JEBI

Journal of Economics and Business Issues

Empowering Green Sukuk Through IoE Towards SDGs Attainment

Adlin Masood [1] and Norfhadzilahwati Rahim [2,*]

[1] Faculty of Economics and Muamalat, Universiti Sains Islam Malaysia; adlin.masood@usim.edu.my
[2] Faculty of Economics and Muamalat, Universiti Sains Islam Malaysia; norfhadzilahwati@usim.edu.my
* Correspondence: norfhadzilahwati@usim.edu.my

Abstract: The 17 SDGs introduced by the United Nations aimed at sustainability, faced setbacks due to COVID-19 reversing 25 years of poverty reduction. Global crises, climate change, and rising prices pushed 95 million into extreme poverty. Green Sukuk, Islamic bonds for eco-friendly projects, has substantial fundraising potential. Adoption requires supportive legal, regulatory, social, and tech environments. Technical advances, including the Internet of Everything, make finance cheaper, aligning with Shari'ah laws and enabling intelligent decision-making. Thus, this study evaluates if Green Sukuk empowered by IoE can achieve SDGS and provide a new paradigm. The research methodology utilized a qualitative approach, extensively examining current literature to gain insights into the Islamic finance ecosystem, specifically focusing on Green Sukuk and the possible integration of the Internet of Everything (IoE). The findings reveal that the proposed model of integrating IoE into Islamic finance, particularly Green Sukuk, holds great potential where the integration of IoE addresses issues of integrity and communication within the Islamic finance ecosystem, providing timely data and information sharing among stakeholders. Analysis from the study points out that mobilising private resources and using new technology can accelerate SDG attainment and make the future more sustainable and equitable.

Keywords: Green Sukuk; Internet of Everything (IoE); Sustainable Development Goals (SDGs); Islamic Finance

1. Introduction

The difficulties of extreme climate change, global health crises, wars, poverty, and inequality are formidable issues of unprecedented magnitude that persistently elude global resolution. The progress made by the United Nations in implementing the 17 Sustainable Development Goals (SDGs), which seek to promote sustainability and equity in the future, has been impeded by the revelation that the COVID-19 pandemic had reversed a significant portion of the poverty reduction achievements made over the past twenty-five years. The confluence of escalating prices attributed to climate change and the persistent geopolitical tensions surrounding the Ukraine issue and Gaza incursion is anticipated to yield a concerning upsurge in the population residing in conditions of extreme poverty. Based on the findings of the United Nations Statistical Division (UN Report 2022), it is projected that around 95 million individuals will be residing in conditions of extreme poverty by the year 2022.

The integration of Islamic finance with advanced technological advancements holds considerable potential for enhancing the worldwide endeavor to attain sustainable development [2]. The Islamic finance industry has increasingly acknowledged the significance of integrating environmental, social, and governance (ESG) concepts into its operations [2]. The Green Sukuk, a groundbreaking financial instrument grounded in Shariah principles, has emerged as a significant entity within the realm of sustainable finance [6]. The establishment of a vehicle for Islamic bonds aimed at supporting projects that foster environmental sustainability demonstrates a resolute dedication to this objective. The Green Sukuk market is seeing tremendous growth and holds the potential to generate substantial capital for the advancement of sustainable development. According to the principles of Shariah law, green sukuk development will result in a favorable and advantageous influence on society at large. Nonetheless, the successful integration of this initiative in nations endeavoring to achieve Sustainable Development Goals (SDGs) necessitates an appropriate and progressive structure encompassing legal, regulatory, social, and technological aspects [47]. Furthermore,

Citation: Masood, A.; & Rahim, N., (**2024)** Empowering Green Sukuk Through IoE Towards SDGs Attainment. *Journal Of Economic and Business Issues, 4(1)*, 113-125.

Received: 29/12/2023
Accepted: 17/02/2024
Published: 29/02/2024

due to technological developments and the implementation of Green Sukuk, the financial burden related to acquiring capital can be significantly alleviated [39]. However, the untapped potential of Green Sukuk in allowing substantial transformation has yet to be fully attained.

Simultaneously, the Internet of Everything (IoE) is a highly advanced network that intimately links diverse devices, humans, and data to deliver fast and correct information to the relevant decision-makers, making it a very effective enabler in the future. The Internet of Things (IoE) possesses the capacity to enhance the efficacy and transparency of sustainable initiatives [32]. Although the Internet of Things (IoT) solely facilitates the connection known as machine-to-machine (M2M) communication, it should be noted that IoT is just one component of the broader concept of the Internet of Everything (IoE), which encompasses a wider range of interconnected entities [26]. The Internet of Everything (IoE) enables individuals to gain a deeper comprehension of the environmental and social consequences of sponsored initiatives by collecting and analysing real-time data [26], that is then fed to the various pillars of IoE. Consequently, this fosters a financial ecosystem characterised by openness and accountability. The integration of the Internet of Everything (IoE) into the Green Sukuk ecosystem signifies a significant change in perspective, introducing a versatile framework that can effectively monitor, evaluate, and enhance the effectiveness of environmentally sustainable initiatives.

Central to this inquiry is the careful utilization of private resources and the adept application of emerging technologies, serving as pivotal catalysts for fostering a future characterized by both sustainability and social equality. The principal aim of this paper is to elucidate the considerable transformative capacity inherent in the model under consideration. It seeks to unravel how the symbiotic relationship between Green Sukuk and IoE can act as a formidable force in accelerating progress towards the SDGs. The crux of this argument lies in the cultivation of innovation, inclusion, and sustainability, positioning the combination of Islamic finance and cutting-edge technology as a pivotal driver for societal progress. By intricately interweaving private sector dynamism with technological prowess, this research contends that a profound and positive impact can be achieved, transcending the conventional boundaries of financial instruments and sustainability initiatives.

Furthermore, the research contends that the Internet of Everything (IoE) emerges as a linchpin in enhancing the efficiency, transparency, and accountability of Green Sukuk issuance, management, and investment. By leveraging IoE, the financial ecosystem of Green Sukuk can be fortified with real-time data analytics, offering stakeholders deeper insights into the environmental and social impact of financed projects. The paper posits that IoE is not merely a technological tool but a transformative enabler, capable of addressing a spectrum of challenges associated with SDGs. Beyond streamlining existing processes, IoE's integration is envisioned to spark innovation, leading to the development of novel Green Sukuk goods and services that have the potential to tackle a broader array of SDG-related concerns.

The 17 Sustainable Development Goals (SDGs) set forth by the UN offer a thorough road map for tackling world issues and creating a sustainable future. Several of these objectives are met by the combination of Green Sukuk and IoE, providing a comprehensive strategy for sustainable development. For example, the global shift to sustainable energy sources is aided by the promotion of renewable energy projects through Green Sukuk, which is in line with SDG 7 (Affordable and Clean Energy). In a similar hint, SDG 9 (Industry, Innovation, and Infrastructure) is aligned with the intelligent monitoring and management enabled by IoE, which fosters innovation in sustainable projects and technical breakthroughs. SDG 17 (Partnerships for the Goals) is further supported by the interconnected IoE structure, which encourages cooperation and communication between the various parties involved in Green Sukuk projects. This alignment highlights Green Sukuk's potential for empowerment.

