.1 Text Mining
In the Business-to-Consumer (B2C) market, more businesses are interested in using big data analysis. Firms are creating a network-driven partnership, involving vast amounts of information flow across and within firms (Kang et al., 2018). Some of the businesses tried several combinations of unigrams, bi-grams and trigrams as features in the use of support vector machines. Understanding the impact of text mining on knowledge discovery is the focus in assisting practitioners to develop big data analytic projects and researches. Mostly, people will look at fast access to the relevant information that helps them address what they need. There is a need to learn a new subject or solving a specific problem. Text mining has been used in many sectors, such as education, government, health care and manufacturing. The text mining process involves several technologies such as pattern matching, topic tracking, summarisation, clustering,

categorisation, etc. Pattern matching for example, increases the knowledge discovery process by using text mining which has attracted interest of a variety of fields such as business and finance. This requires much effort to gather non-trivial information and provide more significant opportunities in implementing a knowledge discovery process (KDP). It allows discerning trivial and non-trivial text data and grasping knowledge present in a large amount of unstructured data. After converting it to a specified structured format, text mining applies the techniques of data mining to the corpus of textual data (Kumar and Ravi, 2016). Text mining is still devising more efficient techniques that are essential for handling and predicting significant data despite the availability of several text mining applications currently. The efficient techniques of text mining are targeted for better prediction by combining numerical data and textual data. Due to its high potential, text mining is vital in every field, including finance.

2.2 Algorithmic Trading
Bendtsen and Peña (2016) stated that algorithmic trading is a process that actively decides when to trade an asset and when not to trade it, to match risk and reward on invested capital on short-term strategy and to compare with holding the asset on a long-term strategy. One of the main reasons why algorithmic trading is becoming so popular is due to its advantages compared to a manual trade. Algorithmic trading offers some advantages related to accuracy, speed and cost reduction (Lakshmi, 2017). Reid (2019) quantified that algorithm trading provides asset liquidity through quick buy and selling orders. Its impact on liquidity is further revealed in the currency market after the Swiss Franc stopped holding the Euro in 2015 (Reid, 2019). According to Zavadskaya (2017), several companies have successfully used algorithmic trading. Sentient Investments, an investment company, uses AI in the form of machine learning (algorithm trading) to develop reasonable quantitative investment and trading strategies. Additionally, algorithm trading is the latest form of AI that has deep learning and image recognition to scan through all the available information and try to figure out a relevant investment strategy for investment decisions. Further, Schmelzer (2019) analysed that some banks delve deep into the AI world by using smart systems to assist them in making investment decisions and to support their investment banking research. Firms like UBS and ING based in the Netherlands have AI system tracking the market for unexplored investment opportunities and later inform their algorithmic trading system. While humans are still at a disadvantage with all investment decisions, AI system on the other hand reveals additional opportunities through better investment modelling and discovery. Following these advantages, algorithmic trading is expected to reduce costs and minimise human error in making investment decisions.

2.3 Stock Picks
According to Agrawal et al. (2019), AI processes large amounts of information much faster and makes predictions more precise than is humanly possible. In relation to this, Wang (2014) stated that AI has many benefits to be used for investing as it can analyse thousands of data in a short period that even human beings are not capable of performing. This is further supported by Brandt (2017) that AI is also being used to achieve faster resolutions, assist customer inquiries, achieve better investment results and risk assessment. AI, hence, will play a significant role in financial services development in which automated financial planners help investors in making financial decisions. The system (AI) includes monitoring activities, stocks and bonds price trends according to the financial goals and personal portfolio of the investors, called "Robo Advisors" (Brandt, 2017). AI is capable of transferring or adapting knowledge gained from one setting to a different setting. Based on Gil et al. (2019), today's most effective financial machine learning requires a large amount of training data, which involves significant investment and expenses to develop. Ahmed (2018) however argued that humans are still capable of improving investment performance and can think better in selecting stocks for investment without having to be bound to the created system. Furthermore, Ahmed also explains that humans will experience extreme job losses because of the implementation of AI. Zavadskaya (2017) stated that by gaining more data, it can be a guide for investors to buy and sell stocks at a target price in future. This is because AI is capable of analysing large amounts of data and can make near-accurate predictions of stock prices in the future. In this regard, Ali (2019) explained that AI is one of the most promising models used by researchers to predict stock movement because Artificial Neural Networks (ANN) can approximate any nonlinear function to an arbitrary degree of accuracy with a fair number of hidden units.