Even though incorporating IoE into Green Sukuk has many potential advantages, adopting and putting such a model into practice will require careful consideration of several aspects. The legal and regulatory frameworks are essential in determining how the IoE is integrated and how Green Sukuk is issued. Governments that want to implement Green Sukuk must set up legal and regulatory frameworks that encourage innovative and moral finance.

In conclusion, this research presents a compelling argument for the synergy between Green Sukuk and IoE, underscoring their collective potential to drive societal progress towards the ambitious goals outlined by the United Nations. Through careful examination, the proposal of a novel framework, and an emphasis on the transformative capacity of this consolidation, the paper contributes to the discourse on the intersection of finance, technology, and sustainability, advocating for a future that is not only economically viable but also socially and environmentally equitable. Thereby achieving Maqasid al-Shariah as decreed in the Quran.

In light of the global complexities posed by climate change, poverty, and inequality, the convergence of Green Sukuk and the Internet of Everything (IoE) presents a potentially viable avenue for tackling these multifaceted concerns. The objective of this study is to evaluate if Green Sukuk

empowered by IoE can achieve SDGS and provide a new paradigm. This study can demonstrate the potential of Islamic financing, namely through the utilisation of Green Sukuk, in mitigating the decline of severe poverty and facilitating the attainment of the Sustainable Development Goals (SDGs).

Furthermore, the technological and social preparedness of the nation's implementing Green Sukuk is essential. Key factors for effective adoption include technological infrastructure that can support Internet of Everything applications, as well as societal acceptance and comprehension of Islamic financial principles.

The research begins with a brief review of Green Sukuk and IoE before delving into the potential benefits of IoE towards empowering the Green Sukuk ecosystem. It presents earlier research papers on how digitalisation and the Internet of Things (IoT), which is a component of IoE, are already being utilised to improve the Green Sukuk market. In doing so, it contributes significantly to continuing research on the critical role of Green Sukuk in achieving global sustainability goals. The sections that follow examine the theoretical underpinnings, methodology, and literature findings that underline the need to imbue Green Sukuk with the Internet of Everything (IoE) to effectively fulfil the Sustainable Development Goals (SDGs). Finally, the study discusses the policy consequences and future research objectives.

2. Conceptual Framework

The incorporation of the Internet of Everything (IoE) into the Green Sukuk ecosystem presents a promising opportunity, as it introduces a flexible structure that can effectively monitor, analyse, and improve the efficacy of environmentally sustainable initiatives. This academic study aims to enhance the effectiveness of Green Sukuk in contributing to the attainment of the United Nations' Sustainable Development Goals (SDGs). It explores a transformative approach by integrating the Internet of Everything (IoE) into the existing ecosystem. The primary objective of this paper is to elucidate the considerable potential of the paradigm for facilitating transformative outcomes. By undertaking this endeavour, the intention is to illustrate the potential synergy between the objectives of innovation, inclusivity, and sustainability in accelerating the advancement towards the achievement of Sustainable Development Goals (SDGs).

3. Theoretical Framework

The integration field of using the Internet of Everything (IoE) to enable Green Sukuk in the pursuit of Sustainable Development Goals (SDGs) is informed by several theoretical frameworks. The theoretical foundations for our knowledge of how Islamic finance, environmental sustainability, and technology innovation intersect to support global sustainable development are examined in this section.

3.1. Islamic Finance Principles

The theoretical framework is based on the fundamental ideas of Islamic finance. As an Islamic financial product, Green Sukuk follows Sharia law and prioritises morally and socially conscious investing. A framework for sustainable and fair financial transactions is provided by the tenets of Islamic finance, which include risk-sharing, asset backing, and the avoidance of excessive uncertainty (gharar) and speculation (maisir) [21].

According to the philosophy of Islamic finance, financial transactions ought to uphold moral principles and promote the welfare of society. By its very nature, green sukuk invests money in green projects, supporting the goals of sustainable development, clean energy, and sustainable infrastructure while also conforming to the larger ideals of climate action.

3.2. The Internet of Everything (IoE)

The transformative force of technological innovation is the foundation for the adoption of IoE within the theoretical framework. According to the thesis of technological determinism, society structures and behaviours are shaped by technical progress [38]. IoE, an advancement of the Internet of Things (IoT), conforms to this notion by establishing a networked framework that connects people, things, information, and processes. IoE becomes a facilitator of communication, real-time monitoring, and intelligent decision-making in the context of Green Sukuk.

Moreover, [45] the theory of diffusion of innovations holds relevance in comprehending the possible integration of the Internet of Everything (IoE) in the Islamic finance sector. Because IoE provides real-time data, transparency, and efficiency improvements, it is in line with the characteristics that promote the spread of innovations. The IoE's adoption in the context of Green Sukuk is likely to be influenced by factors such as relative advantage, compatibility with existing practices, complexity, trialability, and observability.

3.3. Sustainable Development Goals (SDGs)

The idea of the SDGs is also incorporated into the theoretical framework as a guiding principle. The SDGs offer a thorough and internationally acknowledged road plan for tackling urgent issues including inequality, poverty, and climate change. According to Locke and Latham's (2002) goal-setting and goal-alignment theory, performance and motivation are improved by well-defined goals [35]. The linkage of Green Sukuk and IoE with certain Sustainable Development Goals (SDGs) offers a well-defined direction and purpose, inspiring stakeholders to work together for sustainable development.

In conclusion, the theoretical framework that guides the integration of IoE to support Green Sukuk in achieving the SDGs is based on the broad principles of sustainable development, Islamic financing, environmental finance, and technological innovation. With the support of IoE, Green Sukuk takes on the characteristics of these theories ethical finance, environmental stewardship, technical innovation, and the pursuit of global sustainability objectives.

4. Research Methodology

This research is conceptual and takes a multidisciplinary approach to investigating the phenomenon of endowing things with smartness, and its consequences. Owing to the diverse, recency and transcendental nature of the topic, a critical literature review on the Green Sukuk ecosystem and previously related innovation, gleaning research information about IoE is a challenge; this is compounded by the scarcity of relevant papers published in scientific management journals.

The current investigation is a qualitative research study, which entailed doing a comprehensive analysis of existing literature. This study included qualitative descriptive analysis and content analysis approaches. The research will utilise a methodological framework that involves undertaking a thorough examination of pertinent bibliographic sources to solve the research problem and achieve the stated objectives. This study combines a deductive with an inductive approach. This research follows an inductive approach through a vignette description of real examples, to both interrogate and expand on the theoretical foundations, as well as develop the researcher's understanding of smart things in the IoE. The primary aim of this study is to augment the existing knowledge base and comprehend the issues encountered by the Green Sukuk market. The potential application of the Internet of Everything (IoE) as an intermediary holds the potential for facilitating the continuous functioning of the Islamic Finance sector, guaranteeing the preservation of its ethical tenets, and promoting sustainable development goals thereby achieving Maqasid al-Shariah. This study presents a comprehensive overview of the current body of literature about the potential augmentation of the Green Sukuk ecosystem by using IoE to ensure adherence to the principles of Syariah Law. The main aim of integrating IoE into the Green Sukuk ecosystem is to support the achievement of the Sustainable Development Goals (SDGs) while also ensuring the implementation of risk mitigation measures.

The initial step of this study involves doing a comprehensive assessment of existing literature to gain a thorough understanding of the various aspects of the Islamic Finance ecosystem, with a specific emphasis on Green Sukuk. Additionally, the study aims to investigate the methods of communication and information dissemination among the diverse stakeholders within the Islamic Finance ecosystem. The study will also examine the existing system and explore the feasibility of incorporating IoE framework into the system. The focus of previous research on Green Sukuk and the application of IoE in an Islamic Finance context will be determined by retrieving information from bibliographic databases. Finally, the study will analyse the results and propose suggestions and strategies for governments, financial institutions, and producers to achieve, sustain, and enhance their Environmental and Sustainable (ESG) programs. It will also outline potential areas for future research investigations.

4.1. Literature Review

Malaysia has taken the lead in the implementation of cutting-edge instruments and solutions within the realm of Islamic finance. The nation's implementation of Islamic banking exemplifies its commitment to constructing a forward-thinking and contemporary financial system through the seamless incorporation of Islamic tenets into routine banking operations. To attain the SDGs and ESG-related objectives, Malaysia has developed a robust Islamic finance ecosystem that employs an array of technologies, procedures, and tools [46]. Fintech, value-based intermediation, zakat, sukuk, waqf, and charity crowdfunding are some examples. Moreover, Innovative financial products have arisen from the nexus of Islamic finance and sustainable development, with Green Sukuk emerging as a major player. The Internet of Everything (IoE) has been more and more integrated

into Green Sukuk initiatives in recent years, which has transformed sustainable finance. The empowerment of Green Sukuk through IoE and its role in assisting in the achievement of the Sustainable Development Goals (SDGs) are examined in this literature study.

4.1.1. Environmental Degradation

The post-industrial society is confronted with significant environmental concerns of immense magnitude. Throughout human life within the ecosystem, the post-industrial era has presented significant challenges to the planetary boundaries, resulting in an unparalleled decline in biodiversity [29]. The word 'Anthropocene' was coined by Paul Crutzen in the mid-1970s, and it is employed to describe the pollutant emissions generated as a consequence of human activity. The current state of affairs can be attributed to several contributing factors, namely individual self-interested behaviour, the prevalence of money-based usurious financial intermediation, and the separation of moral ideals in the post-industrial human relationship with the ecosystem and environment. Approximately three centuries following the advent of the Industrial Revolution, this research has successfully attained unparalleled economic expansion. Throughout the twentieth century, there was a significant increase in global population by a factor of four, while industrial output had a substantial growth of forty-fold. Conversely, there has been a significant rise in the magnitude at which environmental resources are depleted throughout production operations. In the twentieth century, the past two generations witnessed a notable surge in energy consumption, resulting in a sixteen-fold rise [29].

As per the World Health Organisation, air pollution stands as the foremost environmental health concern on a global scale at present. Global Health Organisation estimates that the combined impacts of household and ambient air pollution cause 6.7 million premature deaths annually. Globally, annual waste production is projected to increase by 73% from 2020 levels to 3.88 billion tonnes in 2050 due to urbanisation and rapid population growth; this could result in soil and waterway contamination, plant mortality, and damage to animals and humans (World Bank).

According to research published in 2020, the rate of warming in the oceans has escalated significantly over the past few decades and increased by 450% between 1987 and 2019 compared to the preceding era. In the past quarter-century, global society has deposited enough heat into the world's oceans to equal the output of 3.6 billion Hiroshima atom-bomb explosions which is equivalent to dropping approximately four Hiroshima weapons into the oceans per second [17]. Based on data released annually by the Internal Displacement Monitoring Centre, the global average annual displacement caused by natural disasters such as droughts, floods, windstorms, or earthquakes has been 26.4 million individuals since 2008.

Land degradation escalated throughout the 20th century because of escalating and interconnected pressures associated with livestock and agricultural production (overgrazing and forest conversion), urbanisation, deforestation, and extreme weather phenomena ([18];[30]), which contribute to soil salinity ([18];[30]). As 20 million hectares of arable land degenerate annually, the deterioration and desertification of the earth pose a threat to people's livelihoods on a worldwide scale. Degradation over the past four decades has turned around a third of the world's arable land into Bora [3]. All these disconcerting figures underscore the criticality of adopting proactive measures to revolutionise production, consumption, and lifestyle. Modifications to food production, business processes, and technical capabilities are required. For society to develop a more conscientious attitude towards the environment, there must be a corresponding shift in the value system. The study will examine how an Islamic worldview fortified with IoE could assist in improving the relationship with the environment.

4.1.2. Sukuk

Sukuk, derived from the Arabic term "صكوك" which represents the plural form of "صك" (sakk), meaning a legal instrument, deed, or cheque, serves as a financial certificate in the Islamic financial system, functioning as a counterpart to conventional bonds. The fundamental underpinning of Islamic finance resides in the imperative to eradicate the presence of both interests, commonly referred to as riba, and uncertainty, known as gharar, within the realm of financial transactions. To address this requirement, sukuk was introduced as a viable means of securing funding that aligns with the principles of Shari'a law. According to Islamic jurisprudence, the practice of charging or receiving interest, as well as engaging in trade characterised by excessive uncertainty and ambiguous outcomes, commonly referred to as "gharar" or gambling, is strictly prohibited [22].

Sukuk, by the principles and concepts sanctioned by the esteemed Shariah Advisory Council Malaysia (SAC), as per the authoritative Securities Commission Malaysia (SC), are certificates of equal value that serve as a testament to undivided ownership or investment in assets. Sukuk, as per the definition provided by the Accounting and Auditing Organisation for Islamic Financial Institutions (AAOIFI), refers to securities of uniform value that represent individual ownership interests

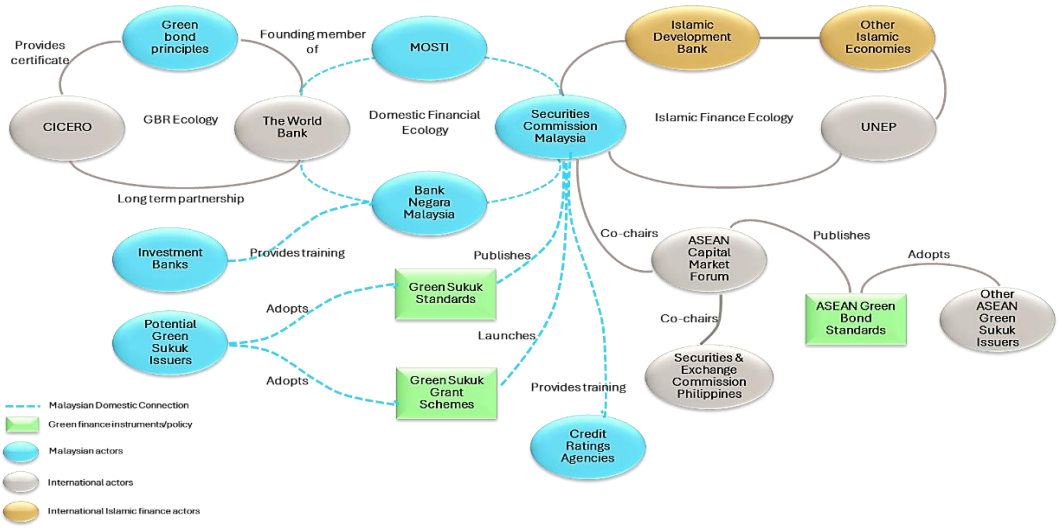
in a collection of present or future assets that fulfil the specified eligibility requirements [1]. The aforementioned definition garners substantial support within the scholarly literature, as evidenced by the works of Hassan et al. (2018), Ahmed and Elsayed (2018), and Asutay and Hakim (2017).