2.4   Robots in Investment

AI has assisted many processes of the Islamic financial industry including investments, retirement planning and wealth management. In today's' world, many robotic models have been created that possess the AI features that can help to ease the work of humans in many aspects of life. This includes the AI robotic model of Robotic Radio Frequency Ablation (RFA) Surgery that was created to perform minimally invasive ablation surgery based on commonly used clinical radio frequency needles. Therefore, in order to perform an extensive and multi-purposed liver tumour case with precision, high consistency and efficiency, the RFA is very appropriate (Tan et al., 2017). According to Buchanan (2019), the term "Robo Advisor" was essentially non-existent a decade ago, but it is now relatively a common term in the financial landscape. However, despite the term "Robo", the advisory process does not involve robots at all. Instead, Robo Advisors are algorithms built to calibrate a financial portfolio based on the investors' investment goals and risk tolerance. This advancement in financial advisory will therefore help policymakers take the right steps in formulating investment policies. Buchanan (2019) reported that Robo Advisors (chatbots) are powered by natural language processing (NLP) and machine learning (ML) algorithms and have become powerful tools to provide a personalised, conversational and natural experience to users in different domains.

Robo Advisors (chatbots) have gained significant appeal with millennial consumers who do not need a physical advisor and may feel more comfortable in dealing with robots while investing. Further, Robo Advisors offer are cost-effective since no fees are to be paid to human advisors and AI has provided all the relevant information pertaining to the investment decisions such as the gross domestic product, inflation, deficit and relevant data on companies' performance before making any investments (Jiao, 2018). According to Beketov et al. (2018), the wealth management industry is currently facing a new generation of investors which they are educated, technology literate and savvy, prefer to have control over their investment, actively seeking information virtually and less dependent on the financial advisors.

2.4.1   Robo Advisor

According to Fazmi (2019), Robo Advisors are becoming smarter and faster day by day and play an important role in IFIs. This includes Robo Advisors in Islamic Banking, Robo Islamic Advisors, Robo Financial Advisors, Smart *Muftis* and Robo Mentors. By implementing this technology, it can help the industry to gain an area that has massive visibility, cost efficiency and increased productivity (Fazmi, 2019). Besides, Robo Advisor can help the player to develop their business and ensure long term success. According to Margin (2019), Robo Advisor helps the process and direction of businesses. Also, it has been crucial sources for market players, helping IFIs' customers in the various application area and as a market solution. According to Carey (2019), USD 2.2 trillion size of the Robo Advisor market are predicted by 2020 although the assets under management as at September 2019 are very much lower. With the implementation of this technology, wealth managers can focus on affluent investors who are underserved with the combination of human and digital engagement. It is also stated that the Robo Advisor gets its assets under management base on the initial tract that was projected. Another suggestion was to re-framed the machine-human interface to human vulnerability so that the machine is more sensitive to human vulnerability. Thus, Robo Advisor can be a better asset allocator than human advisors (Beltramini, 2018). To conclude, Robo Advisor plays a significant role in providing better investment opportunities and it gives a positive impact on the industry.

2.4.2   Robo Islamic Advisor (RIA)

Robo Islamic Advisor (RIA) is the world's first automated Islamic investment platform to customers (Friedberg, 2019). RIA aims to provide access to *halal* portfolio management for 2 billion Muslims around the world (Friedberg, 2019). Besides, the introduction of RIA is considered to be the world's first automated ethical investment platform. Wahed Invest (the investment company) offers a lower minimum investment of USD 7,500 as a starter. The investment company claims to be the first global Robo Advisor and their services are accessible for the lower socio-economic demography (Fazmi, 2019). In the beginning, Wahed Invest is only available in the United States; it then expanded its business to over 100 countries worldwide by 2017. Two months after the launching of the world's first Islamic Robo Advisor, another company known as the Kuala Lumpur-based Farringdon Group launched the Asia's first Shariah-compliant Robo Advisor (Global Islamic Finance Report, 2017). The online tool, called Algebra, will provide automated portfolio management advice and will be opened to investors across all geographies with a minimum investment of USD 200 per month. In this regard, clients can choose funds from its Islamic Master Select Portfolio (Rahman, 2019). This

shows that RIA is important in Islamic investment where it will help investors to perform investment on an Islamic platform.