Sukuk, subsequently, is an Islamic financial product that allows investors to generate returns on their investments in a manner consistent with the principles of Islamic Shariah. It functions similarly to asset-backed securities. It can be designed with a structured framework that provides a predetermined return, much to the interest received from a traditional bond. However, unlike bondholders, Sukuk holders are granted an ownership stake in the assets or business that is being funded. The return on Sukuk is contingent upon the performance of the underlying assets, rather than being interest-based.

Fitch Ratings has projected that Islamic banks will maintain a growth advantage over conventional banks due to the adoption of Sharia-compliant services, the supportive regulatory environment, and the presence of an Islamic finance ecosystem within the country. In the year 2022, Islamic financing experienced a notable increase, reaching its highest level in five years at 13%. This growth may be attributed to a strong economic recovery, primarily fueled by an extended rise in working capital loans and a stable household sector. The aforementioned development has reinforced Malaysia's standing as the third-largest global market for Islamic banking. The proportion of Islamic financing in the whole portfolio of banking system loans increased from 38%, after 2021, to 41% by the conclusion of 2022. Malaysia's sukuk market is recognised globally for its established status and significant contribution, with sukuk accounting for around 64% of the total local outstanding issue as of November 2022.

4.1.3. Green Sukuk

Emerging economies have seen significant expansion in green bond markets, which finance green infrastructure like renewable energy, green housing, and low-carbon transportation [15]. Islamic scholars, financial practitioners, and environmental think tanks argue that Islamic finance is inherently compatible with green finance, which seeks to channel investments for environmental benefit. Wasatiyyah demands avoiding waste, luxury, and corruption to sustain mizan (the natural state of the world). Fasad (promoting disorder) and unethical transactions including interest/usury (riba), uncertainty or deceitful contracts (gharar), and gambling (maysir) are forbidden in Islam [41]. This framework requires enterprises to provide people's demands within a sustainable and efficient economy. Thus, financial operations that cause disorder, particularly environmental degradation, are illegal ([38] and [41]). Islamic scholars say that Sharia and environmental sustainability need Islamic finance to contribute to environmental conservation and climate action in the face of climate change, environmental degradation, and humanitarian disaster [38]. Green sukuk, with its structural requirements and concept of expressing economic, environmental, and Islamic principles, may solve some challenges confronting green finance.



Source: Adapted from Liu, F. H., & Lai, K. P. (2021)

Figure 1. The financial ecologies of green sukuk in Malaysia

Through the development of green Islamic finance markets, the World Bank Group Knowledge and Research Hub, Bank Negara Malaysia, and the Securities Commission have been working together to promote the Malaysia Green Finance Programme since 2016. This program's overarching goal is to increase financing for environmentally friendly projects. In 2017, with help from the programme, the first Green Sukuk was issued, raising USD 59 million to fund a solar power plant in Malaysia. With its initiative to launch novel Green Sukuk projects, Malaysia became the pioneer in Green Sukuk issuance [33]. These efforts serve as a conduit for sukuk to be invested in ways that prioritise addressing societal and environmental concerns. Therefore, Green Sukuk play a vital role in bridging the gap between infrastructure development and the field of economically viable practices that give top priority to environmental concerns by Shariah Law. Figure 1 demonstrates the Green Sukuk ecosystem in Malaysia.

According to the World Bank, whilst acting as a bridge between conventional and Islamic finance, the adoption of Green Sukuk can make substantial progress towards the achievement of diverse Sustainable Development Goals including SDG3 pertains to the promotion of good health and well-being, SDG4 focuses on the provision of quality education, SDG6 emphasises the importance of clean water and ınfrastructure, SDG7 underscores the need for affordable and clean energy, SDG8 centres around fostering decent work and economic growth, SDG9 highlights the significance of ındustry, ınnovation and ınfrastructure, SDG11 addresses the creation of sustainable cities and communities, SDG12 advocates for responsible consumption and production, and finally, SDG13 underscores the imperative of climate action [7].

Furthermore, Bank Negara Malaysia Assistant Governor, in a Bloomberg report (March 2022) reiterated, "*We see Islamic finance with the potential to play a significant part in supporting the sustainable development goal (SDG) commitments. A large financing gap needs to be filled to realize the SDGs in developing nations, which is estimated to be between US$2.5 trillion to US$3 trillion annually. OIC countries alone need about US$1 trillion annually to implement the SDGs. In Malaysia, green and SRI sukuk issuances have served as a bridge between Islamic finance and sustainable investment. As of February 2021, a total of US$2 billion green and SRI sukuk has been issued since its launch in 2014*."

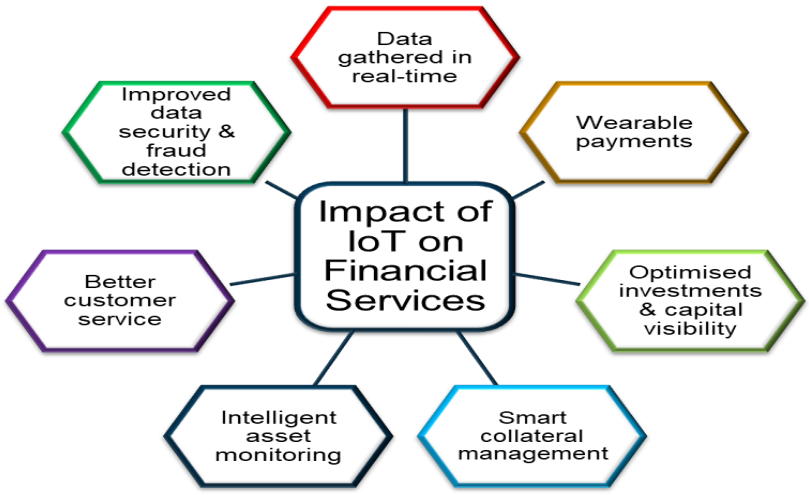
The Global Green Bond Market: Size & Forecast with Impact Analysis of COVID-19 (2021-2025) report highlights the global trend of increasing demand for green, social, and sustainability bonds. This surge in demand can be attributed to various factors such as the growing need for renewable energy, clean drinking water, and sanitation ([19] and [4]). Additionally, there is a rising concern over CO2 emissions, an increased awareness about forest conservation, and the rapid growth of the urban population worldwide [40]. Islamic green financing is experiencing a notable increase as a growing number of investors are redirecting their capital towards business models that prioritise sustainability. According to Fitch Ratings, Environmental, Social, and Governance (ESG), sukuk had robust expansion during the second quarter of 2023, with a total outstanding value of USD 30.5 billion. Being part of ESG Sukuk, Green Sukuk is also seen to be rising. This represents a quarter-on-quarter increase of 22%. It is projected that the proportion of ESG sukuk will surpass 7.5% of the total outstanding sukuk globally within the following five years, with a recorded percentage of 3.8% in the first half of 2023 [24]. The observed growth aligns with the constant pattern observed during the previous five-year period. It is worth mentioning that Malaysia has emerged as one of the leading countries in sukuk issuance, ranking among the top three globally.

4.1.4. Overview of Internet of Things (IoT)

The acronym IoT was coined in 2013 to describe the proliferation of contemporary technologies such as embedded systems, microelectromechanical systems, Web connectivity, and cordless interaction [39]. The advent of wireless networks has enabled the integration of sensors into any object, irrespective of its dimensions, enabling it to become connected to the IoT and undergo autonomous learning and response. IoT has the potential to bring about significant changes in numerous industries, including manufacturing, healthcare, retail, ecology, finance, and more.

As per the Internet Architecture Board, the term "IoT" denotes a technological framework comprising a multitude of embedded devices that communicate via Internet Protocol Communication Services and are not under direct human control. In contrast to its previous emphasis on Internet infrastructure, there has been a shift in focus towards addressing the physical realm. This includes an expanded range of technologies such as smart factory equipment, wearable health monitors, smart home security systems, and autonomous agricultural equipment [44]. More recently, the term IoT has been used to describe the connectivity of things as "a system of uniquely identifiable and connected constituents (termed as Internet-connected constituents) capable of virtual representation and virtual accessibility leading to an Internet-like structure for remote locating, sensing, and/or operating the constituents with real-time data/information flows between them" [37]. The explosion of connectivity is subtle and often not noticeable to many people [31].

In modern financial institutions, the impact of technology transcends a single layer and affects a multitude of operational facets, including information transfer, processing, and management across multiple layers (Figure 2). The integration of devices via the Internet of Things enables smooth functioning and the exchange of data [34].



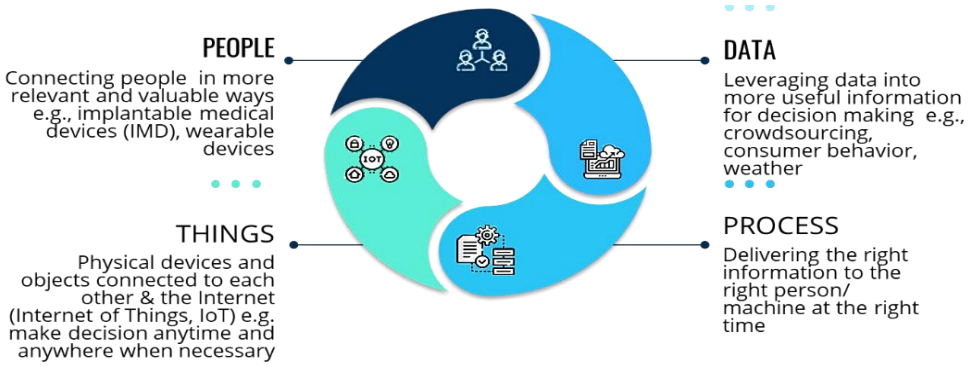
Source: Adapted from Mazlan Abbas (2023)

Figure 2. Top applications of IoT in the Financial Service Industry

4.1.5. Overview of Internet of Things (IoT) Transcending Nature

As a consequence of the worldwide health crisis precipitated by the COVID-19 pandemic, the advancement of pioneering technology has experienced a notable surge and amplification, leading to its widespread adoption by society for the facilitation of daily activities. The proliferation of connectivity is inconspicuous and frequently goes unnoticed by a significant portion of the population. According to [26], hyperconnectivity refers to a wide range of communication and interaction methods that are always available, easily accessible, filled with information, and interactive. This phenomenon facilitates connections between nearly all entities, leading to the expansion of the Internet of Things (IoT) concept into the Internet of Everything.

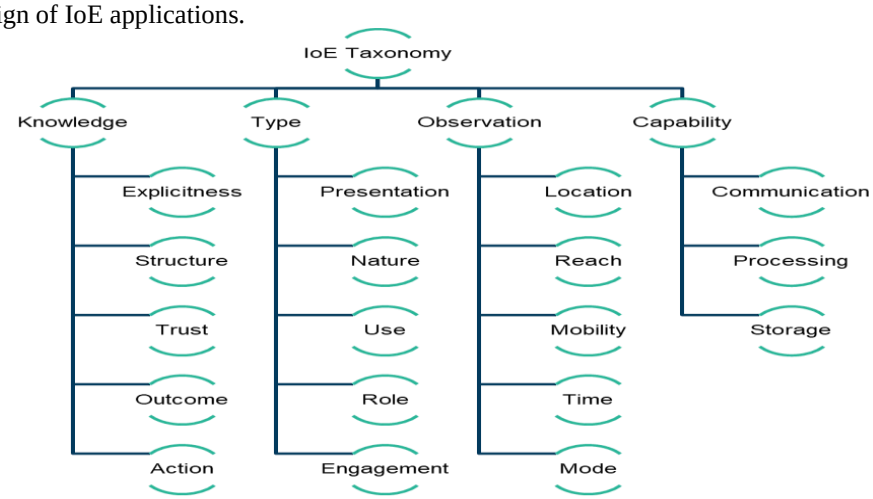
The notion of the Internet of Everything (IoE) is a broadened iteration of the Internet of Things (IoT) that encompasses linkages to data, humans, and business processes [16] that act as IoE pillars. As a result, it includes additional frameworks that are based on connectivity, such as the Internet of Things (IoT), the Internet of People (IoP), and the Industrial Internet (II) [21]. Within the context of this concept, the Internet of Everything (IoE) is understood as a complex network consisting of interconnected intelligent entities, persons, operational processes, and data, where rapid exchanges of data and information occur (Figure 3).



Source: Adapted from Bandara & Ioras (2016)

Figure 3. Pillars of IoE

In 2021, Farias da Costa et al. diagrammatically depicted the entire taxonomy of the Internet of Everything (IoE) (Figure 4). The taxonomy of the Internet of Everything (IoE) is composed of four distinct groups, each encompassing properties that are mutually exclusive and typically comprehensive. The knowledge category examines the attributes of knowledge and the value generated by applications of the Internet of Everything (IoE). It also explores the various types of sensors used in IoE applications and their associated characteristics. The observation category focuses on the methods employed to sense and collect data in IoE observations. Additionally, the capabilities of sensors are categorised into several dimensions that pertain to the technological considerations in the design of IoE applications.