2.4.3 Robo Financial Advisor (RFA)

Islamic banks can feed data into RFA on all available Shariah compliant investment options. This will also encourage the industry to expand its wealth management schemes because with RFAs the visibilities for those investment options will be gaining momentum (Fazmi, 2019). In relation to this, when a Shariah-compliant investor wants to know his or her return, the investor can enter his or her preferences. The robot (RFA) will analyse the various patterns, trends, options and provides the best possible return on investment (Fazmi, 2019). This will pave the way for a universal Islamic wealth management options. Therefore, the services are accessible at any time so investors can analyse and compare the possible results. Following this innovation, the notion that Islamic banking is only for Muslims can be eradicated.

3. Islamic Investment System

In this digital age, the inclusion of AI in investment can be seen more widely. In this regard, it is important to ensure that the investments not only generate good returns, but preserve good ethics and values as well (Wahed Invest, 2017). Times (2019) stated that there are still many broad opportunities to offer ethical inputs as well as ethical principles following Islamic teachings where Islamic ethics is based on Shariah (Islamic law), *fiqh* (jurisprudence), *urf'* (customers practices), and *qanun* (ordinance). AI can help to make wise decisions on stock investing, as well as Shariah-compliant stocks (MyFinB, 2019).

Mookerjee (2017) stated that the neutral network technology (AI) which is developed by a Californian start-up (Maxsys), will be used by Malaysian-based company in order to construct investment portfolio comprising of 20-50 stocks from the Shariah-compliant universe of the S&P 500 Index. This index is based on 125 component stocks that fit with Islamic principles. The machine-learning algorithm (MLA) will process millions of data points from new flow of data obtained, stock volumes and any other market data to come out with a stock recommendation. There will be two portfolio managers who will subsequently manage the final call to the end client upon recommendation from the MLA (Mookerjee, 2017). Beltramini (2018) further stated that machines are used to decrease human imperfection; the machine nevertheless does not decrease human vulnerability because technology advancement does not affect human nature. Despite this, Mookerjee (2017) commented that consumers are still in doubt on the effectiveness of AI and machine learning because it is still new. Mookerjee further stated that human beings are the ones who will act at the end of the process, not the machines.

3. Discussion and Conclusion

The Islamic financial industry's acceptance towards the use of Artificial Intelligence (AI) technologies in investment is particularly important as the use of AI affects the Islamic financial growth in Malaysia. This study meets its objective in reviewing the impact of Text Mining, Algorithmic Trading, Stock Pick, and Robo in Islamic investment system based on the application of AI in Islamic investment. First is on Text Mining in which this is one of the technologies to extract information from the vast amount of big data. After converting the information into data format, Text Mining applies the data mining technique to the corpus of textual data (Kumar and Ravi, 2016).With big data, data mining method will help investors analyse market data, price levels and perform forecasting activities. Bach et al. (2019) confirmed that Text Mining had been used in many sectors, such as education, government, health care, and manufacturing. Pattern matching, topic tracking, summarisation, clustering, categorisation, and information are the technologies in the Text Mining process. Pattern matching, for example, increases the knowledge discovery process using Text Mining which has attracted interest from a variety of fields such as finance, business and AI. In this regard, this study led to the discussion on the factors that affect the acceptance rate of AI application in Islamic investment.

Algorithmic Trading (AT) as part of AI is the instrument used in Islamic investment to reduce possible errors that could occur during the trading process by investors. This is due to AI's capabilities to place an investment for investors in a more accurate and effective process in comparison to trades placed by humans which sometimes are exposed to mistakes due to wrong decision-making process. The AT helps several investment companies in making investment decisions by scanning all the market or stock information. Most importantly, AT can reduce cost and minimise human errors throughout the investment decision-making process.

This study also discovered that Stock Pick has proven to help investors to predict future market price such as through market analysis, logistics planning along with the management of the stock more accurately and systematically, thus improving the market timing. Stock Pick also helps investors to make an investment decision by referring to all the analysed data based on the current market price and stock movement and subsequently for investors' future investment.

Considering AI to operate in the Islamic investment system, AI brings a positive impact to the consumers in making smart decisions in Shariah compliant stocks investment as AI can provide a high-quality service in the investment system. In this case, AI can provide lots of advantages to its uses since it is Shariah compliant and does not affect the human nature.