Source: Adapted from Farias da Costa VC (Figure. 2)

Figure 4. Taxonomy of IoE

According to a report from Bloomberg (March 2022), Bank Negara Malaysia Assistant Governor, Adnan Zaylani Mohamad Zahid was quoted as saying, "*Islamic financial institutions should step up the adoption of emerging technologies such as artificial intelligence and big data to tap into new opportunities in under-served markets. Bank Negara Malaysia will strengthen key infrastructures to ensure the ecosystem remains vibrant for digitalization, including enhancements to the regulatory sandbox to accelerate time to market for digital innovation*."

In the field of Technology and Innovation Management, a key direction has been the new opportunities for creating value offered by digital technologies, such as those incorporated in the IoE [30]. Indeed, digital technology offers opportunities throughout the entire process of value creation and appropriation whereby it influences not only the functional level of business operations but also the strategic level of business purpose and ability to generate new value propositions [11]. Already the finance institutions understand the importance of taking care of the macro, meso and micro ecosystems however in the case of Green Sukuk it involves many institutions both domestic and international including regulators thus making it more imperative to use technology innovatively (Figure 1). It must be highlighted that implementing IoE also poses considerable challenges to firms, including the development of interoperability between systems, coping with entrenched industry partners that do not collaborate with the new developments, path-dependent legacy processes and transactions, contractual and liability issues, security challenges, loss of control, as well as privacy concerns related to the explosion of data collected and used by businesses and their smart things. For businesses, it is therefore important to understand the extent to which smart things will transform existing business models, and as a part of this, how value creation in such service ecosystems will be affected by the rise of the IoE [32]. This would critically depend on the configuration of the smart things and their capabilities.

The advent of digital platforms has facilitated remote labour and communication, as seen by the recent pandemic. According to Statistics Malaysia, firms recorded a total e-commerce income of RM279 billion in the third quarter of 2021, representing a year-on-year growth of 17.1%. Murali Raman (2022), in his study, anticipated that the metaverse, if well incorporated into corporate strategies and societal principles, will exhibit longevity akin to the rise and fall of the e-commerce "dotcom to dot-gone" phenomenon. According to [32], the Internet of Everything (IoE) serves as a means of connecting individuals, objects, data, and processes to enhance user experiences and facilitate intelligent decision-making. The integration of diverse components within the Islamic Finance ecosystem, such as the green Sukuk ecosystem, necessitates the implementation of the Internet of Everything (IoE) to achieve comprehensive connection, enhanced intelligence, and advanced

cognition. The strategy outlined in this study encompasses a multifaceted system that incorporates individuals and their behaviours [26]. The concept of the Internet of Everything comprises a diverse array of user-generated communications and activities occurring within the global network of interconnected devices. The utilisation of the Internet of Everything (IoE) technology, which is characterised by its interactive and interconnected nature, has promise in addressing various worldwide limitations. Consequently, it is seen as highly suitable for ensuring the integrity of Green Sukuk initiatives.

5. Findings and Discussion

Although efforts were made to glean more information on previous research conducted on Green Sukuk, IoT and SDGs there is currently no research published using this search string in SCOPUS. However, there is little research on Green Sukuk, digitalisation and SDGs on Google Scholar. Authors thus concluded that IoE is a relatively new framework that has not been tested in the realm of Islamic Finance and Green Sukuk. The ASEAN green standards, SRI Sukuk and sustainable investment in addition face several challenges such as messy green taxonomy, trouble in identifying green assets of projects, time consuming and costly, no compelling benefit and exposure to higher risk profiles [47].

The possible resolution of several integrity and communication challenges in Islamic Finance, particularly the timely sharing of data and information among diverse stakeholders, can be facilitated through the seamless integration of the Internet of Everything (IoE) inside the Green Sukuk ecosystem. The Internet of Things (IoT) refers to a network of physical objects equipped with sensors, software, and other technological components, enabling them to establish connections and autonomously exchange data without the need for human intervention (Shafiq, 2022). The utilisation of real-time data from the Internet of Things (IoT) facilitates the facilitation of remote office operations. The exchange of information among Internet of Things (IoT) devices, known as Machine-to-Machine (M2M) communication, offers the advantage of efficient data packet exchange via a network, resulting in time and cost savings. While the Internet of Things (IoT) primarily focuses on the interaction between individuals and objects (People-to-Things or P2T) as well as the communication between objects themselves (Things-to-Things or T2T), the concept of the Internet of Everything (IoE) encompasses the interconnection of people, objects, data, and processes. Figure 5 depicts the simplified connection paradigm proposed by the author for the Internet of Everything (IoE), which undoubtedly can potentially enhance individual experiences and decision-making by establishing uninterrupted connections among the four pillars of the Internet of Everything (IoE).

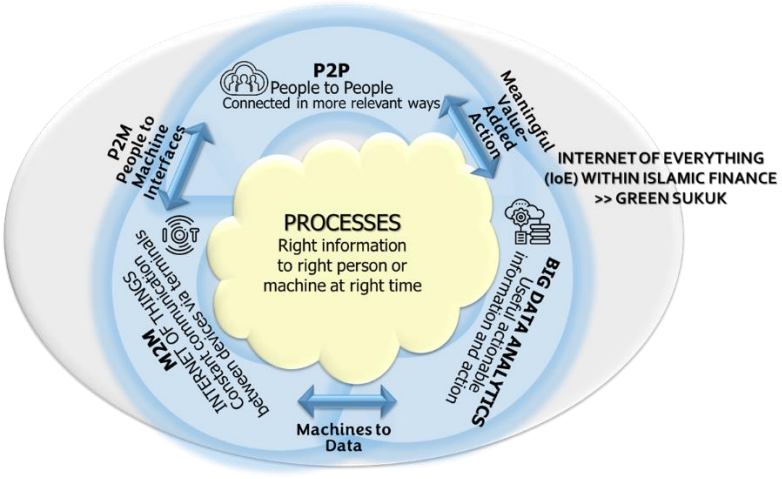


Figure 5. Proposed Model of Internet of Everything Incorporated into Islamic Finance

The Islamic Finance ecosystem, including Green Sukuk, is characterised by its broad scope, involving both domestic and international entities. Additionally, it operates within a regulatory framework overseen by relevant agencies, ensuring that transactions and communications adhere to the policies and standards prescribed by Shariah Law. Nevertheless, the incorporation of the Internet of Everything (IoE) into the Islamic Finance ecosystem would guarantee the smooth and trustworthy execution of these procedures, hence enhancing the Green Sukuk ecosystem and facilitating the achievement of Sustainable Development Goals (SDGs).

Although the incorporation of IoE in Green Sukuk exhibits great potential, it is imperative to consider certain obstacles and limitations. To effectively utilise the benefits of IoE in the context of Green Sukuk, several difficulties need to be resolved, including privacy concerns, data security, and the requirement for standardised protocols [26]. Strong cybersecurity measures are necessary to guard against any intrusions due to the sensitivity of financial transactions and environmental data.

6. Conclusions and Recommendations

In conclusion, this research searches into the transformative potential of integrating the Internet of Everything (IoE) into the realm of Green Sukuk to enhance its impact on achieving the Sustainable Development Goals (SDGs). The research recognizes the formidable global challenges posed by extreme climate change, the health crisis, wars, poverty, and inequality. The United Nations' 17 SDGs were designed to address these challenges, but the COVID-19 epidemic has set back poverty reduction progress significantly. The research posits that the combination of Islamic finance, particularly Green Sukuk, and cutting-edge technologies like IoE can offer a promising solution. Green Sukuk, based on Shariah principles, has emerged as a significant player in sustainable finance, yet its full potential remains untapped. The integration of IoE introduces a flexible and efficient framework capable of monitoring, evaluating, and enhancing the effectiveness of environmentally conscious projects, thereby accelerating progress toward SDGs.

The research methodology employed a qualitative approach, thoroughly analyzing existing literature to understand the Islamic finance ecosystem, with a focus on Green Sukuk and the potential application of IoE. The research emphasizes the importance of communication and information dissemination among stakeholders and explores the feasibility of incorporating the IoE framework. The literature review highlights Malaysia's leadership in Islamic finance, particularly in Sukuk issuance, and the global trend of increasing demand for green, social, and sustainability bonds. The observed growth in Islamic green financing aligns with the rising awareness of environmental and social issues. The findings and discussion reveal that while there is limited research on the specific intersection of Green Sukuk, IoT, and SDGs, the proposed model of integrating IoE into Islamic finance, particularly Green Sukuk, holds great potential. The seamless integration of IoE addresses issues of integrity and communication within the Islamic finance ecosystem, providing timely data and information sharing among stakeholders.

In essence, this research suggests that the wise use of private resources, combined with the application of emerging technologies like Green Sukuk and IoE, can contribute significantly to a future marked by sustainability and equity. By bridging the gap between Islamic finance and technology, this integrated approach aims to play a vital role in slowing the progression of extreme poverty and expediting the achievement of the SDGs. The proposed model presents a paradigm shift, emphasizing innovation, inclusion, and sustainability as key drivers for progress toward global sustainability goals.

Acknowledgements: The authors would like to acknowledge the financial support of this research by Universiti Sains Islam Malaysia under the Matching Grant Scheme (USIM/UNIDA/FEM/SEPADAN/72923).

References

1. AAOIFI. *Accounting and Auditing Organization for Islamic Financial Institutions's Shari'ah Standards*. (Accessed from: http://www.aaoifi.com).
2. Aassouli, D.; Shah, M. E. Aligning sustainability ıntegration, digitalization and ınclusivity for green, sustainable recovery. *Journal of Infrastructure Policy and Management* 2022, 5(1), pp. 39-47.
3. AbdelRahman, M.A.E. An overview of land degradation, desertification and sustainable land management using GIS and remote sensing applications. *Rendiconti Lincei. Scienze Fisiche e Naturali* 2023, 34, pp. 767–808. https://doi.org/10.1007/s12210-023-01155-3
4. Abdullah, M. S.; Keshminder, J. S. What drives green sukuk? A leader's perspective. *Journal of Sustainable Finance & Investment* 2022, 12(3), pp. 985-1005.
5. Ahmed, H.; Elsayed, A. H. Are Islamic and conventional capital markets decoupled? Evidence from stock and bonds/sukuk markets in Malaysia. *The Quarterly Review of Economics and Finance* 2019, Volume 74, pp. 56-66.
6. Alam, N., Duygun, M.; Ariss, R. T. Green sukuk: an innovation in ıslamic capital markets. In A. B. -Dorsman, Ö. Arslan-Ayaydin, & M. B. Karan (Eds.), Energy and finance. *Springer International Publishing* 2016, pp. 167–186.
7. Araminta, D. V.; Timur, Y. P. The Role of Green Sukuk in Realızıng the Sustaınable Development Goals 2030 Agenda. *Jurnal Ekonomi & Bisnis Islam* 2022, Volume 8, Issue 2.
8. Asutay, M., & Hakim, A. Exploring international economic integration through sukuk market connectivity: A network perspective. *Research in International Business and Finance* 2018, Volume 46, pp. 77-94.
9. Bandara, I., & Ioras, F. The evolving challenges of internet of everything: enhancing student performance and employability in higher education. In INTED2016 Proceedings 2016, pp. 652-658
10. Bansal, N. *IoT Applications in Financial Services. In: Designing Internet of Things Solutions with Microsoft Azure*. Apress, Berkeley, CA, , 2020. https://doi.org/10.1007/978-1-4842-6041-8_10