Since today is the era of robots which are becoming smarter and faster day by day, Robo in investment has played a significant role in Islamic investment. This is due to the easy use of robots' financial advisors, coupled with the lower fee model for professional Islamic investment management. Apart from that, it is also believed that Robo investment can help investors to mitigate risks in investment. Further, robots' financial advisors can help to make a better decision in Shariah compliant investment since users can restrict the scope of investments to exclude alcohol, gambling, speculative and any activities which are not according to Shariah.

This study, therefore, has opened many future research opportunities in the area of AI in Islamic investment and discovered many new factors that contribute to the development of AI in investment system. Besides, the present study appears to be the first attempt to discuss the application of AI in Islamic investment thoroughly and contributes to the existing knowledge in the context of Islamic investment. This study also helps to increase the understanding of the uses of the AI application in Islamic investment among Malaysian investors.

The findings of this study, lead to several policy implications. For the practitioners, this study will be a benchmark to provide investment products and services which employ the application of AI. While to the policymakers, this study will be considered as a stepping stone for preparing the regulatory framework for the investment industry related to AI. Therefore, it is crucial that this area of study be continued and further developed to facilitate financial flows in the Malaysian economy in particular.

This work has examined a range of issues pertinent to AI and its implementation in the Islamic financial industry. Most importantly, this study adds to the existing literature in Islamic finance and financial technology. This work suffers from several limitations - notably related to detailed application and user acceptance on the implementation of AI in Islamic investment. In future work, it may be useful to study on the other aspects of Shariah compliant investment not covered in this study where the use of AI is possible. Besides, the current study suggests that future research may explore and provide empirical evidence on the understanding of investors towards the application of AI in Islamic investment.

Acknowledgement

References
Ahmed, H. E. (2018). AI Advantages and disadvantages. *International Journal of Scientific Engineering and Applied Science (IJSEAS), 4*(4)*,* 22–25.

Agrawal, A., Gans, J., & Goldfarb, A. (2019). *The economics of artificial intelligence*. Chicago: The University of Chicago Press.

Beketov, M., Lehmann, K., & Wittke, M. (2018). Robo advisors: quantitative methods inside the robots. *Journal of Asset Management*, *19*(6), 363–370.

Beltramini, E. (2018). Human vulnerability and robo-advisory: an application of Coeckelbergh's vulnerability to the machine-human interface. *Baltic Journal of Management*, *13*(2), 250–263.

Bendtsen, M., & Peña, J. M. (2016). Gated Bayesian networks for algorithmic trading. *International Journal of Approximate Reasoning*, *69*, 58–80.

Brandt, J. (2017). Artificial intelligence applications in financial markets forecasting. a systematic mapping. Retrieved November 12, 2020, from https://www.diva-

portal.org/smash/record.jsf?pid=diva2%3A1168746&dswid=5846

Buchanan, B. G. (2019). *Artificial intelligence in finance*. Retrieved November 12, 2020, from http://doi.org/10.5281/zenodo.2612537

Carey, B. Y. T. W. (2019). Robo-advisors 2019: still waiting for the revolution. Retrieved October 15, 2019, from https://www.investopedia.com/robo-advisors-2019-where-have-all-the-assets-gone-4767826

Dahlan, H. A. (2018). Future interaction between man and robots from Islamic perspective. *International Journal of Islamic Thought*, *13*(1), 44–51.

DinarStandard. (2018). Islamic fintech report 2018: current landscape & path forward. 1–38. Retrieved November 12, 2020, from https://www.dinarstandard.com/wp-content/uploads/2018/12/Islamic-Fintech-Report-2018.pdf

Fazmi, F. (2019). Role of robo-advisors in Islamic financial institutions. Retrieved November 12, 2020, from https://journal.wahedinvest.com/role-of-robo-advisors-in-islamic-financial-institutions/

Friedberg, B. A. (2019). Wahed Invest: a look at the new islamic robo-advisor. Retrieved November 12, 2020, from https://www.investopedia.com/articles/personal-finance/112516/wahed-invest-peek-new-islamic-roboadvisor.asp#:~:text=Both%20access%20and%20investments%20are,risk%E2%80%94than%20their%20traditional%20competitors.

Gil, Y., Selman, B., Desjardins, M., Forbus, K., Mckeown, K., Weld, D., & Drobnis, A. S. (2019). A 20-Year Community Roadmap for Artificial Intelligence Research in the US Roadmap Co-chairs: Workshop Chairs: Steering Committee. Retrieved October 15, 2019, from https://bit.ly/2ZNVBVb

Global Islamic Finance Report. (2017). *Islamic Finance in the Digital Age*, 282–290.