11. Barrett, M.; Davidson, E.; Prabhu, J.; Vargo, S. L. Service innovation in the digital age. *MIS Quarterly* 2015, Volume 39, Issue 1, pp. 135-154.
12. Belmontes, M.; Kramarz, B. *H1* populated by ESG Sukuk featuring offshore centers Islamic Finance News, 2023, Volume 20, Issue 30 (Accessed from: https://www.mondaq.com/islamic-finance/1358358/h1-2023-populated-by-esg-sukuk-featuring-offshore-centers#:~:text=During%20H1%202023%2C%20Fitch%20Ratings,quarter%2Don%2Dquarter%20increase.)
13. BIXMalaysia. *What is Sukuk?* (Retrieved from: https://www.bixmalaysia.com/learning-center/articles-tutorials/what-is-sukuk)
14. Bloomberg. Malaysia Seeks Sustainable Lead to Drive Islamic Finance Growth, 2022. (Retrieved from: https://www.bloomberg.com/news/articles/2022-03-24/malaysia-seeks-sustainable-lead-to-drive-islamic-finance-growth?embedded-checkout=true)
15. Climate Bond Initiative (CBI). *Bonds and Climate Change: State of the Market*, 2018. Available at: https://www.climatebonds.net/resources/reports/green-bonds-state-market-2018.
16. Charmonman, S.; Mongkhonvanit, P. Special consideration for big data in IoE or Internet of Everything. In 2015 13th International Conference on ICT and Knowledge Engineering (ICT & Knowledge Engineering 2015), *IEEE* 2015, pp. 147-150.
17. Cheng, L.; Abraham, J.; Zhu, J. Record-setting Ocean Warmth Continued in 2019. *Advances in Atmospheric Sciences* 2020. 37, pp. 137–142. https://doi.org/10.1007/s00376-020-9283-7
18. Delang CO. The consequences of soil degradation in China: a review. *GeoScape* 2018, Volume 12, Issue 2, pp. 92–103. https://doi.org/10.2478/geosc-2018-0010
19. Delle Foglie, A.; Keshminder, J. S. Challenges and opportunities of SRI sukuk toward financial system sustainability: a bibliometric and systematic literature review. *International Journal of Emerging Markets* 2022.
20. Di Martino, B.; Li, KResearchL.T.; Esposito, A. *Trends and Strategic Researches in Internet of Everything*. In: Di Martino, B., Li, KC., Yang, L., Esposito, A. (eds) Internet of Everything. Internet of Things. Springer, Singapore, 2018. (Retrieved from: https://doi.org/10.1007/978-981-10-5861-5_1.)
21. El-Hawary, D., Grais, W., & Iqbal, Z. Diversity in the regulation of Islamic financial institutions. The Quarterly Review of Economics and Finance 2007, Volume 46, Issue 5, pp. 778-800.
22. El Shazly, M. R.; Tripathy, P. Sukuk structures, profiles and risks. Paper of Columbia College, 2013, pp. 1-18.
23. Farias da Costa VC; Oliveira L; de Souza J. Internet of Everything (IoE) Taxonomies: A Survey and a Novel Knowledge-Based Taxonomy. *Sensors.* 2021, Volume 21, Issue 2, pp. 568. https://doi.org/10.3390/s21020568
24. Fitch Rating ESG-Sukuk Strengthening as Pivot Towards Sustainability Grows (Accessed from: https://www.fitchratings.com/research/non-bank-financial-institutions/esg-sukuk-strengthening-as-pivot-towards-sustainability-grows-08-08-2023)
25. Fredette, J.; Marom, R.; Steinert, K.; Witters, L. The promise and peril of hyperconnectivity for organizations and societies. The Global Information Technology Report. *World Economic Forum*, 2012. https://www3.weforum.org/docs/GITR/2012/GITR_Chapter1.10_2012.pdf
26. Hamid, F. A., Ali, M. J., & Abdul Hamid, A. Internet of Everything (IoE) and its potential application in Islamic finance: A conceptual framework. In Advances in Human Factors, Business Management and Society 2022, pp. 147-155. Springer.
27. Hassan, M. K., Aliyu, S., Paltrinieri, A., & Khan, A. A review of Islamic investment literature. *Economic Papers: A journal of applied economics and policy* 2019, Volume 38, Issue 4, pp. 345-380.
28. Internal Dispalcement Monitoring Centre (website: https://www.internal-displacement.org/)
29. Ismail, A. G.; Shaikh, S. Role of Islamic Economics and Finance in Sustainable Development Goals, 2017. DOI: 10.13140/RG.2.2.14806.09288. (Retreived from: https://www.researchgate.net/publication/333103001_Role_of_Islamic_Economics_and_Finance_in_Sustainable_Development_Goals)
30. Janečková M. K.; Sklenička P.; Bohnet I. C.; Lowther-Harris F.; van den Brink A.; Movahhed Moghaddam S.; Fanta V.; Zástěra V.; Azadi H. Impacts of land consolidation on land degradation: a systematic review. *J Environ Manage*, 2023, 329:117026. (Retrieved from: https://doi.org/10.1016/j.jenvman.2022.117026. (PMID: 36608617)
31. Keen, P.; Williams, R. Value architectures for digital business: beyond the business model. MIS quarterly, 2013, Volume 37, Issue 2, 643-647.
32. Langley, DJ.; Doorn, JV; Ng, ICL.; Stieglitz, S.; Lazovik, A.; Boonstra, A. The Internet of Everything: Smart things and their impact on business models, *Journal of Business Research* 2021, Volume 122, Pp 853-863, ISSN 0148-2963, (Retrieved from: https://doi.org/10.1016/j.jbusres.2019.12.035.)
33. Lim, A., Jensen, D., and Rahman, ZA. Facilitating SDGs with Islamic Finance (Part1) Malaysia's Leadership in Sukuk An INFAC Content Series Internation Federation of Accountants 2022.
34. Liu, F. H., & Lai, K. P. Ecologies of green finance: Green sukuk and development of green Islamic finance in Malaysia. *Environment and Planning A: Economy and Space* 2021, Volume 53, Issue 8, pp. 1896-1914.
35. Locke, E. A., & Latham, G. P. Building a practically useful theory of goal setting and task motivation: A 35-year odyssey. American Psychologist 2002, Volume 57, Issue 9, pp. 705-717.
36. Maiti M, Ghosh U. Next generation Internet of Things in fintech ecosystem. *IEEE Internet Things Journal* 2021. doi: 10.1109/JIOT.2021.3063494.
37. Mazlan Abbas. Empowering Financial Services with IoT: Top Applications 2023. (Available at: https://iotworld.co/2023/10/empowering-financial-services-with-iot-top-applications/)
38. McLuhan, M. Understanding media: The extensions of man. New York: McGraw-Hill 1964.
39. Musari, K., Hidayat, S.E. The Role of Green Sukuk in Maqasid Al-Shariah and SDGs: Evidence from Indonesia. In: Jumat, Z.r., Hafiz Khateeb, S., Nazim Ali, S. (eds) Islamic Finance, FinTech, and the Road to Sustainability. Palgrave CIBFR Studies in Islamic Finance. Palgrave Macmillan, Cham 2023. https://doi.org/10.1007/978-3-031-13302-2_9
40. Ng, I.C.L. and Wakenshaw, S.Y.L. The Internet-of-Things: Review and Research Directions. *International Journal of Research in Marketing* 2017, Volume 34, Issue 1, pp. 3-21 (Retrieved from: https://doi.org/10.1016/j.ijresmar.2016.11.003)
41. Obaidullah, M. Managing climate change: The role of Islamic finance. *IES journal Article* 2018, Volume 26, Issue 1.
42. Prasanthi, D., & Kumar, B. Design And Implementation Of High Security BankingSystem By Using Iot Technology, *International Journal of InnovativeTechnology and Research* 2019, Volume 7, Issue 5.
43. Rahman, A., Hanife, M. A., Ab Halim, A. H., & Markom, R. The Challenges of Green Sukuk Policy Implementation for Achieving Sustainable Environment. *Malaysian Journal of Social Sciences and Humanities* 2022, 7(11), e001987-e001987.
44. Responsible Finance Institute (RFI). Environmental Impact in Islamic Finance, 2018. Available at: http://report.rfi-foundation.org/download.html.
45. Rogers, E. M. Diffusion of innovations. New York: Free Press 1962.

46. Rosman, R.; Redzuan, NH; Mokhtar, NZN.; Alid, ERAE; Mohammed, MO. Islamic Social Finance and Sustainable Development Goals: Issues and Challenges. *Journal of Islamic Finance* 2022, Volume 11, Issue 2; pp56-67 ISSN 2289-2117 (O) / 2289-2109 (P) (Retrieved from: https://journals.iium.edu.my/iiibf-journal/index.php/jif/article/download/690/295)
47. Saba, I., Khan, A., Jawed, H. Islamic Finance and SDGs: connecting dots. In: Hassan, M.K., Saraç, M., Khan, A. (eds) Islamic Finance and Sustainable Development . Palgrave Macmillan, Cham, 2021. https://doi.org/10.1007/978-3-030-76016-8_4
48. Sadiq, A. S., Dehkordi, A. A., Mirjalili, S., Too, J., & Pillai, P. Trustworthy and efficient routing algorithm for IoT-FinTech applications using non-linear Lévy Brownian generalized normal distribution optimization, 2021.
49. Tahmoures, A. A. Compare and contrast Sukuk (Islamic Bonds) with conventional bonds, Are theycompatible? *The Journal of Global Business Managemen*t 2013, Volume 9, Issue 1, pp. 44–52. (Retrieved from: http://www.jgbm.org/page/5%20Tahmoures%20A%20%20Af-shar.pdf)
50. World Bank (Retrieved from: https://www.worldbank.org/en/topic/urbandevelopment/brief/solid-waste-management)