Hussain, M. S. (2015). An overview of Islamic finance. *IMF Working Paper*.

Jiao, Y. (2018). Applications of artificial intelligence in e-commerce. Retrieved October 15, 2019, from https://tel.archives-ouvertes.fr/tel-01892576/

Kang, M., Ahn, J., & Lee, K. (2018). Opinion mining using ensemble text hidden Markov models for text classification. *Expert Systems with Applications*, *94*, 218–227.

Kumar, B. S., & Ravi, V. (2016). A survey of the applications of text mining in financial domain. *Knowledge-Based Systems*, *114*, 128-147.

Lakshmi, R. (2017). Survey of algorithmic trading strategies in equities and derivatives. *International Journal of Mechanical Engineering and Technology (IJMET)*, *8*(12), 817–825.

Margin, G. (2019). Robo-advisor market trends 2019 growth by top companies. Retrieved October 15, 2019, from https://wheelchronicle.com/2019/10/14/robo-advisor-market-trends-2019-growth-by-top-companies-betterment-futureadvisor-personal-capital/

Mat Rahim, S. R., Mohamad, Z. Z., Abu Bakar, J., Mohsin, F. H., & Md Isa, N. (2018). artificial intelligence, smart contract and Islamic finance. *Asian Social Science*, *14*(2), 145.

Mijwel, M.M. History of artificial intelligence. *Comput. Sci. Coll. Sci.*, 1–6.

Mookerjee, I. (2017). Shariah compliant robo advisor to use AI. Retrieved October 20, 2019, from https://citywireasia.com/news/shariah-compliant-robo-advisor-to-use-ai/a1064772

MyFinB. (2019). Picking strong Shariah compliant stocks with. Retrieved November 12, 2020, from https://myfinb.com/press-release/picking-strong-shariah-compliant-stocks-with-a-i/

Bach, M.P., Krstić, Z., Seljan, S., & Turulja, L. (2019). Text mining for big data analysis in financial sector : a literature review. *Sustainability*, *11*(1277), 1-27.

Rahman, A. (2019). Opportunities and threats of Shariah-compliant robo advisory. the case of Wahed Invest. Retrieved October 15, 2019, from, https://www.grin.com/document/540407

Reid, S. G. (2019). Algorithmic trading system. Retrieved from, https://www.investopedia.com/terms/a/algorithmictrading.asp

Ramaswamy, S. (2017). How companies are already using AI. Retrieved October 15, 2019, from https://hbr.org/2017/04/how-companies-are-already-using-ai

Schmelzer, R. (2019). 5 benefits of AI in the banking industry. Retrieved October 14, 2019, from https://searchenterpriseai.techtarget.com/feature/AI-in-banking-industry-brings-operational-improvements

Tabash, M. I., & Dhankar, R. S. (2018). The relevance of Islamic finance principles in economic growth. *International Journal of Emerging Research in Management and Technology*, *3*(2), 49–54.

Tan, X., Chng, C. B., Duan, B., Ho, Y., Wen, R., Chen, X., & Chui, C. K. (2017). Cognitive engine for robot-assisted radio-frequency ablation system. *Acta Polytechnica Hungarica*, *14*(1), 129–145.

Times, N. S. (2019). Ethical code needed for AI. Retrieved November 12, 2020, from https://www.nst.com.my/opinion/columnists/2018/11/435928/ethical-code-needed-ai

Tuomi, I. (2018). The impact of artificial intelligence on learning, teaching, and education. Policies for the future. JRC Science for Policy Report. Retrieved October 14, 2019, https://publications.jrc.ec.europa.eu/repository/bitstream/JRC113226/jrc113226_jrcb4_the_impact_of_arti ficial_intelligence_on_learning_final_2.pdf

Wahed Invest. (2017). The halal investing guide. Retrieved October 4, 2019, from https://journal.wahedinvest.com/the-halal-investing-guide/

Wang, P. (2014). What do you mean by "Artificial Intelligence"? *Frontiers in Artificial Intelligence and Applications*, *171*(1), 362–373.

Zavadskaya, A. (2017). Artificial intelligence in finance : forecasting stock market returns using artificial neural networks. Retrieved October 14, 2019, from https://helda.helsinki.fi/dhanken/bitstream/handle/123456789/170154/zavadskaya.pdf?sequen